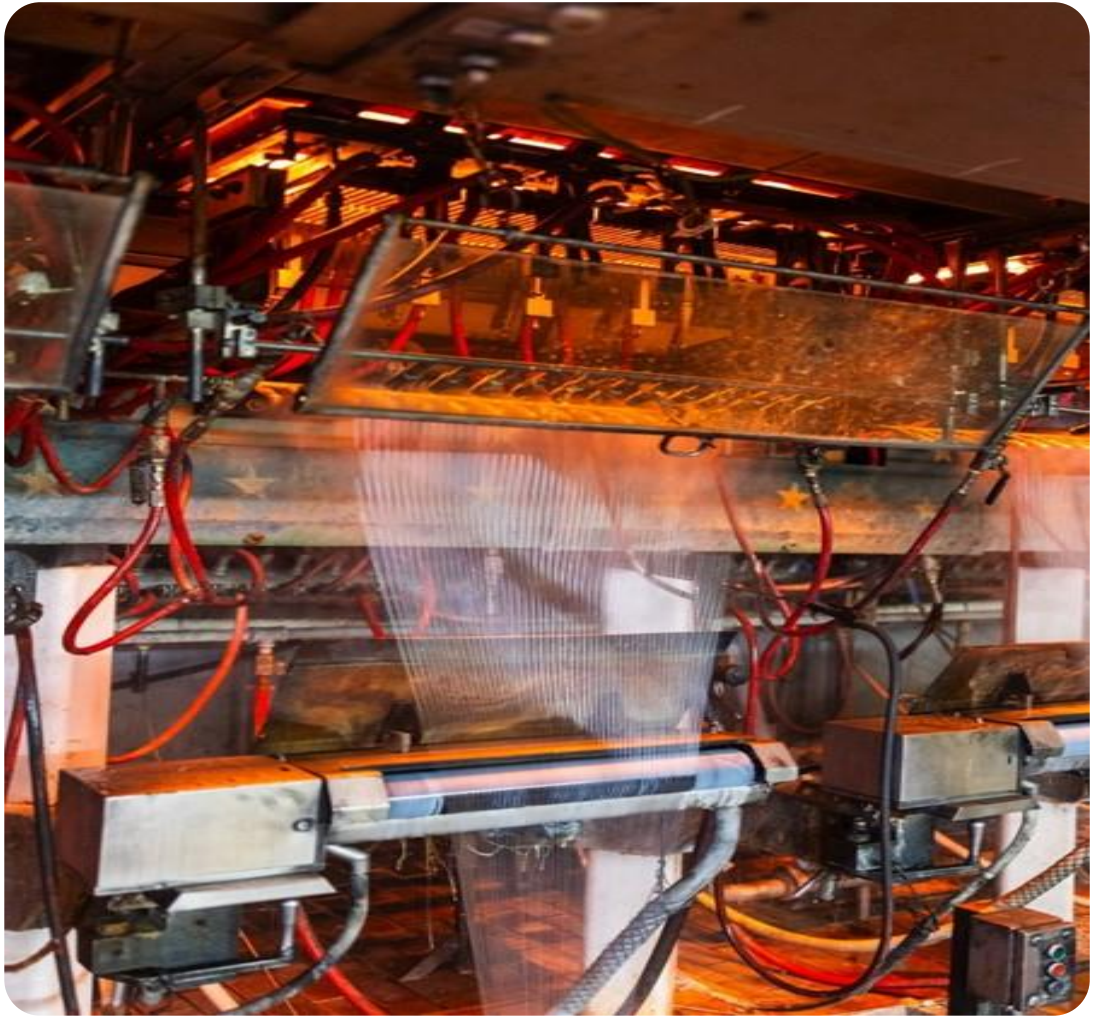
The Original Composites Company™

WHO IS THE ORIGINAL COMPOSITES COMPANY?

https://www.compositesworld.com/articles/what-is-the-future-for-owens-corning-glass-reinforcements



GLASS REINFORCEMENTS AT A GLANCE

COMPOSITES PIONEER & MOST EXPERIENCED SUPPLIER TO INDUSTRY

$1.3b*

2024 REVENUE

4,000+

EMPLOYEES

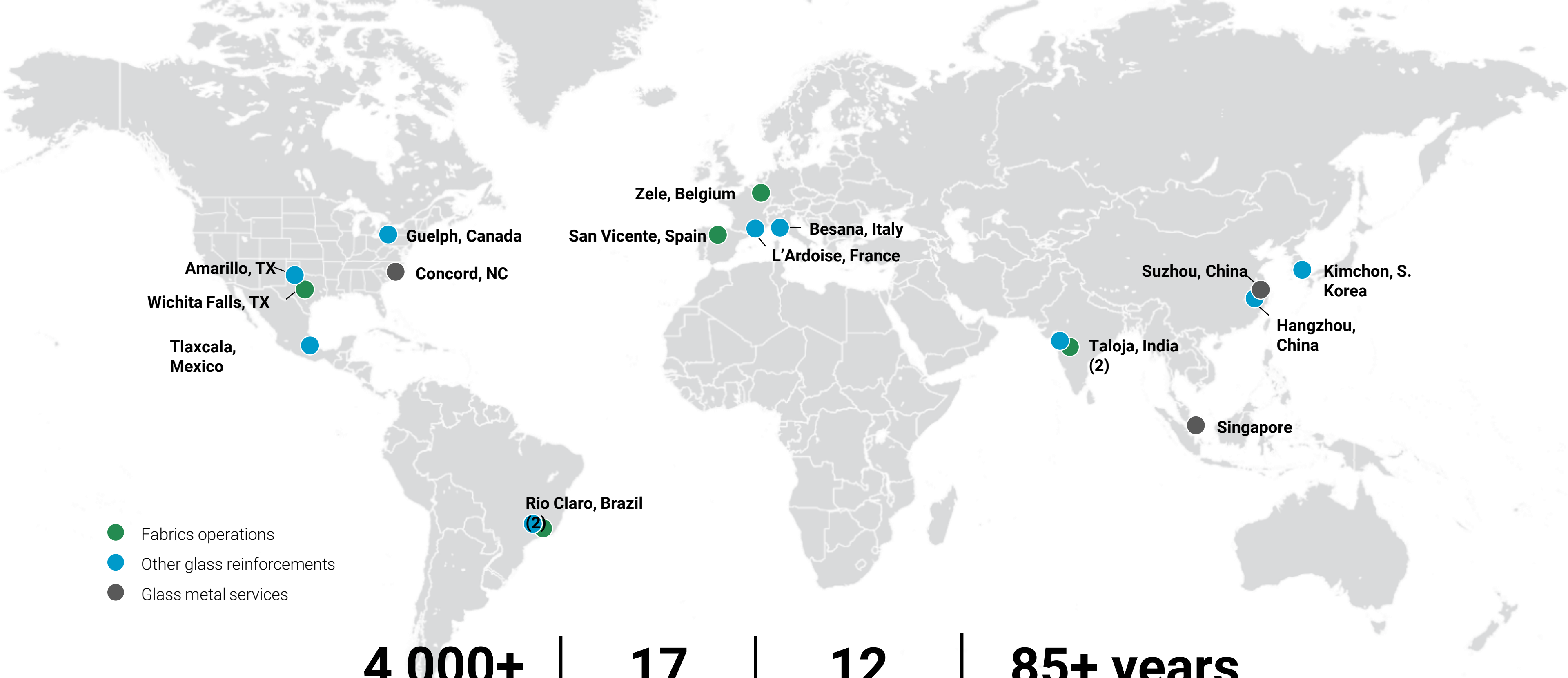
12

COUNTRIES WHERE WE OPERATE

MAKE MORE POSSIBLE™

* Revenue reflects full chain margin view of Glass Reinforcements and the revenue of Glass Metal Services

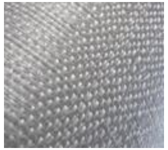
THE INDUSTRY'S MOST DIVERSE FOOTPRINT



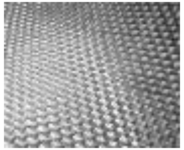
4,000+ EMPLOYEES | **17** FACILITIES | **12** COUNTRIES | **85+ years** of Glass Fiber Innovations

MAKE MORE POSSIBLE™

WHAT WE MAKE IN OUR 1.0M TONS OF GLASS FIBER



Knitted fabrics
Wind, pipe, thermoplastic composites, industrial, recreational



Woven fabrics
Wind, pipe, thermoplastic composites, industrial, recreational

Complexes
Wind, pipe, thermoplastic composites, industrial, recreational

Continuous filament mat
Marine, transportation, construction

Chopped strand mat
Marine, transportation, recreation, corrosion resistance, construction

Continuous Fiber Type 30® single end roving
Chemical and sewage, oil, water processing (pipe and tanks), industrial (high-pressure vessels, pultruded items), wind energy, aerospace, ballistics, transportation (muffler filling), electrical (optical cable)

Continuous fiber multi-end roving
Construction (panels and translucent panels), corrosion resistant pipe and tanks, consumer (sanitary, recreational vehicles), transportation (headliner, body parts, semi-structural parts)

Chopped strand, dry-use
Automotive applications, electrical applications and industrial specialties

Chopped strand, wet-use
Building products (roofing and gypsum), industrial specialties

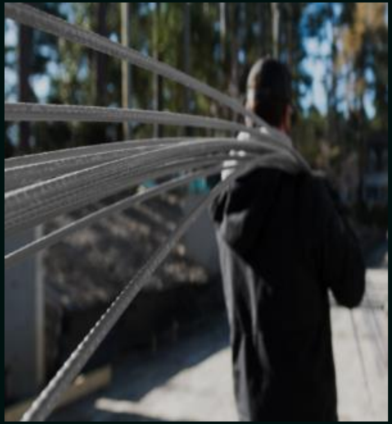
MAKE MORE POSSIBLE™

The Original Composites Company™

HOW TO GUARANTEE 100YRS CONSTRUCTION LIFE FOR REINFORCED CONCRETE STRUCTURES

Eng.Ph.D. Paolo Casadei

Business Development Leader Europe




20
22


SERVICE LIFE OF STRUCTURES GREATLY REDUCED BY CORROSION

Remedial for existing reinforced concrete structures so far?

Chlorides from air-borne salt or seawater penetrate concrete and reach steel rebar:

- Via concrete porosity
- Via cracks

Traditional corrosion mitigation efforts center on keeping chlorides from getting to the reinforcing steel or simply delaying the time:

- Admixtures
- Increase Concrete Cover
- Alter Concrete Mix
- Membranes & Overlays
- Epoxy coated or Stainless Steel

All these remedies add costs as well as reduce sustainability efforts for greener structures

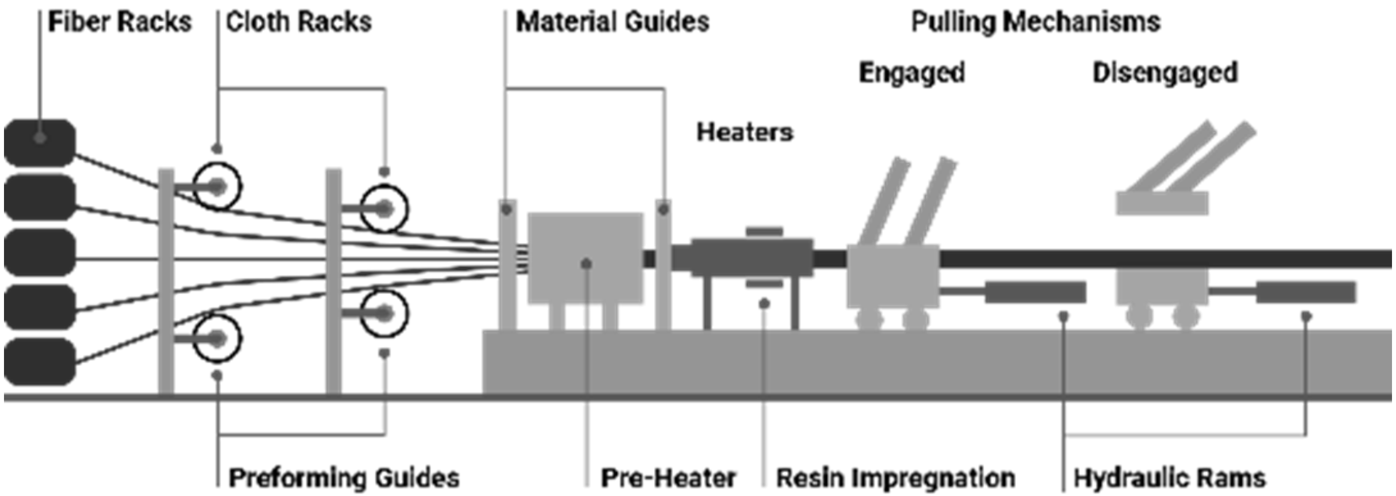
MAKE
MORE
POSSIBLE™

The Original Composites Company™

WHAT ABOUT GFRP REBARS?

GFRP REBARS ARE MADE USING A PULTRUSION PROCESS

ADVANTEX T30 roving is used by many GFRP rebar manufacturers worldwide



MAKE
MORE
POSSIBLE™

FIBERGLASS – GFRP REBAR

What is it?

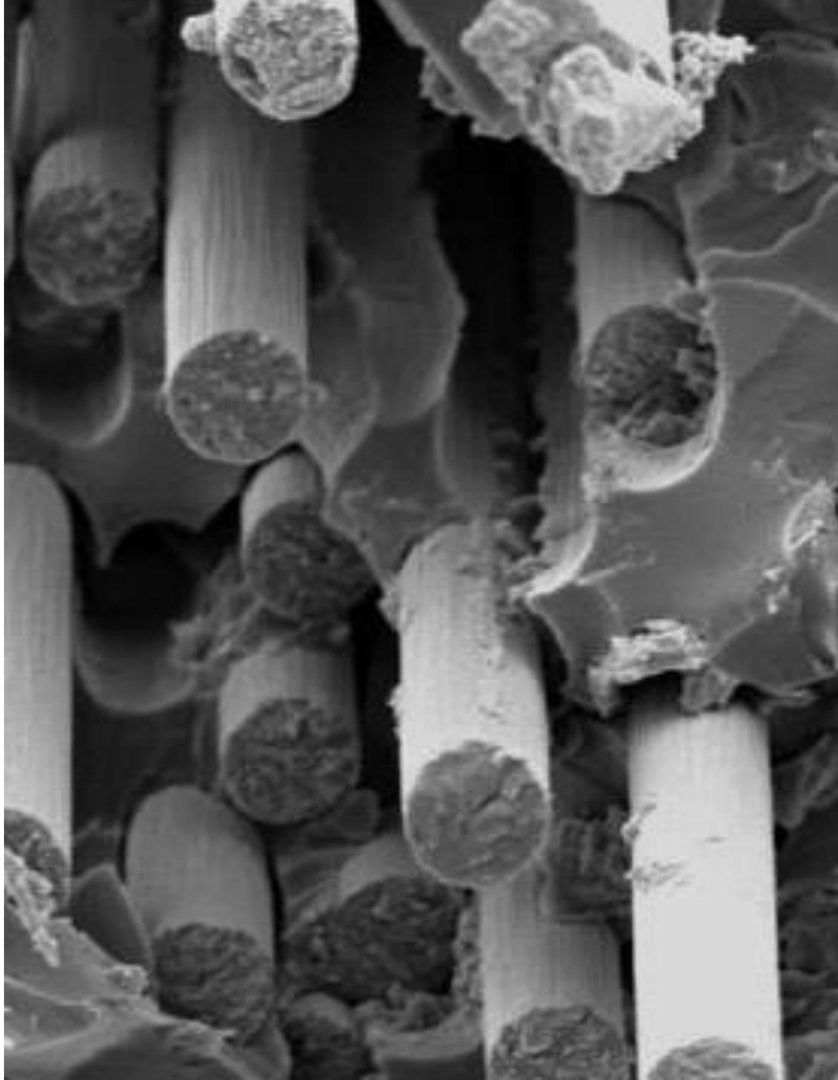
- Fiberglass rebar is a composite material made of two non-metallic components and is used for concrete reinforcing.

  - **Fiber - Structural carrying constituent**
    - **E-CR Glass**

    Provides to the mechanical performances of the rebar in terms of ultimate tensile capacity and E modulus.

  - **Matrix - Binder**
    - **Thermoset**
      - **Vinyl Ester**
      - **Epoxy**
    - Thermoplastic

    Provides protecting the fibers from alkali degradation and guarantee long term durability in addition to determining composite action between glass fibers and resin.

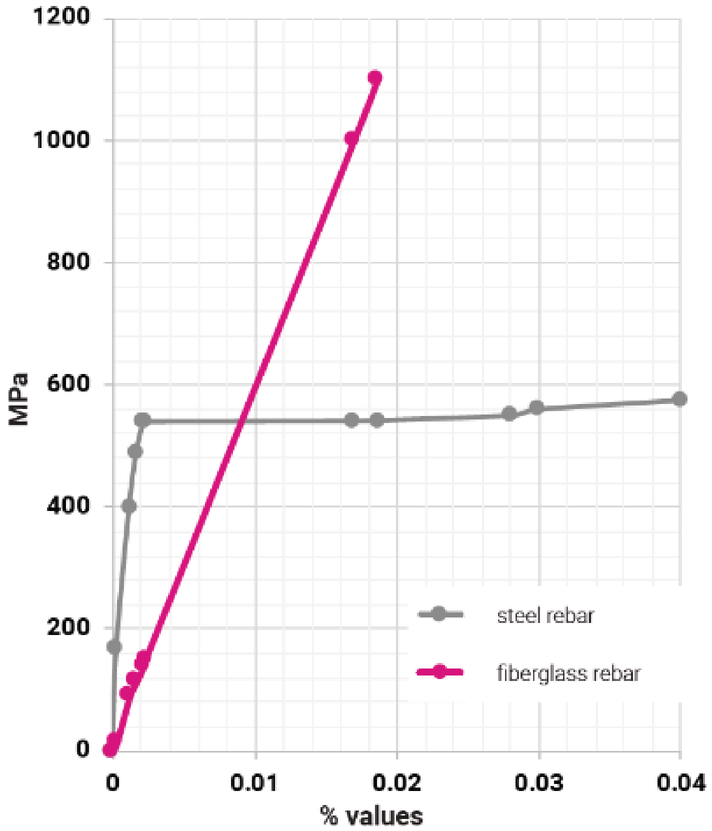


MAKE MORE POSSIBLE™

FIBERGLASS – GFRP REBAR

Mechanical properties of GFRP vs Steel

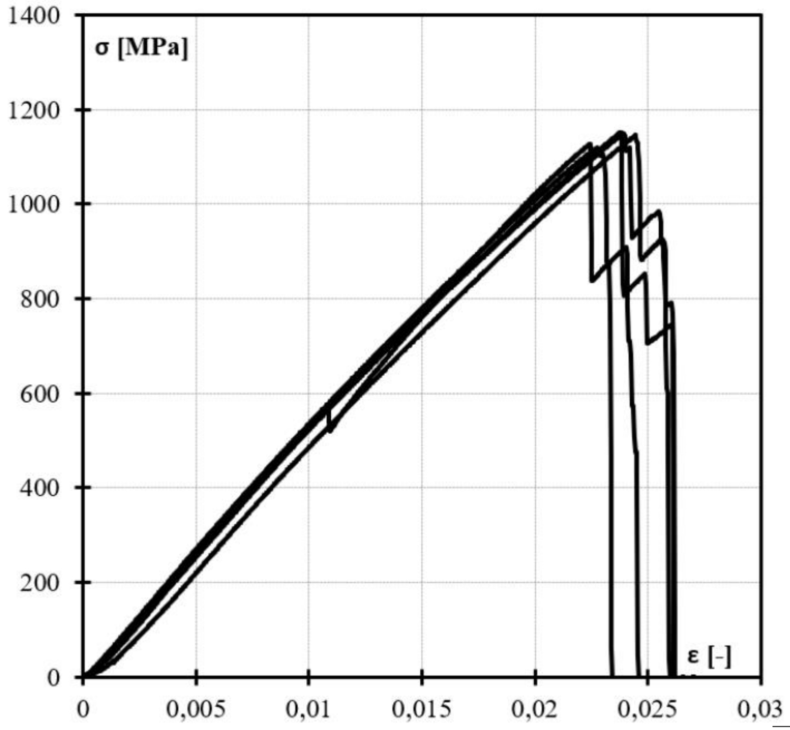
- **GFRP rebars are anisotropic materials;** for such reason its tensile properties are not comparable to its transverse ones
- **Fiberglass Rebars are Linear Elastic up to failure**
    - 2,5x tensile strength of steel (≈1000Mpa)
    - No yielding.
- **End State Failure Mode:**
    - Steel – Yielding of Reinforcement
    - Fiberglass Rebar – Concrete Crushing
    - Warning signs present: Large deformability (significant deflection or crack widths) are visible indicators of pending failure.
- **Lower Modulus of Elasticity**
    - Serviceability issues such as deflections and crack widths typically governs the Fiberglass Rebar layout
    - E GFRP (≈ 50GPa) = 1/4 E steel (≈ 200GPa)



MAKE MORE POSSIBLE™

FIBERGLASS – GFRP REBAR

Mechanical properties of GFRP for laboratory testing



T_MATEENBAR_Φ19_B2

University of Naples "Federico II"
Department of Structures for Engineering and Architecture

Table 2 - Tabulated results

Line #	ID Specimen	A_{tot} mm²	F_u kN	f_{ft} MPa	EA kN	E_f GPa	ε_{ft} %
1	Φ19_B1_01	277,43	328,61	1184	13051	47,04	2,52%
2	Φ19_B1_02	277,43	321,72	1160	13538	48,80	2,38%
3	Φ19_B1_03	277,43	326,87	1178	15334	55,27	2,13%
4	Φ19_B1_04	277,43	314,52	1134	12796	46,12	2,46%
5	Φ19_B1_05	277,43	328,43	1184	14323	51,63	2,29%
6	Φ19_B2_01	277,43	312,90	1128	15126	54,52	2,07%
7	Φ19_B2_02	277,43	317,70	1145	14406	51,93	2,21%
8	Φ19_B2_03	277,43	310,32	1119	15235	54,91	2,04%
9	Φ19_B2_04	277,43	319,68	1152	14675	52,90	2,18%
10	Φ19_B2_05	277,43	318,66	1149	14410	51,94	2,21%
11	Φ19_B3_01	277,43	310,32	1119	14822	53,43	2,09%
12	Φ19_B3_02	277,43	323,03	1164	13433	48,42	2,40%
13	Φ19_B3_03	277,43	319,68	1152	13629	49,13	2,35%
14	Φ19_B3_04	277,43	302,83	1092	14112	50,87	2,15%
15	Φ19_B3_05	277,43	311,70	1124	14847	53,52	2,10%
16	Φ19_B4_01	277,43	342,82	1236	14308	51,57	2,40%
17	Φ19_B4_02	277,43	330,95	1193	14714	53,04	2,25%
18	Φ19_B4_03	277,43	321,12	1157	13262	47,80	2,42%
19	Φ19_B4_04	277,43	316,74	1142	13133	47,34	2,41%
20	Φ19_B4_05	277,43	327,59	1181	13048	47,03	2,51%
21	Φ19_B5_01	277,43	325,37	1173	13774	49,65	2,36%
22	Φ19_B5_02	277,43	317,82	1146	14514	52,31	2,19%
23	Φ19_B5_03	277,43	308,83	1113	15732	56,71	1,96%
24	Φ19_B5_04	277,43	313,02	1128	14619	52,70	2,14%
25	Φ19_B5_05	277,43	331,01	1193	13929	50,21	2,38%
	Average		320,09	1154	14191	51,15	2,26%
	St. Dev.		8,85	32	804	2,90	0,16%
	C.O.V. (%)		2,77%	2,77%	5,66%	5,66%	6,93%
	Characteristic		304,64	1098	12789	46,10	1,99%

Average	320,09	1154	14191	$\boxed{51,15}$	2,26%
St. Dev.	8,85	32	804	2,90	0,16%
C.O.V. (%)	2,77%	2,77%	5,66%	5,66%	6,93%
Characteristic	304,64	$\boxed{1098}$	12789	46,10	$\boxed{1,99\%}$

MAKE MORE POSSIBLE™

PULTRON'S MATEENBAR

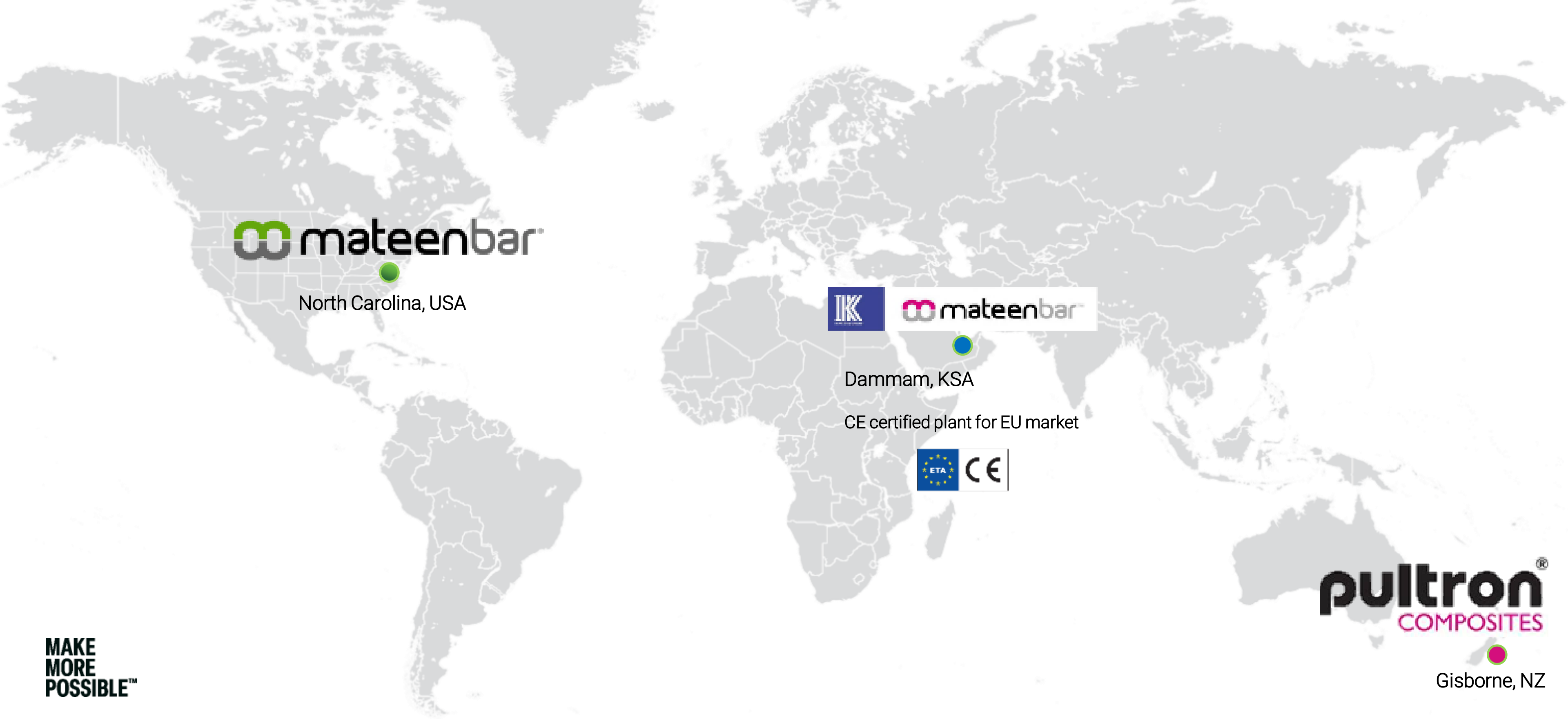
Best GFRP rebar worldwide

- **Pultron**® **Composites** is at the forefront of pultrusion technology, developing high-performance glass fiber-reinforced polymer (GFRP) composites that industry leaders are turning to.
- **Mateenbar**™ was developed at **Pultron**® with decades of product development experience in construction, mining, and infrastructure composites. Possessing a deep understanding of these industries, the team developed fiberglass rebar to meet the highest standards required by leading engineering bodies and transportation departments worldwide.
- Completed technology transfers to North Carolina (USA) and Dammam (Saudi Arabia) on the back of the success of concrete reinforcement development, **Mateenbar**™.
- The **Original Composites Company** (i.e. Owens Corning Glass Reinforcement) has signed strategic agreement to play the role of exclusive distributor in Europe of **Mateenbar™ products,** while providing continuous support improving glass fiber rowing as well as new glass roving developments for more efficient, performing and sustainable GFRP **Mateenbar™.**

MAKE
MORE
POSSIBLE™

MATEENBAR MANUFACTURING LOCATIONS WORLDWIDE

Manufacturing plants with Pultron's proprietary technology



MAKE
MORE
POSSIBLE™

MATEENBAR™

Why is it different from all others?

- **ADVANTEX™ Glass Type 30** Roving guarantees high mechanical performances.

- Grooving enhances bond to concrete vs. competitive products (surface treatment). Mechanical grooving guarantees constancy of bond to concrete like no other GFRP rebar.

- Vinylester thermoset resin protects and guarantees durability of mechanical properties over time and guarantee perfect composite behaviour.

Thanks to the unique manufacturing proprietary process, **Mateenbar™** is capable to guarantee the highest mechanical properties and durability performance, while optimizing material consumption and with the most efficient cost-effective manufacturing process.

MAKE MORE POSSIBLE™

GFRP vs steel rebars

RUST-PROOF, STRONGER, LIGHTER, CODE APPROVED...AND MORE

RUSTPROOF

MATEENBAR™ will never rust, enabling more durable structures.

MATEENBAR™ will allow development of new concrete mixes looking for more sustainable and less CO2 impacting mixes.
It will also allow reducing concrete covers contributing to less CO2, less labor and less costs.

NO RUST MEANS MORE FRESH DRINKING WATER

MORE OPTIONS FOR CONCRETE

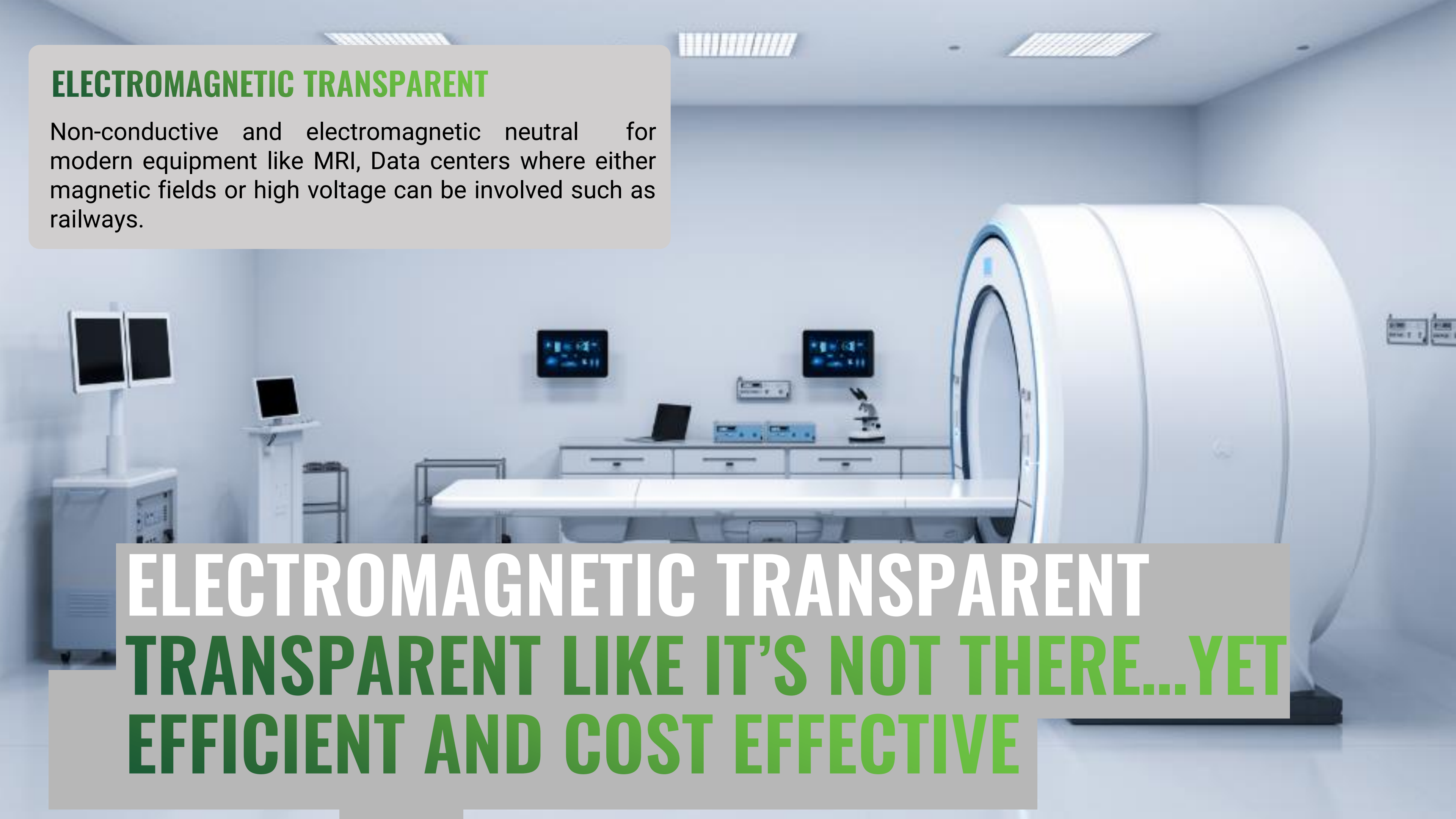

STRONGER LASTS LONGER
STRONGER IS SUSTAINABLE
STRONGER
2,5x stronger in tensile strength compared to the same size diameter

LIGHTER THAN STEEL

4x lighter compared to the same size diameter.
It allows transporting larger amount of material in a container or truck and using less heavier equipment for loading an unloading

LIGHTER REDUCES TRUCKS

LESS IMPACT, LESS CO2, MORE ROUTES



ELECTROMAGNETIC TRANSPARENT

Non-conductive and electromagnetic neutral for modern equipment like MRI, Data centers where either magnetic fields or high voltage can be involved such as railways.

ELECTROMAGNETIC TRANSPARENT
TRANSPARENT LIKE IT’S NOT THERE...YET EFFICIENT AND COST EFFECTIVE

Low-Thermal Conductivity and No-thermal cycling impact

Maintains excellent thermal insulation and creates no thermal bridges. It is ideal as reinforcement of insulation precast panels and in all applications where insulation is crucial for the project.

.

LOW-THERMAL CONDUCTIVITY HELPS SAVING ENERGY

MATEENBAR™: A SUSTAINABLE IMPACT

MORE BARS PER TRUCKLOAD

MATEENBAR™ is up to 4X lighter than equivalent steel rebar diameter. It means that more can be delivered with fewer trucks.

= FEWER CO_2 EMISSIONS

MORE DURABLE

MATEENBAR™ won't crack concrete from the inside, which means less maintenance and even replacement over time.

= LESS MAINTENANCE

SAFER

MATEENBAR™ is lighter to carry, significantly enhancing health & safety ratings on the jobsite.

= LESS INJURY + PRODUCTIVITY

MAKE MORE POSSIBLE™

MAKES MORE POSSIBLE WITH JUST A FIBERGLASS REBAR

GFRP rebar

HANDLING & INSTALLING

HANDLING

Easy and safer handling and placement with fewer workers and faster work

MATEENBAR™ won't get hot in direct sunlight, or cold in winter like steel does

Due to its increased flexibility, MATEENBAR™ can easily be field-formed into large radius curves

CUTTING

- Can be easily cut using a fine toothed saw in field, or a diamond tipped blade in a chop saw used in factory
- Softer material results in easier, faster, and safer cutting
- No metal means less sparking and heat generation during cutting

TYING

- Plastic clips, zip ties, PVC coated wire, epoxy coated wire, standard steel wire
- Tie guns
- Recommended that chairs be placed more frequently for stability.

Safety: MATEENBAR™ lacquered enables better product visibility on-site. OSHA recommends to wear gloves and any other standard project/site specific safety gear that is required.

Storage: MATEENBAR™ is durable in the outdoor environment. Discoloration, fading or chalking of the surface can occurs due to oxidation or UV exposure, though these effects won't impact the product performance. If extended outdoor exposure is possible, it's recommended that the bars should remain in their packaging or be tarped

MAKE MORE POSSIBLE™


4 - 6M LONG - 20MM REBARS BY HAND
CAN YOU DO IT OR IS SIMPLY THIS GUY TOO STRONG FOR YOU?


GFRP REBARS CAN BE TIED
SIMILARLY TO STEEL ONES

MateenBar™
MateenMesh™
MateenDowel™

APPLICATION & PROJECTS SPOTLIGHTS

MATEENBAR™ FIBERGLASS REBAR

Residential, Commercial and Heavy-Load Applications

Residential & Light commercial applications
Smarter solution for more productive job-sites and more durable slab-on-ground applications

- Parking lots & driveways
- Pools
- Precast architectural and structural elements
- Masonry, retaining and basement walls
- Commercial floors
- and many more

Heavy-load structural applications
High-performance, structural, lightweight, corrosion free concrete reinforcement

- Sea walls
- Industrial floors
- Tram slabs
- Building skeletons
- Bridges
- Piles
- Concrete repair









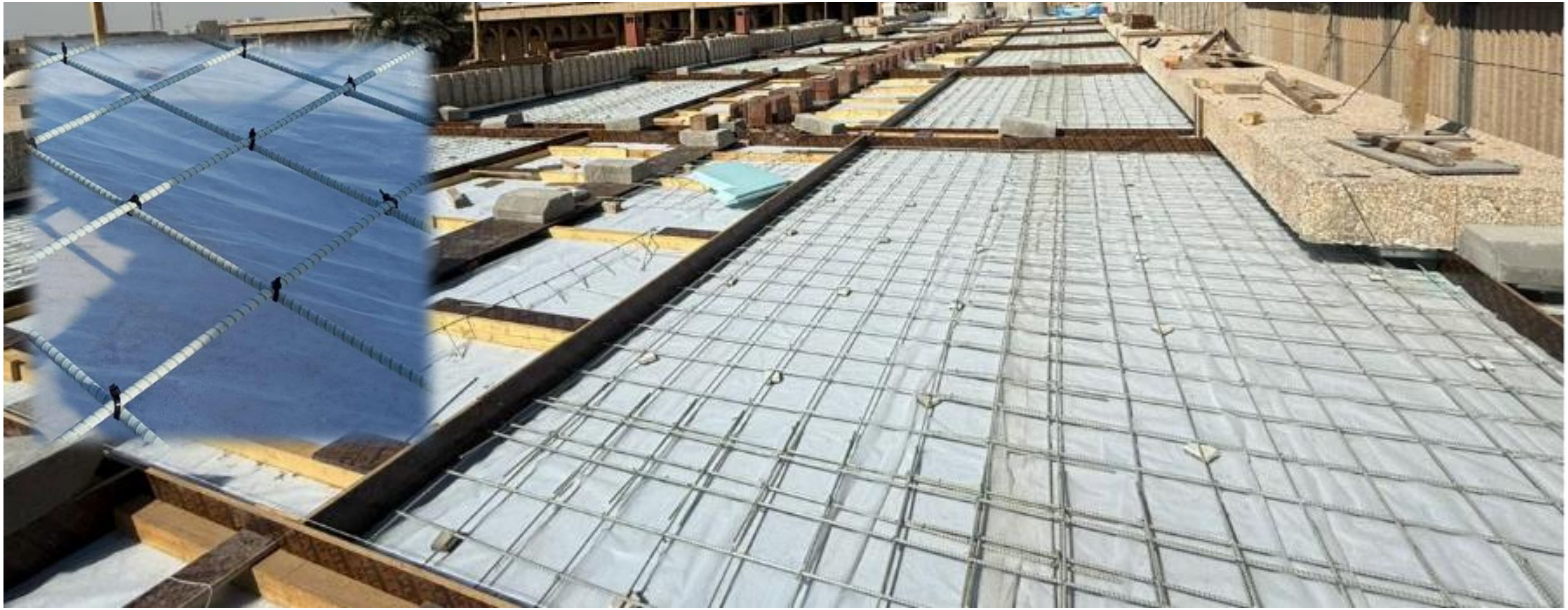
MAKE
MORE
POSSIBLE™

MULTIPLE APPLICATIONS

Residential slab on ground - USA

MULTIPLE APPLICATIONS

Flat work with MateenMesh - KSA



MAKE
MORE
POSSIBLE™

MULTIPLE APPLICATIONS

Elevated Structural Slabs - USA


Elevated Parking Garage slab


Miami MetroRail, FL – Heavy Rail

MAKE
MORE
POSSIBLE™

MULTIPLE APPLICATIONS

Marine and coastal infrastructures: decks, seawalls and RC walls - KSA

MAKE
MORE
POSSIBLE™

MULTIPLE APPLICATIONS

SeaWall application: Low Battery Seawall Repair - USA

MAKE
MORE
POSSIBLE™

MULTIPLE APPLICATIONS

Concrete REPAIR – Pearl Harbor and Malta Island

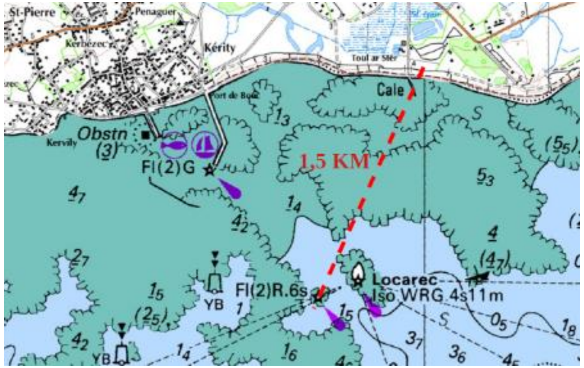
Pearl Harbor, HI – Dry Dock repair

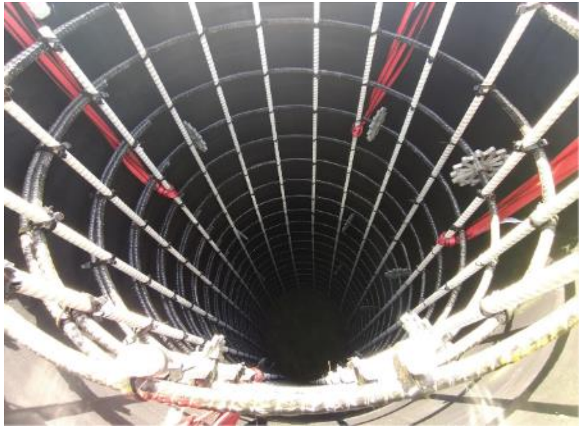
Great Siege Hotel Malta – Balcony repair

MAKE
MORE
POSSIBLE™

MULTIPLE APPLICATIONS

Repair of a light house for coastal signaling with external jacketing - France





MAKE
MORE
POSSIBLE™

MULTIPLE APPLICATIONS

Repair of a light house for coastal signaling with external jacketing - France

MAKE
MORE
POSSIBLE™

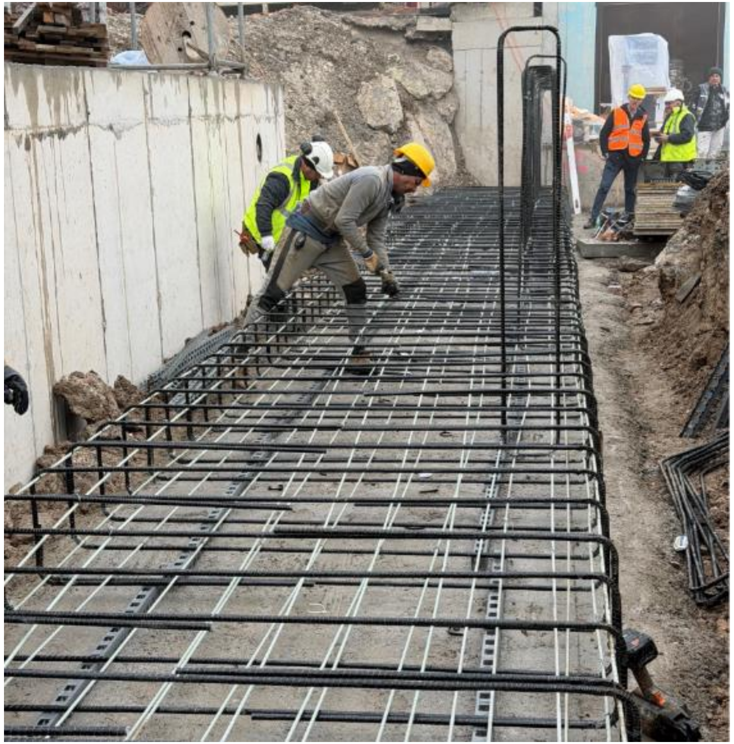
MULTIPLE APPLICATIONS

Foundations for substation - KSA

MAKE
MORE
POSSIBLE™

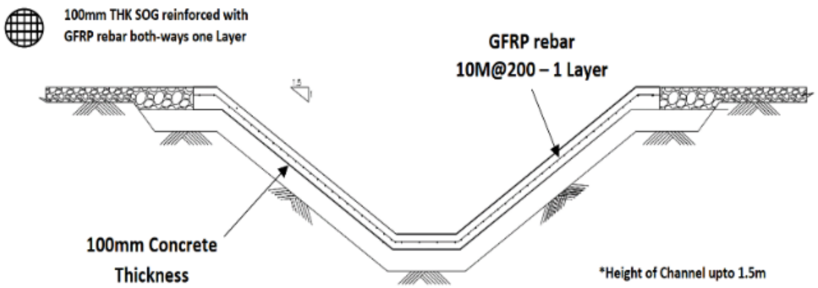
MULTIPLE APPLICATIONS

Retaining wall in Data Center - Italy



MULTIPLE APPLICATIONS

Drain concrete channel - KSA



Reinforced Concrete Pier – Public Doc

MAKE
MORE
POSSIBLE™

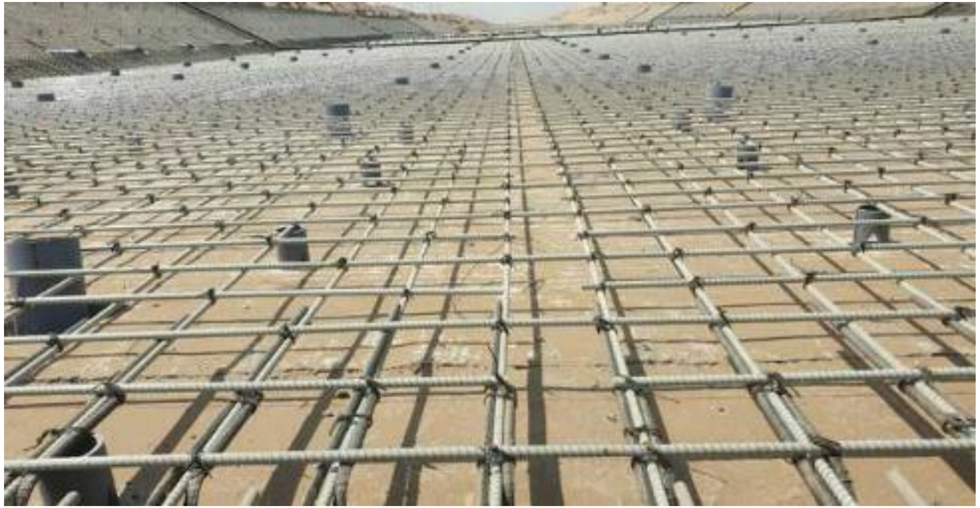
MULTIPLE APPLICATIONS

Aramco Jazan flood channel – largest GFRP project in the world

MAKE
MORE
POSSIBLE™

MULTIPLE APPLICATIONS

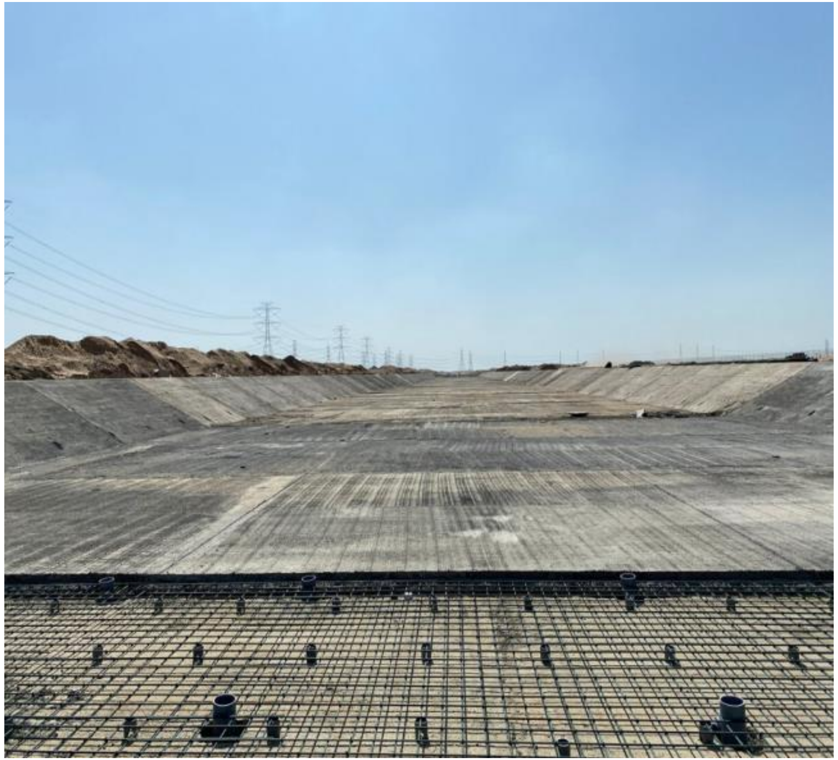
Aramco Jazan flood channel – largest GFRP project in the world



MAKE
MORE
POSSIBLE™

MULTIPLE APPLICATIONS

Aramco Jazan flood channel – largest GFRP project in the world



MAKE
MORE
POSSIBLE™

MULTIPLE APPLICATIONS

Aramco Jazan flood channel – largest GFRP project in the world

Cost comparison for ECS and GFRP options:

Expenditure item	ECS bars, $	GFRP bars, $	GFRP cost / ECS cost, %	
Reinforcing bars	9235	8222	89	11% saving
Concrete	17,514	15,840	90	10% saving
Bar supports	486	608	125	
Bar ties	2856	1659	58	
Labor	3852	1284	33	77% saving
Crane	1068	0	0	100% saving
Safety gloves	9.60	15	156	
Total	**35,021**	**27,628**	**79**	**21% saving**

Table 3: Based on a 30 x 30 x 0.2 m slab panel (180m3)

MAKE
MORE
POSSIBLE™

HARKERS ISLAND BRIDGE

Largest & First worldwide bridge ever built ONLY with FRP reinforcement

COURTESY OF: Balfour Beatty

COURTESY OF: Balfour Beatty


DO IT RIGHT
COURTESY OF: Balfour Beatty


COURTESY OF: Balfour Beatty


National
Erectors
DOZIER
COURTESY OF: Balfour Beatty


COURTESY OF: Balfour Beatty

HARKERS ISLAND BRIDGE

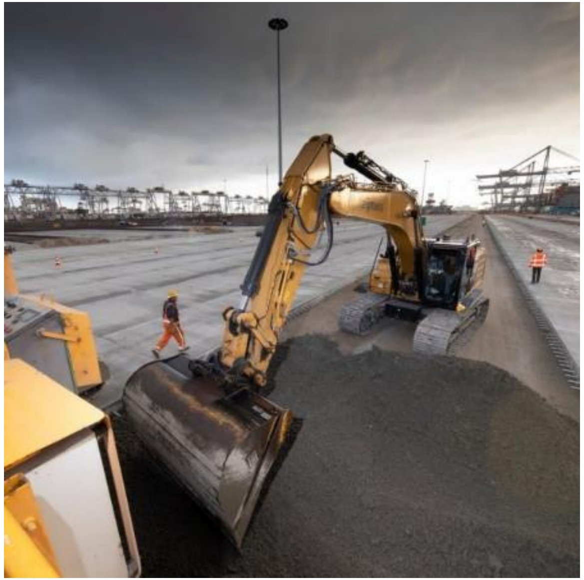
160MT of MateenBar for sub-structure and slab & 12 MT of MateenBents for columns, piercaps and beams – 50% overall saving time of construction

MULTIPLE APPLICATIONS

MateenDowel for Road Construction – INTERSTATE I-84 FRANKLIN, IDAHO, USA

MULTIPLE APPLICATIONS

MateenDowel for Pavement Construction – ECT Terminal Rotterdam, NETHERLANDS



MULTIPLE APPLICATIONS

MateenDowel for Road Construction – Ras al Khair Industrial City, KSA

MAKE
MORE
POSSIBLE™

CODE APPROVED

STANDARDS, TESTING & DESIGN

CE MARKING FOR CONSTRUCTION PRODUCTS

Why CE marking is essential?

- Harmonizes marketing conditions for construction products;
- Removes technical barriers to trade across countries;
- Enables free movement via unified standards and conformity;
- Outside Europe, CE marking for non-standardized products like GFRP rebars ensures third-party verification of testing and ongoing inspection to guarantee constancy of performance.

HARMONIZED TECHNICAL SPECIFICATIONS

Harmonised Standards (hENs) → MANDATORY CERTIFICATION

European Assessment Documents (EADs) → VOLUNTARY CERTIFICATION

CE MARKING FOR CONSTRUCTION PRODUCTS

The European Technical Assessment route

INNOVATIVE PRODUCTS AND MATERIALS

ABSENCE OF HARMONISED STANDARDS

The product does not fall within the scope of any existing harmonised standard

LACK OF APPROPRIATE ASSESSMENT METHOD

For at least one essential characteristic of that product, the assessment method provided for in the harmonised standard is not appropriate

ABSENCE OF ASSESSMENT METHOD

The harmonized standard does not provide for any assessment method in relation to at least one essential characteristic of that product

CE MARKING FOR CONSTRUCTION PRODUCTS

How the process works

VOLUNTARY CERTIFICATION

Promoter | Specification writers | Harmonised specifications | Harmonised Production Quality Control | Mandatory Declaration for CE

Manufacturer

Request →

TAB → EAD

ETA

European Organisation for Technical Assessment

1+

1

2+

3

4

AVCP systems

NB where necessary →

FPC

DoP
By Manufacturer →

CE

Yearly surveillance by NB

Construction Products Regulation (CPR) EU 305/2011

MAKE MORE POSSIBLE™

CE MARKING FOR CONSTRUCTION PRODUCTS

European Assessment Document

Manufacturer[1]

Request for a European Technical Assessment **(ETA)** →

Technical Assessment Body **(TAB)** →

European Assessment Document **(EAD)**

[1]Any natural or legal person who manufactures a construction product or who has such a product designed or manufactured, and markets that product under his name or trademark (CPR Art. 2(19))

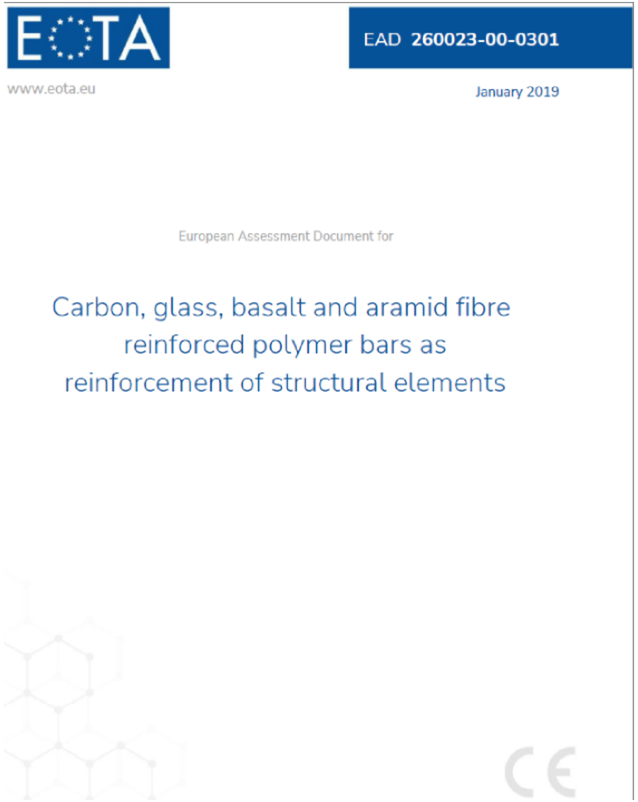
MAKE
MORE
POSSIBLE™

EAD 260023-00-0301

What does an EAD contains?

The European Assessment Document contains:

- A general **description of the construction product**
- The list of **essential characteristics** relevant to the **intended use** of the product
- The **methods and criteria** for evaluating the performance of the product in relation to these essential characteristics
- **Principles relating to factory production control** to be applied, taking into account the conditions of the manufacturing process of the construction product concerned


EOTA

EAD 260023-00-0301

www.eota.eu

January 2019

European Assessment Document for

Carbon, glass, basalt and aramid fibre reinforced polymer bars as reinforcement of structural elements

Essential characteristics: those characteristics of the construction product which relate to the basic requirements for construction works.

Basic requirements for construction works (BWR): Construction works as a whole and in their separate parts must be fit for their intended use, taking into account in particular the health and safety of persons involved throughout the life cycle of the works.

MAKE MORE POSSIBLE™

EAD 260023-00-0301

Essential Characteristics & Assessment Methods

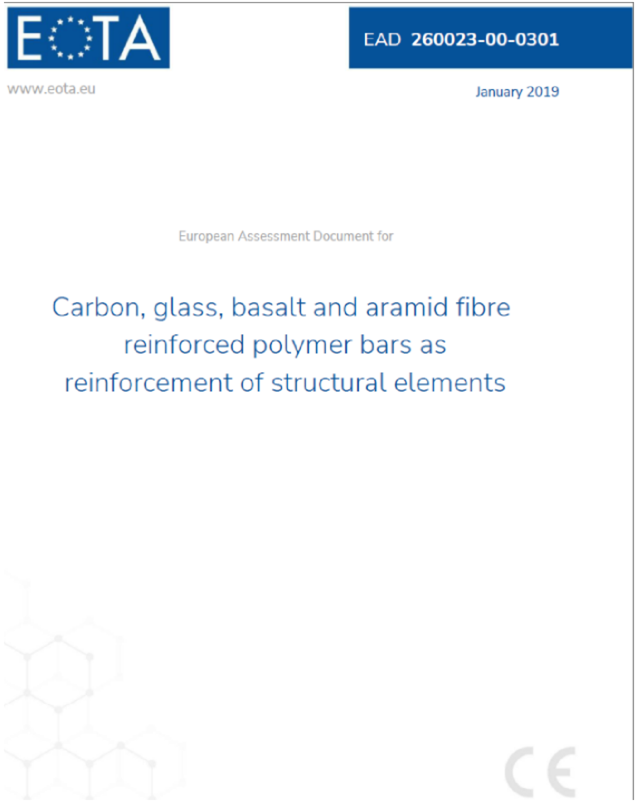
Scope of Evaluation：Carbon, glass, basalt, and aramid FRP bars are assessed for use in structural reinforcement. Evaluation follows EN 1990, Annex D, with a focus on statistical reliability and production consistency.

Key Definitions

- Bar Size: Defined as effective diameter for circular bars and effective width for flat bars.
- Effective Cross-Sectional Area (Aeff): Used to assess all essential mechanical characteristics, including:
  - Tensile strength & modulus
  - Shear strength
  - Interlaminar shear
  - Bond pull-out performance

Testing Protocols

- Specimen quantity is increased compared to ISO 10406-1.
- Tests span multiple production lots to capture variability and ensure homogeneity across manufacturing.


EOTA

EAD 260023-00-0301

www.eota.eu

January 2019

European Assessment Document for

Carbon, glass, basalt and aramid fibre reinforced polymer bars as reinforcement of structural elements

EAD 260023-00-0301

Essential Characteristics

No	Essential characteristic	Assessment method	Type of expression of product performance
	Basic Works Requirement 1: Mechanical resistance and stability		
1	Cross-sectional properties	2.2.1	Level Effective cross-sectional area, A_{eff} [mm^2] Effective diameter, d_{eff} [mm] *or* Effective width, b_{eff} [mm]
2	Tensile strength	2.2.2	Level and description f_{ft0} [MPa], f_{ftk0} [MPa]
3	Tensile modulus of elasticity	2.2.2	Level and description E_f [GPa]
4	Ultimate strain	2.2.2	Level and description ε_{ftk0} [mm/mm], ε_{fk0} [mm/mm]
5	Compressive strength	2.2.3	Level and description f_c [MPa]
6	Compressive modulus	2.2.3	Level and description E_c [MPa]
7	Bond strength in concrete by pull-out testing	2.2.4	Level and description τ_b [MPa] and failure mode (before and after alkali exposure) Reduction in bond strength R_{cb} [%]
8	Transverse shear strength	2.2.5	Level and description τ_s [MPa] and failure mode
9	Interlaminar shear strength	2.2.6	Level and description Span to diameter ratio, l/d [-] τ_i [MPa] and failure mode
10	Tensile Fatigue	2.2.7	Level and description S-N curve Fatigue strength for 2 .10^6 cycles, $f_{fatigue}$ [MPa]
11	Creep failure	2.2.8	Level and description Load ratio/creep failure time curve Creep failure load ratio R_{Yc} and/or $R_{Yc,a}$ [-] (test in alkali solution) Million-hour creep failure capacity, F_{rc} [N] Million-hour creep failure strength, $f_{ftk,c}$ [MPa] and/or $f_{ftk,100a}$ [MPa] (test in alkali solution)
12	Alkali resistance	2.2.9	Level and description Rate of percentage mass loss, $R_{\Delta m}$ [%] Tensile $R_{et,t}$ [%] and interlaminar $R_{et,i}$ [%] capacity retention rate
13	Flexural tensile properties	2.2.10	Level and description Bending tensile capacity, f_b [MPa] and failure mode
14	Coefficient of longitudinal thermal expansion	2.2.11	Level $\alpha_{sp,L}$ [°C^{-1}]
15	Coefficient of transverse thermal expansion	2.2.12	Level $\alpha_{sp,T}$ [°C^{-1}]
16	Glass transition temperature or fusion temperature	2.2.13	Level T_g [°C] or T_{pm} [°C] Cure ratio [°C]
17	Long-term relaxation	2.2.14	Level and description Relaxation rates Y_{10}, Y_{120}, Y_{1000} [%] Average relaxation curve Million-hour relaxation rate $Y_{million}$ [%]
18	Maximum service temperature	2.2.15	Level T_{max} [°C]
19	Bond strength at maximum service temperature	2.2.16	Level and description τ_{Tmax} [MPa] Retained bond strength, τ_{ret} [%]
20	Strength of FRP bent bars	2.2.17	Level and description Bend capacity, f_{ub} [MPa] (before and after alkali exposure) Strength-reduction factor, χ (before and after alkali exposure)
	Basic Works Requirement 2: Safety in case of fire		
21	Reaction to fire	2.2.18	Class

MAKE MORE POSSIBLE™

EAD 260023-00-0301

ETA: scope and strategy

- Manufacturers define the range of diameters they intend to certify for both straight and bent bars.
- Rebars outside this certified range are not CE-marked and cannot be marketed as compliant.
- Testing is selective: only small, medium, and large diameters may undergo full testing. Not all diameters are tested for every essential characteristic.
- Diameter and area tolerances are defined by National Design Standards.
- For untested characteristics on certain diameters, such as pull-out strength, durability, fatigue, creep, relaxation, and bent bar strength, a conservative design approach is applied.
- Manufacturers can certify as many diameters as needed to stay competitive and align with their target concrete reinforcement applications.

MAKE MORE POSSIBLE™

EAD 260023-00-0301

Testing strategy

- Not all tests in EAD 260023-00-0301 are mandatory. Manufacturers select which performance characteristics to declare based on intended use/application and market requirements.
- Choices may be influenced by national design laws and regulatory standards in specific regions.
- Once selected, essential characteristics are submitted to the Technical Assessment Body (TAB), which then defines the testing plan and locations.

Testing Requirements

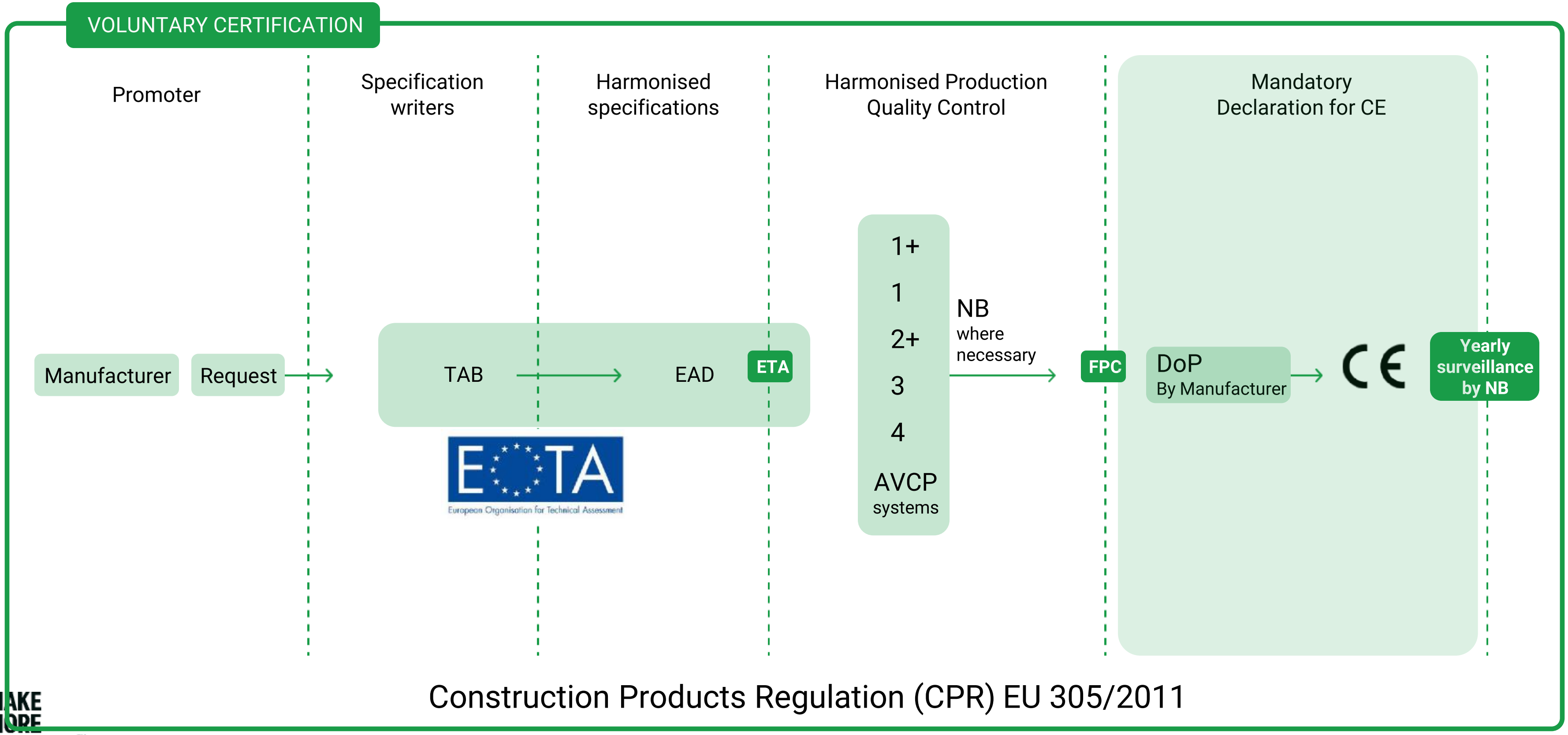
All testing must comply with ISO 17025 standards. Laboratories may be internal or third-party, but the TAB has final authority to ensure testing quality under EOTA guidelines.

Why ISO 17025 Accreditation Matters

Recognised nationally and internationally
Valid for certifications, public tenders, CE marking, and building permits
Traceable and reliable, guaranteeing quality and consistency throughout the testing process

EAD 260023-00-0301

The Process – FPC & DoP

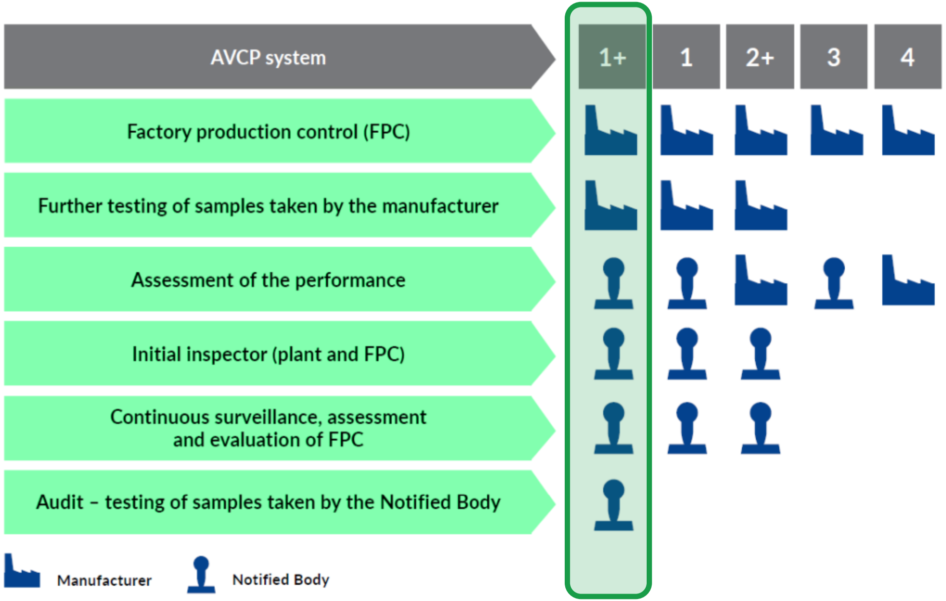


MAKE MORE POSSIBLE™

EAD 260023-00-0301

Assessment & Verification of Constancy of Performance AVCP1+

- AVCP is a harmonized EU system that defines how products are assessed and how consistency is maintained across results.
- For FRP rebars, the applicable AVCP system is 1+, the most stringent level, ensuring robust oversight and reliability.
- This system underpins the Declaration of Performance, safeguarding its accuracy and credibility.
- When paired with CE-marking, AVCP guarantees high-quality product circulation across the EU with stricter requirements than those defined by ASTM D7957 or D8505.
- Manufacturers aiming for CE compliance must meet higher standards, reinforcing trust and performance in the market.



EAD 260023-00-0301

Assessment & Verification of Constancy of Performance AVCP1+

Table 3.2.1 Control plan for the manufacturer; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Factory production control (FPC) [including testing of samples taken at the factory in accordance with a prescribed test plan]					
1	Incoming material	Supplier's data check	Control Plan	-	100% batch(1)
2	Effective cross-sectional area	2.2.1	Control Plan	3	100% batch(1)
3	Tensile strength	2.2.2	Control Plan	3	100% batch(1)
4	Mean tensile modulus of elasticity	2.2.2	Control Plan	3	100% batch(1)
5	Density	Control Plan	Control Plan	3	100% batch(1)
6	Glass transition temperature	2.2.13	Control Plan	3 samples of one random diameter	Every six months
7	Cure ratio	2.2.13	Control Plan	3 samples of one random diameter	Every six months
8	Fibre/matrix ratio	Control Plan	Control Plan	3	Every six months
9	Water absorption	Control Plan	Control Plan	3	100% batch(1)
10	Capillary voids (or void content)	Control Plan	Control Plan	3	100% batch(1)
11	Interlaminar shear strength	Control Plan	Control Plan	3 samples of one random diameter	Every year
12	Alkali resistance	Control plan	Control plan	3 samples of one random diameter	Every year
13	Bond strength (centric tests on low strength concrete)	2.2.4	Control Plan	3 samples of s/m/l diameter(2)	Every year
14	Strength of FRP bent bars	2.2.17	Control Plan	3 samples of one random diameter	Every year

(1) Any batch of bar produced from start to finish with the same constituent materials used in the same proportions without changing any production parameter, such as cure temperature or line speed for a maximum of 60.000 linear meters of the same diameter, also in multiple shifts of production, and at least once a year for each diameter.

(2) Among those produced in the year.

Table 3.3.1 Control plan for the notified body; cornerstones

No	Subject/type of control	Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Initial inspection of the manufacturing plant and of factory production control					
1	The Notified Body shall ascertain that, in accordance with the control plan, the manufacturing plant of the product manufacturer, in particular personnel and equipment, and the factory production control are suitable to ensure a continuous and orderly manufacturing of the carbon, glass, basalt and aramid FRP bars.	Verification of the complete FPC as described in the control plan agreed between the TAB and the manufacturer	As defined in the control plan	As defined in the control plan	When starting the production or a new line
Continuous surveillance, assessment and evaluation of factory production control					
1	The Notified Body will ascertain that the system of factory production control and the specified manufacturing process are maintained taking account of the control plan.	Verification of the controls carried out by the manufacturer as described in the control plan agreed between the TAB and the manufacturer with reference to the raw materials, to the process and to the product as indicated in Table 3.2.1	As defined in the control plan	As defined in the control plan	1/year
Audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities					
1	Effective cross-sectional properties	2.2.1	As defined in the control plan	3 samples of one bar diameter and manufacturing process	Each Inspection or 2/year
2	Tensile properties	2.2.2	As defined in the control plan	3 samples of one bar diameter and manufacturing process	Each Inspection or 2/year

MAKE MORE POSSIBLE™

FACTORY PRODUCTION CONTROL CERTIFICATION

Notifikovaná osoba č. 1301

TSUS

TECHNICKÝ A SKÚŠOBNÝ ÚSTAV STAVEBNÝ, n. o.
BUILDING TESTING AND RESEARCH INSTITUTE
Studená 3, 821 04 Bratislava, Slovenská republika

Certificate of constancy of performance

1301 – CPR – 2565

In compliance with Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 (the Construction Products Regulation or CPR), this certificate applies to the construction product

Composite GFRP reinforcement

MATEENBAR ™ and MATEENBAR ™+

is used as reinforcement of inorganic matrixes (like concrete, lime-stone based mortars, Portland, CSA cement, hydraulic reactive powder, light-weight concrete, etc.) to build and repair beams, columns, slabs and other structural elements.
Composite GFRP bar reinforcement MATEENBAR ™ and MATEENBAR ™+ is intended to be used as reinforcement of construction works and elements made of reinforced concrete (beams, columns, panels, slabs and other structural elements) and as post-installed rebars.

Placed on the market under the name of

Europen Owens Corning FiberGlas Srl
Chaussèe de la Hulpe, 166, 1170 Bruxelles
Belgium

and produced in the manufacturing plant

IKK MATEENBAR
3rd Industrial City MODON, 34223 Dammam
Saudi Arabia

This certificate attests that all provisions concerning the assessment and verification of constancy of performance described in the

ETA 25/0588 – version 01, issued on 24/10/2025

and

EAD 260023-00-0301

under system 1+ for the performance set out in the ETA are applied and that the factory production control conducted by the manufacturer is assessed to ensure the

constancy of performance of the construction product.

This certificate was first issued on 12 December 2025 and will remain valid as long as neither the ETA, the EAD, the construction product, the AVCP methods nor the manufacturing conditions in the plant are modified significantly, unless suspended or withdrawn by the notified product certification body.

Bratislava, 12 December 2025

Technický a skúšobný ústav stavebný, n. o. TSUS - 1 - Notifikovaná osoba 1301

Dipl. Ing. Daša Kozáková
Head of Notified Body 1301

191472

MAKE MORE POSSIBLE™

EAD 260023-00-0301

Declaration of Performance_DoP

- CE-marking begins only after the manufacturer secures an ETA (European Technical Assessment) and successfully passes a Factory Production Control audit conducted by a notified body within EOTA.
- Once approved, the manufacturer can issue the Declaration of Performance (DoP), affix the CE mark, and begin selling in the EU market.
- The DoP is a formal document issued under Regulation (EU) No 305/2011 (Construction Products Regulation - CPR).
- Through the DoP, the manufacturer assumes legal responsibility for the product’s conformity with its declared performance, specifically the essential characteristics defined in the ETA and aligned with a specific EAD (European Assessment Document).

In short, the DoP acts as the product’s “performance identity card” for construction use. Its format and required content are strictly defined by the CPR.

MAKE
MORE
POSSIBLE™

DECLARATION of PERFORMANCE

Specific format for the DoP

The Original Composites Company™

CE

DECLARATION OF PERFORMANCE

DoP

In accordance with Annex III of Regulations (EU) No. 305/2011 Construction Product Regulation

1	Unique identification code of the product type	MateenBar™
2	Intended use	GFRP bars made with ECR glass roving and thermosetting resins, to be applied as reinforcement of inorganic matrices (such as concrete, lime-based mortars, Portland, CSA cement, hydraulic reactive powder, lightweight concrete, etc.) to build and repair beams, columns, slabs and other structural elements either cast in situ or precast.
3	Manufacturer	European Owens Corning FiberGlas (EOCF) Srl Chaussée de la Hulpe, 166 à 1170 Bruxelles
5	System AVCP	1+
6b	European Assessment Document	260023-00-0301
	European Technical Assessment	25/0588 v01 dated 25 October 2025
	Technical Assessment Body	i-Tab / ITC-CNR (CPR NB n.0970)
	Notified Body	TSUS CPR NB n.1301

The Original Composites Company™

CE

7	Declared Performances

<table>
<tr><th>Essential Characteristic</th><th>Symbol</th><th>Unit</th><th>Test Method</th><th>MB 6</th><th>MB 8</th><th>MB 10</th><th>MB 12</th><th>MB 16</th><th>MB 19</th><th>MB 22</th><th>MB 25</th><th>MB 32</th></tr>
<tr><td>Nominal Bar diameter</td><td>d</td><td>mm</td><td>/</td><td>6</td><td>8</td><td>10</td><td>12</td><td>16</td><td>19</td><td>22</td><td>25</td><td>32</td></tr>
<tr><td>Effective Bar diameter</td><td>d_{eff}</td><td>mm</td><td rowspan="2">ISO 10406-1 Clause 5</td><td>6,71</td><td>7,66</td><td>9,91</td><td>11,35</td><td>15,78</td><td>18,79</td><td>21,65</td><td>24,86</td><td>31,11</td></tr>
<tr><td>Measured Cross Sectional Area (tolerance ±5%)</td><td>A_{eff}</td><td>mm^2</td><td>35,4</td><td>46,1</td><td>77,2</td><td>101,2</td><td>195,6</td><td>277,4</td><td>368,0</td><td>485,5</td><td>760,4</td></tr>
<tr><td>Characteristic Short-Term Tensile strength</td><td>f_{fk0}</td><td>MPa</td><td rowspan="4">ISO 10406-1 Clause 6</td><td colspan="8">> 1000</td><td>900</td></tr>
<tr><td>Characteristic Ultimate Tensile Failure Load</td><td>F</td><td>kN</td><td>> 38</td><td>>48</td><td>>82</td><td>>110</td><td>>200</td><td>>290</td><td>>390</td><td>>505</td><td>690</td></tr>
<tr><td>Avarage Modulus of Elasticity</td><td>E_f</td><td>Gpa</td><td colspan="9">> 50</td></tr>
<tr><td>Characteristic Tensile failure Strain</td><td>ε_{ft}</td><td>%</td><td colspan="9">> 1,8</td></tr>
<tr><td>Average Interlaminar shear strength</td><td>τ_i</td><td>MPa</td><td>EAD 2.2.6</td><td colspan="9">>40</td></tr>
<tr><td>Characteristic Tranverse shear strength</td><td>τ_s</td><td>MPa</td><td>ISO 10406-1 clause 13</td><td colspan="9">>150</td></tr>
<tr><td>Characteristic Compressive strength</td><td>f_c</td><td>MPa</td><td rowspan="2">EAD 2.2.3 & ISO 604</td><td colspan="9">>400</td></tr>
<tr><td>Avarage Compressive Modulus of Elasticity</td><td>E_c</td><td>Gpa</td><td colspan="9">>50</td></tr>
<tr><td>Centric Bond strength in concrete C20/25 by pull-out testing</td><td>τ_b</td><td>MPa</td><td>ISO 10406-1 clause 7</td><td colspan="5">>11</td><td colspan="4">>9</td></tr>
<tr><td>Reduction in Bond strength from centric to eccentric tests</td><td>Rcb</td><td>%</td><td>ISO 10406-1 clause 7</td><td>0</td><td colspan="2"><23</td><td colspan="2"><29</td><td colspan="4"><44</td></tr>
<tr><td>Centric Bond strength in concrete C50/60 by pull-out testing</td><td>τ_b</td><td>MPa</td><td>ISO 10406-1 clause 7</td><td colspan="8"></td><td>>9</td></tr>
</table>

The Original Composites Company™

CE

Other performances declared:

Fiber mass Content ≥80%

Moisture Absorption in 24hr at 50°C ≤0,05

Moisture Absorption to saturation at 50°C <0,75

Mean Glass Transition Temperature (DSC) >100°C

Maximum service temperature >70°C

Degree of cure ≥99%

The performance of the product identified above is in conformity with the set of declared performance/s. This declaration of performance is issued, in accordance with Regulation (EU) No 305/2011, under the sole responsibility of the manufacturer identified above.

Signed for and on behalf of the manufacturer by:

Bruxelles, May 8th, 2026

Dr. Christopher Skinner

Vice President Strategic Marketing

CE Marked MATEENBAR products

SIZES AND AVAILABILITY

Straight bars

Construction bar diameters as for steel: 6, 8,10,12,16,19, 22, 25, 32 mm

Stock lengths 6, 12m but may be produced and cut at desired length for large special projects

Straight rebars are available lacquered and not to provide a different touch experience.

MateenBar+ are lacquered bars providing a scratch free handling experience, ideal for everydays job. Manufacturing process is identical but given the small increase of area due to lacquer derived mechanical properties are affected according to EAD testing protocol.

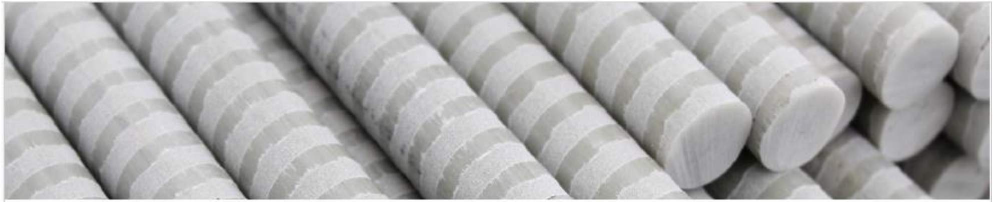
MateenBar & MateenBar+ are both **CE marked** with **ETA 25/0588** according to **EAD 260023-00-0301**.

MateenBar & MateenBar+ are also compliant with ASTM D7957, CSA S807

MAKE
MORE
POSSIBLE™

MATEENBAR™ DATA PRINCIPLES

TDS following European certification



MATEENBAR™ FIBERGLASS REBAR

STRONGER. LIGHTER. RUSTPROOF.

MATEENBAR Fiberglass Rebar is a stronger, lighter weight, rustproof concrete reinforcement designed to meet the codes and standards you trust, help you increase on-site productivity, and deliver more durable structures.

Product Advantages Compared to Steel

STRONGER
- 2,5x stronger in tensile strength compared to the same size diameter

LIGHTER
- 4x lighter compared to the same size diameter

RUSTPROOF
- More durable structures

DESIGNED FOR PROS
- Heat-free handling
- Not electrically conductive
- Low thermal conductivity
- No thermal cycling impact

ESSENTIAL CHARACTERISTIC	SYMBOL	UNIT	TEST METHOD	MB 6	MB 8	MB 10	MB 12	MB 16	MB 19	MB 22	MB 25	MB 32
Nominal Bar diameter	d	mm	/	6	8	10	12	16	19	22	25	32
Nominal area of the Bar	A_{nom}	mm^2	/	28,27	50,27	78,54	113,10	201,06	283,53	380,13	490,87	804,25
Effective Bar diameter	d_{eff}	mm	EAD 2.2.1 & ISO 10406-1 Clause 5	6,71	7,66	9,91	11,35	15,78	18,79	21,65	24,86	31,11
Measured Cross Sectional Area (tolerance ±5%)	A_{eff}	mm^2		35,38	46,07	77,17	101,20	195,65	277,43	367,97	485,50	750,36
Linear weight (tolerance ±10%)	/	kg/m	/	0,076	0,096	0,165	0,225	0,414	0,593	0,776	1,03	1,603
Characteristic short-term tensile strength	f_{ftk0}	MPa	EAD 2.2.2 & ISO 10406-1 Clause 6	>1000								
Characteristic Ultimate failure load	F	kN		>36	>47	>78	>102	>196	>278	>368	>486	>723
Average Modulus of elasticity	E_f	GPa		>50								
Tensile failure strain	ε_{ft}	%		>1,8								
Average interlaminar shear strength	τ_i	MPa	EAD 2.2.6	>40								
Average transverse shear strength	τ_s	MPa	EAD 2.2.5 & ISO 10406-1 Clause 13	>150								
Characteristic compressive strength	F_c	MPa	EAD 2.2.3 & ISO 604	>400								
Average elastic modulus in compression	E_c	GPa		>50								
Bond strength in concrete C20/25 by pull-out testing	τ_b	MPa	EAD 2.2.4 & ISO 10406-1 Clause 7	>11					>9			
Alkali Resistance – Rate of % tensile retention[1]	$R_{et,t}$	%	EAD 2.2.16	>65%								
Alkali Resistance – Rate of % tensile retention[2]				>95%								

[1] Alkali solution as reported in ISO 10406-1:2015, with initial pH > 13 and made with 8.0 g of NaOH & 22.4 g of KOH for every liter of dionized water

[2] Alkali solution with initial 12,6 < pH > 13 and made with 118.5 g di $Ca(OH)_2$, 0.9 g of NaOH & 4.2 g of KOH for every liter of dionized water

MAKE MORE POSSIBLE™

MATEENBAR+™ DATA PRINCIPLES

TDS following European certification

MATEENBAR™+ FIBERGLASS REBAR

STRONGER. LIGHTER. RUSTPROOF.

MATEENBAR+ Fiberglass Rebar is a stronger, lighter weight, rustproof concrete reinforcement designed to meet the codes and standards you trust, help you increase on-site productivity, and deliver more durable structures.

Product Advantages Compared to Steel

STRONGER
- 2,5x stronger in tensile strength compared to the same size diameter

LIGHTER
- 4x lighter compared to the same size diameter

RUSTPROOF
- More durable structures

ENHANCED PRO EXPERIENCE
- Scratch-free, heat-free handling
- Not electrically conductive
- Low thermal conductivity
- No thermal cycling impact

ESSENTIAL CHARACTERISTIC	SYMBOL	UNIT	TEST METHOD	MB 6	MB 8	MB 10	MB 12	MB 16
Nominal Bar diameter	d	mm	/	6	8	10	12	16
Nominal area of the Bar	A_{nom}	mm²	/	28,27	50,27	78,54	113,10	201,06
Effective Bar diameter	d_{eff}	mm	EAD 2.2.1 & ISO 10406-1 Clause 5	6,74	7,79	10,06	11,81	15,92
Measured Cross Sectional Area (tolerance ±5%)	A_{eff}	mm²		35,73	47,59	79,51	109,47	199,15
Linear weight (tolerance ±10%)	/	kg/m	/	0,076	0,096	0,165	0,225	0,414
Characteristic short-term tensile strength	f_{ftk0}	MPa	EAD 2.2.2 & ISO 10406-1 Clause 6	>1000				
Characteristic Ultimate failure load	F	kN		>36	>48	>80	>110	>200
Average Modulus of elasticity	E_f	GPa		>48				
Tensile failure strain	ε_{ft}	%		>1,8				
Average interlaminar shear strength	τ_i	MPa	EAD 2.2.6	>40				
Average transverse shear strength	τ_s	MPa	EAD 2.2.5 & ISO 10406-1 Clause 13	>140				
Characteristic compressive strength	F_c	MPa	EAD 2.2.3 & ISO 604	>400				
Average elastic modulus in compression	E_c	GPa		>50				
Bond strength in concrete C20/25 by pull-out testing	τ_b	MPa	EAD 2.2.4 & ISO 10406-1 Clause 7	>10				
Bond strength in concrete C50/60 by pull-out testing	τ_b	MPa		-	-	-	-	>19
Alkali Resistance – Rate of % tensile retention(1)	$R_{et,t}$	%	EAD 2.2.16	>65%				
Alkali Resistance – Rate of % tensile retention(2)				>95%				

(1)Alkali solution as reported in ISO 10406-1:2015, with initial pH > 13 and made with 8.0 g of NaOH & 22.4 g of KOH for every liter of dionized water
(2)Alkali solution with initial 12,6 < pH > 13 and made with 118.5 g di $Ca(OH)_2$, 0.9 g of NaOH & 4.2 g of KOH for every liter of dionized water

MAKE MORE POSSIBLE™

SIZES AND AVAILABILITY

Meshes

Meshes are made by assembling **Mateenbar™** at predetermined spacing, usually 100-150-200mm

MateenMesh is made of **Mateenbar™** 6-8-10-12mm rebars.

Mateenbar™ are tied using standard rebar ties.

MateenMesh guarantees **Mateenbar™ CE marked** mechanical and durability properties, since assembling does not alter GFRP rebar.

Design according to present design standards can be carried out without any modifications as states in CNR-DT 203R1 design guide.

3.6 FRP MESHES

(1) Within the scope of these Guidelines are FRP meshes made as assemblies of FRP bars with circular cross-section, in carbon or glass fibers, in both directions, provided that the assembly does not alter any of the geometric or mechanical properties of the individual bars, which shall be qualified according to the procedures specified in the current qualification documents (*EAD-FRP bars* and *LG-FRP bars*).

(2) These Guidelines currently do not cover the use of other types of FRP meshes. With the availability of standardized qualification procedures and adequate experimental validation, the scope of application may also be extended to other types of meshes, subject to an update of these Guidelines and, if necessary, to the use of "*Design by Testing*" for the definition of specific capacity models.

MAKE MORE POSSIBLE™

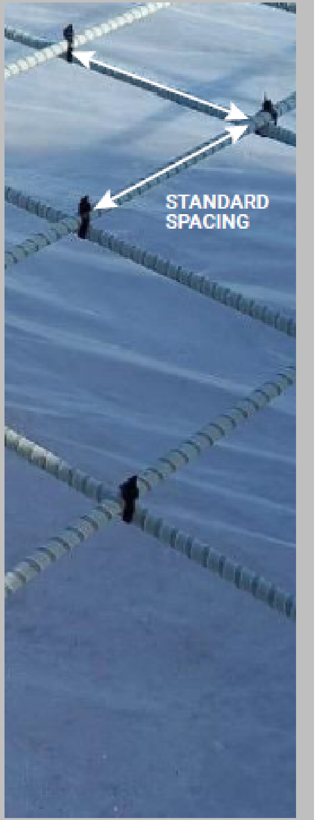
MATEENMESH™ DATA PRINCIPLES

Preassembled Mesh Panels for Smarter Placement

For contractors who typically use welded mesh, MATEENBAR™ **is available in preassembled panels**, offered in 100 mm, 150mm, 200mm (others upon request)spacing, tied together using standard rebar ties. **These panels offer the layout efficiency of mesh while delivering the advantages of fiberglass rebar: stronger, lightweight and rustproof.** It's a practical solution that saves time on-site and meets expectations for durability and performance.

MATEENBAR™ **panels are tied at all key joints following the standard geometry**, ensuring stability and consistency on-site.

- **Standard Dimensions:** 2.0 m or 2.2 m x 3.0 m, or 6.0 m (height x width; others upon request)
- **Number of joints tied:** all border joints secured, with diagonal ties across the panel for added strength.
- **Type of ties:** nylon plastic ties (>1 mm thickness, >100 mm length, >80 N strength) provide consistent performance and durability.



SIZES AND AVAILABILITY

Prefabricated Bent bars

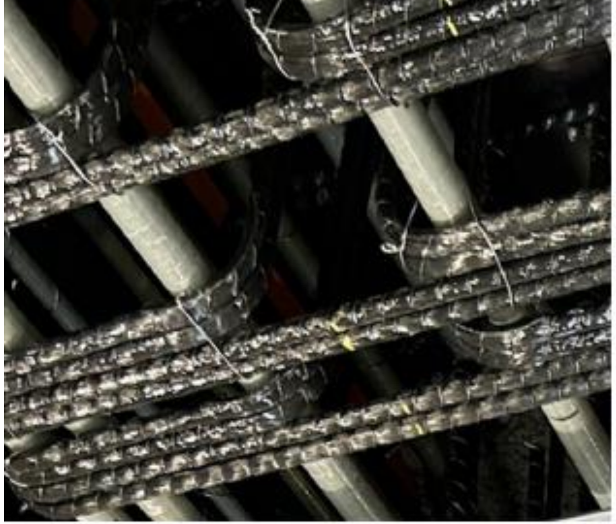
Bent bars are manufactured in-factory in bar diameters from 8,10,12,16,19, 22, 25 mm

- Bent bars are made to order but standard shapes may be available.

Most bent shapes, typical for steel bars, are possible except certain shapes like “Z”.

Bars cannot be bent on site in 90° angle, there minimum allowed bent radius .

Manufacture standard and certified curvature radius of bent bar is 3x rebar diameter.



MATEENBAR BENT™ DATA PRINCIPLES

TDS following European certification

MATEENBAR™ FIBERGLASS REBAR BENT BAR

MATEENBAR Fiberglass Rebar Bent Bar is a stronger, lighter weight, rustproof concrete reinforcement designed to meet the codes and standards you trust, help you increase on-site productivity, and deliver more durable structures.

Product Advantages Compared to Steel

STRONGER
- 2,5x stronger in tensile strength compared to the same size diameter

LIGHTER
- 4x lighter compared to the same size diameter

RUSTPROOF
- More durable structures

DESIGNED FOR PROS
- Heat-free handling
- Not electrically conductive
- Low thermal conductivity
- No thermal cycling impact

ESSENTIAL CHARACTERISTIC	SYMBOL	UNIT	TEST METHOD	MB-B 8	MB-B 10	MB-B 12	MB-B 16	MB-B 20	MB-B 22	MB-B 25
Nominal Bar Diameter	d	mm	/	8	10	12	16	20	22	25
Nominal Area of the Bar	A_{nom}	mm²	/	50,27	78,54	113,10	201,06	314,16	380,13	490,87
Effective Bar diameter (+-5% tolerance)	d_{eff}	mm	EAD 2.2.1 & ISO 10406-1 Clause 5	7,62	9,76	12,13	16,36	20,54	22,13	25,30
Measured Cross Sectional Area (+-5% tolerance)	A_{eff}	mm²		46	75	116	210	331	385	503
Linear Weight	/	g/m	/	0,100	0,160	0,236	0,423	0,671	0,783	1,013
Characteristic Short-Term Tensile Strength	f_{ftk0}	MPa	EAD 2.2.2 & ISO 10406-1 Clause 6	>1000						
Ultimate Tensile Strain of Straight Portion	εftk0	%		≥1.8%						
Average Modulus of Elasticity of Straight Portion	E_f	GPa		>50						
Bend Radius of Bent Shapes	rt	mm	Defined by the manufacturer	≥24	≥30	≥36	≥48	≥57	≥66	≥75
Average Interlaminar Shear Strength	t_l	MPa	EAD 2.2.6	>40						
Characteristic Transverse Shear Strength	t_s	MPa	EAD 2.2.5 & ISO 10406-Clause 13	>140						
Strength of Bent Bar Sections	fub	MPa	EAD 2.2.15	>400						
Strength Reduction Factor (Before Alkali Exposure)	χ	%	EAD 2.2.15	>40%						

MAKE MORE POSSIBLE™

SIZES AND AVAILABILITY

DOWELS

- MateenDowel bars are available in size from 8 to 50mm diameter.
- Dowels are manufactured and cut to order. If required, they can also be cut onsite using an angle grider with diamond blade. Usually but not mandatory, cutting is done using a wet water bath. There is no need to seal end after cutting or greasing the dowels prior to installation.
- Dowels follow a similar production process as for straight rebars, except for the grooving. Despite not holding a CE mark because of absence of an EAD covering such product, MateenDowels are manufactured following the same quality control, inspection and testing as for all other CE marked products. Because of this the AVCP +1 system in place for straight and bent bars according to EAD 260023-00-0301 is applied to MateenDowel production.

MATEENDOWELS™ DATA PRINCIPLES

TDS following international ASTM standard – D 8444-24

Nominal Diameter mm	Nominal Cross Sectional Area mm^2	Product Weight g/m	Transverse Shear Strength (Double Shear) MPa	Longitudinal Shear Strength (Short Beam Shear) MPa
8.0	53	120	> 150	> 50
10.0	71	200	> 150	> 50
12.0	104	240	> 150	> 50
13.0	129	257	> 150	> 50
14.0	149	345	> 150	> 50
16.0	198	425	> 150	> 50
19.0	285	595	> 150	> 50
20.0	288	600	> 150	> 50
22.0	388	784	> 150	> 50
25.0	507	1064	> 150	> 50
28.0	645	1450	> 150	> 50
31.4	792	1605	> 150	> 50
37.5	1140	2320	> 150	> 50
41.5	1139	2790	> 150	> 50
50.0	2027	4300	> 150	> 50

Material Properties (per ASTM D7205-06)

Transverse Shear Strength = ASTM D7617 / D7617M

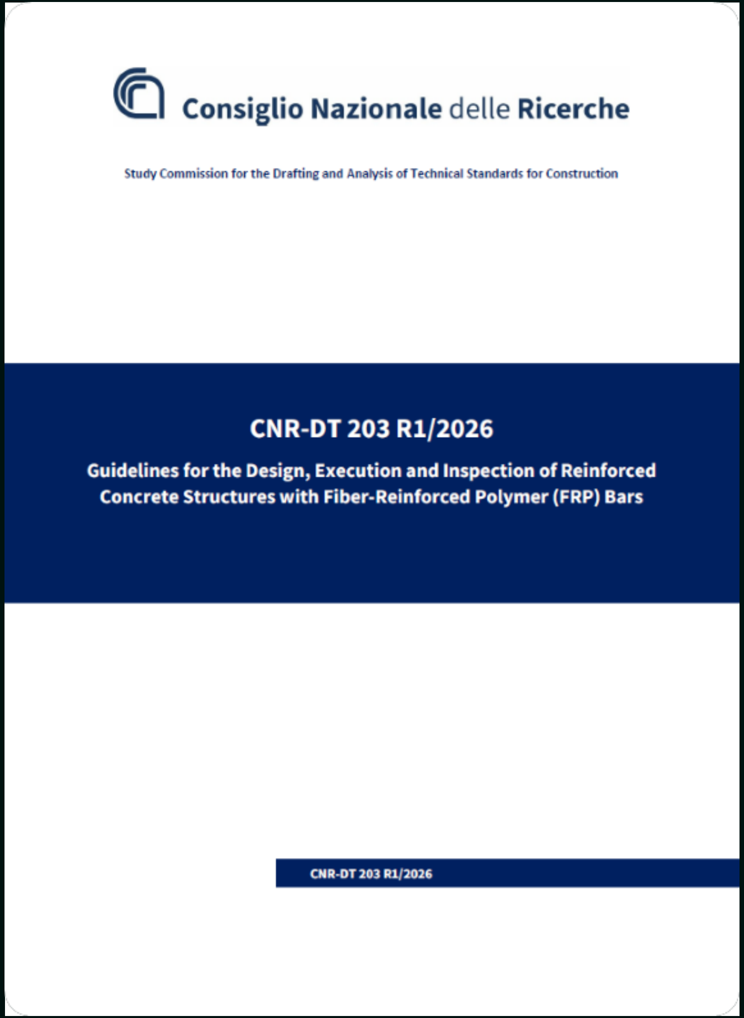
Longitudinal Shear Strength = ASTM D4475

Thermal conductivity	Electrical Resistivity	Density	Fibre Mass content	Moisture Absorption (at 50 °c)	Glass Transition Temp. (DSc)
W/m °C	Ωm	kg/m^3	%	%	°C
< 1	> 200x10^10	2,100	≥ 70	≤ 0.1	≥ 100

MAKE MORE POSSIBLE™

The Original Composites Company™

INTRODUCTION TO THE CNR-DT 203R1/2026 DESIGN GUIDE


Consiglio Nazionale delle Ricerche

Study Commission for the Drafting and Analysis of Technical Standards for Construction

CNR-DT 203 R1/2026

Guidelines for the Design, Execution and Inspection of Reinforced Concrete Structures with Fiber-Reinforced Polymer (FRP) Bars

CNR-DT 203 R1/2026

CNR-DT 203R1/2026

Italian Code for designing Reinforced Concrete structures with GFRP rebars.

Prescriptive design guide written in mandatory language that is absorbed by the existing national design guides NTC 2018.

How does the national Italian standard recognize the CNR DT 203R1/2026 guide line?

1.1 SUBJECT

These Technical Standards for Construction define the principles for the design, execution, and testing of constructions, with regard to the performance required in terms of essential requirements of mechanical resistance and stability, including in the event of fire, as well as durability.

They therefore provide the general safety criteria, specify the actions to be considered in design, define the characteristics of materials and products, and, more generally, address aspects relating to the structural safety of works.

With regard to application guidelines for achieving the prescribed performance, ***for matters not expressly specified in this document, reference may be made to regulations of proven validity and to other technical documents listed in Chapter 12****. In particular, those provided by the Eurocodes together with their respective National Annexes constitute guidance of proven validity and provide systematic application support for these Standards.*

MAKE
MORE
POSSIBLE™

CNR-DT 203R1/2026

Italian Code for designing Reinforced Concrete structures with GFRP rebars.

Unless otherwise specified in this Standard, the provisions contained in the following documents are deemed to be consistent with the principles underlying it:

- Structural Eurocodes published by CEN, together with the specifications set out in the corresponding National Annexes;
- Harmonised UNI EN standards whose references are published in the Official Journal of the European Union;
- Standards for testing materials and products published by UNI.

Furthermore, in addition to these Standards and insofar as they do not conflict with them, the documents listed below may also be used, as they constitute references of proven validity:

- Instructions issued by the Supreme Council of Public Works;
- Guidelines issued by the Central Technical Service of the Supreme Council of Public Works;
- Guidelines for the assessment and reduction of seismic risk of cultural heritage, and subsequent amendments, issued by the Ministry for Cultural Heritage and Activities, subject to the opinion of the Supreme Council of Public Works on the document;
- **Instructions and technical documents issued by the National Research Council (C.N.R.).**

For aspects not covered by this Standard or by the references of proven validity listed above, other international codes may also be used; it is the designer's responsibility to expressly ensure safety levels consistent with those required by these Technical Standards.

The Supreme Council of Public Works, through the Central Technical Service, prepares and publishes—after consultation with the National Research Council (C.N.R.) and the Italian Standards Body (UNI)—the list of documents that constitute technical references for the Technical Standards for Construction pursuant to this chapter. Following the same procedure, periodic updates to this list are also prepared and published, as well as updates to the lists of voluntary UNI, EN and ISO technical specifications referred to in this Standard.

CNR-DT 203R1/2026

General provisions

These Guidelines provide design indications **solely** for **circular-section FRP bars made of glass or carbon fibers** that bear the **CE marking on the basis of a European Technical Assessment (ETA) issued in accordance with EAD 260023-00-0301 and with the intended use declared therein** (FRP bars used as internal reinforcement for beams, columns, walls, slabs, and any other structural concrete elements, or as post-installed reinforcement for strengthening interventions).
They apply to the geometric and mechanical characteristics deemed mandatory for design purposes, as specified in this document, or to bars covered by a Technical Evaluation Certificate (CVT) issued in accordance with the aforementioned Guideline.

https://www.iccsafe.org/building-safety-journal/bsj-technical/fiber-reinforced-polymer-reinforcement-for-concrete-members/

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

Essential characteristics required for STRAIGHT BARS

Table 3-1 - Mandatory characteristics for FRP bars and acceptance limits

Mandatory characteristic	Symbol [unit]	Reference standard	Acceptance limit
Effective area	$A_{b,eff}$ [mm^2]	*EAD-FRP bars* §2.2.1 / *LG-FRP bars* – Tab. 1	Table 3-2
Effective diameter (circular bars)	$d_{b,eff}$ [mm]	*EAD-FRP bars* §2.2.1 / *LG-FRP bars* – Tab. 1	Table 3-2
Fiber volume fraction Fiber weight fraction[1]	V_{fib} [%] P_{fib} [%]	*LG-FRP bars* – Tab. 1	≥ 70% (by volume), ≥ 50% (by weigth)
Characteristic tensile strength	f_{ftk0} [MPa]	*EAD-FRP bars* §2.2.2 / *LG-FRP bars* – Tab. 2	Classes in Table 3-3
Mean longitudinal modulus of elasticity	E_f [GPa]	*EAD-FRP bars* §2.2.2 / *LG-FRP bars* – Tab. 2	Classes in Table 3-3
Glass transition temperature	T_g [°C]	*EAD-FRP bars* §2.2.11 / *LG-FRP bars* – Tab. 1	≥ 100 °C
Maximum service temperature	T_{max} [°C]	*EAD-FRP bars* §2.2.13 / *LG-FRP bars* – Tab. 1	See (5) of §4.1.
Transverse shear strength[2] (characteristic value)	τ_t [MPa]	*EAD-FRP bars* §2.2.5 / *LG-FRP bars* – Tab. 2	≥ 115
Interlaminar shear strength (mean value)	τ_i [MPa]	*EAD-FRP bars* §2.2.6 / *LG-FRP bars* – Tab. 2	≥ 38
Mean pull-out strength from concrete support (centered bar, C20/25 concrete)	τ_{bm} [MPa]	*EAD-FRP bars* §2.2.4 / *LG-FRP bars* – Tab. 2	≥ 7.0
Residual mean tensile strength in alkaline environment after 3000 hours at 60 °C	$R_{at,t}^{3000}$ [%]	*EAD-FRP bars* §2.2.16 *LG-FRP bars* – Tab. 2	GFRP bars: ≥ 60%[3] ≥ 80%[4] CFRP bars: ≥ 85%[3] ≥ 95%[4]

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

Essential characteristics required for BENT BARS

For shaped FRP bars (stirrups or bent bars): - Bend radius	r_t [mm]	*LG-FRP bars* – Tab. 1	$2r_t \geq 7\ d_b$
- Characteristic tensile strength of the straight portion	$f_{ftk,st}$ [MPa]	*EAD-FRP bars* §2.2.15 / *LG-FRP bars* – Tab. 2	Classes in Table 3-3 of this document
- Characteristic tensile strength of the bent portion[5]	f_{fbk} [MPa]	*EAD-FRP bars* §2.2.15 / *LG-FRP bars* – Tab. 2	$\geq$ 40% $f_{ftk,st}$
- Reduction factor of bent portion strength after 3000 hours at 60 °C in alkaline environment	χ_b [%][6]	*EAD-FRP bars* §2.2.15	GFRP bars: $\geq$ 60%[3] $\geq$ 80%[4] CFRP bars: $\geq$ 85%[3] $\geq$ 95%[4]

MAKE
MORE
POSSIBLE™

CNR-DT 203R1/2026

Important notes on how to determine essential characteristics

[3] This acceptance threshold applies if the test is conducted according to the methods specified in the *EAD-FRP bars*, adopting, as required by ISO 10406-1:2015, a solution with initial pH > 13 consisting of 8.0 g NaOH and 22.4 g KOH per liter of deionized water.

[4] This acceptance threshold applies if the test is conducted according to the methods specified in the *EAD-FRP bars*, adopting a solution with an initial pH between 12.6 and 13.0 consisting of 118.5 g $Ca(OH)_2$, 0.9 g NaOH, and 4.2 g KOH per liter of deionized water.

[5] The failure mode observed in the test must not be pull-out, as this would indicate that the bend radius r_t, or the length of bar beyond the bend, is inadequate. For stirrups, the length shall be at least equal to the stirrup width, B_s, and the two straight segments beyond the bends shall overlap. For bent anchorage bars, the length shall be at least 10 times the nominal bar diameter, d_b.

[6] The reduction factor $\chi_a = f_{ubk,a} / f_{ubk}$, where $f_{ubk,}$ is the characteristic tensile strength of the bent portion after 3000 hours of alkaline exposure at 60 °C, and f_{ubk} is the characteristic tensile strength of the bent portion under standard conditions.

CNR-DT 203R1/2026

Definition of nominal diameter and area of FRP bars

Table 3-2 - Minimum and maximum permissible tolerances in terms of cross-sectional area for bars with nominal diameters ranging from 5 to 32 mm

Nominal diameter d_b [mm]	Nominal area A_b [mm^2]	Minimum area $A_{b,min}$ [mm^2]	Maximum area $A_{b,max}$ [mm^2]
5	19.6	18	26
6	28.3	26	35
7	38.5	35	47
8	50.2	47	59
9	63.6	59	73
10	78.5	73	89
11	95.0	89	103
12	113.0	103	123
13	132.7	123	144
14	153.9	144	165
15	176.6	165	190
16	201.0	190	212
17	226.9	212	239
18	254.3	239	265
19	283.4	265	293
20	314.0	293	324
21	346.2	324	357
22	379.9	357	392
23	415.3	392	429
24	452.2	429	467
25	490.6	467	506
26	530.7	506	547
27	572.3	547	590
28	615.4	590	635
29	660.2	635	681
30	706.5	681	729
31	754.4	729	778
32	803.8	778	861

CNR-DT 203R1/2026

Definition of nominal diameter and area of FRP bars

(1) The procedures for evaluating the diameter and the effective area of FRP bars are provided in the *EAD-FRP bars* and in the *LG-FRP bars* documents. Accordingly, the nominal diameter of circular sections ranges from 5 mm to 32 mm, inclusive of the lower and upper limits.

(2) Given the considerable variety of bars available on the market, during the design stage, the calculation of the resisting area shall be based on the nominal diameter, d_b, of circular-section FRP bars. It is possible to associate a given nominal diameter and its corresponding nominal area, A_b, with an FRP bar if its effective area $A_{b,eff}$ falls within the intervals reported in Table 3-2 ($A_{b,min} \leq A_{b,eff} < A_{b,max}$), with the effective area measured according to the methods indicated in the current qualification documents. The tolerances reported in Table 3-2 were established based on a statistical analysis of effective areas measured in an extensive sample of glass-fiber bars available on the market. For carbon-fiber bars, in the absence of an equivalent statistical sample, the same tolerances are assumed.

(3) The Manufacturer, once having defined the range of diameters to be placed on the market, may group 2 or 3 of consecutive diameters and consider the union of the ranges indicated for these diameters. In this case, the nominal diameter shall be taken as the smallest value among the chosen grouped diameters. In the technical datasheet, however, the Manufacturer shall also report the mean effective diameter, enabling an accurate evaluation of the reinforcement area, when necessary, such as when applying capacity design criteria in seismic design.

CNR-DT 203R1/2026

FRP rebar classification

Table 3-3 - Classes of FRP bars made by glass and carbon fibers

Class E_f/f_{ftk0}	**Fiber type**	**Mean elastic tensile modulus, E_f [GPa]**	**Characteristic tensile strength, f_{ftk0} [MPa]**
E45/850	Glass	45	850 750 for diameters $d_b \geq 24$ mm
E50/1000	Glass	50	1000 900 for diameters $d_b \geq 24$ mm
E60/1100	Glass	60	1100 1000 for diameters $d_b \geq 24$ mm
C130/1000	Carbon	130	1000

CNR-DT 203R1/2026

FRP rebar classification

The Manufacturer shall assess these characteristics on the basis of the results of the qualification procedures described in §3.2 and shall refer to the effective cross-sectional area of the bar.

(3) Table 3-3 lists the classes of FRP bars and the corresponding values of the above mechanical characteristics. Belonging to a class requires that the determined mean modulus of elasticity and characteristic tensile strength values of the bars are greater than or equal to those indicated in Table 3-3.

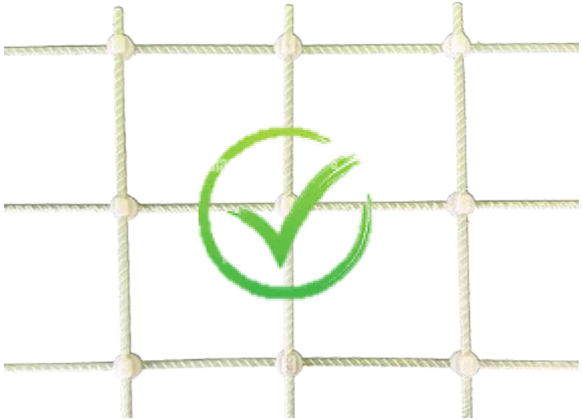
(4) For a specific product, all FRP bars with different nominal diameters shall fall within the same class. If, within the same product, bars with different nominal diameters show, during the qualification phase, modulus of elasticity and tensile strength values belonging to different classes, the product classification shall be based on the class with the lower characteristics.

(5) If an FRP bar exhibits mechanical characteristics lower than those of the minimum class indicated in Table 3-3, it may not be used in accordance with these Guidelines.

CNR-DT 203R1/2026

FRP meshes

(1) The scope of **these Instructions includes FRP meshes manufactured as assemblies of FRP bars** with circular cross-sections made of carbon or glass fibres in both directions, provided that the assembly does not alter any of the geometric or mechanical properties of the individual bars, which must be qualified according to the procedures specified in the current qualification documents (EAD-FRP bars and Guideline-FRP bars).



(2) **These Instructions currently do not cover the use of other types of FRP meshes**. When standardized qualification procedures and adequate testing become available, the scope of application may be extended to include additional types of meshes, subject to an update of these Instructions and, if necessary, by applying a "Design by Testing" approach to define specific capacity models.

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

SITE ACCEPTANCE PROCEDURES

Table 3-5 - Geometric and mechanical characteristics to be verified on samples taken on site according to the *LG-FRP bars*, and acceptance limits

	Characteristic	Symbol [unit]	Acceptance Limit
Geometric	- Effective area of the bar	$A_{b,eff}$ [mm^2]	Within the tolerances given in Table 3-1 relative to the nominal value declared by the Manufacturer for that diameter
	- Raggio di sagomatura delle staffe	r_t [mm]	$2r_t \geq 7\ d_b$
Mechanical	Tensile strength[1]	f_{ft} [MPa]	$\geq$ 95% of the certified characteristic value, f_{ftk0}
	Mean longitudinal elastic modulus[2]	E_f [GPa]	$\geq$ 95% of the certified mean value, E_f
	Ultimate strain[1]	ε_{ft} [mm/mm]	$\geq$ 95% of the certified characteristic value, ε_{ftk0}
	Tensile strength of the straight portion of the stirrup[1]	$f_{ft,st}$ [MPa]	$\geq$ 95% of the certified characteristic value, $f_{ftk,st}$

[1] The inequality shall be satisfied for the result of each specimen.

[2] The inequality shall be satisfied for the mean value of the three specimens.

CNR-DT 203R1/2026

SITE ACCEPTANCE PROCEDURES

(5) If the product is qualified through CE marking, the Field Engineer shall ensure that the corresponding *Certificate of Constancy of Performance and Product Conformity* (CCPC), issued by a qualified notified body, is valid and that the product arrives on site accompanied by the *Declaration of Performance and Conformity* (DoPC). In this case, the procedures referred to in points (1)–(3) are not required, and it remains at the discretion of the Field Engineer to decide whether to carry out additional acceptance tests on site according to Table 3-5, also considering that improper storage during the various phases of material supply could affect the mechanical characteristics of the bars.

4.4.4 Geometric and material properties

(1) The values of the geometric and mechanical characteristics of FRP bars shall be determined through measurements and laboratory tests carried out according to standardized procedures, as indicated in Appendix A. The design rules outlined in this document apply exclusively to products that meet the characteristics listed in Table 3-1, with diameters and corresponding effective areas specified in Table 3-2, and which fall within the classes defined in Table 3-3.

(2) The corresponding characteristic values shall quantify the mechanical properties related to the strength and deformation of FRP bars. Only stiffness parameters (as example, the elastic moduli) are to be evaluated by their corresponding mean values. In the absence of specific technical data for FRP bars, the values of strength and modulus of elasticity corresponding to one of the classes listed in Table 3-3 shall be used for the verifications in these Guidelines. Where the mandatory mechanical characteristics listed in Table 3-1 are known for a given product, or where the chosen product has mechanical characteristics exceeding the threshold values of the classes, and provided that the mandatory characteristics have been obtained through qualification carried out in accordance with the *EAD-FRP bars* or the *LG-FRP bars*, the actual strengths supplied by the Manufacturer may be used.

CNR-DT 203R1/2026

DESIGN PRINCIPLES – Partial factors for materials

$$X_d = \eta_T \cdot \eta_a \cdot \eta_{c,l} \frac{X_k}{\gamma_f}$$

(1) X_d is the characteristic value of the strength or deformation parameter. When it represents the tensile strength f_{tk0} it corresponds to the value defining the class as specified in Table 3-3 – FRP rebar classification.

- γ_f is the partial factor for FRP bars defined by Eq. (4.2) and to be evaluated as described in §4.5;

4.5 PARTIAL FACTORS FOR MATERIALS

(1) For ultimate limit states (ULS), in case of flexural verifications, the value to be assigned to the partial factor for FRP bars, γ_f is equal to 1.25 for permanent and variable actions and equal to 1.10 for accidental actions. Details on the procedure followed to define the value of the partial factor γ_f are provided in Appendix B.

(2) For ultimate limit states (ULS), in case of shear stress and for assessing the effect of confinement induced by FRP stirrups on concrete elements under axial and bending forces or under mainly axial stresses, the value to be assigned to the partial factor for FRP bars, γ_f, is 1.40 for permanent and variable actions and 1.25 for accidental actions. Details on the procedure followed to define the value of the partial factor γ_f are provided in Appendix B.

(3) For all serviceability limit state (SLS) verifications, the value to be assigned to the partial factor is $\gamma_f = 1$.

(4) For concrete and steel reinforcement (in the case of hybrid reinforcement structures), the partial factors prescribed by the current Standards shall be adopted.

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

DESIGN PRINCIPLES – Temperature & environmental conversion factors

- η_T is a conversion factor accounting for temperature effects, to be evaluated as described in § 4.6.1 depending on the exposure conditions of the structure;
- η_a is an environmental conversion factor accounting for the durability of the bars as a function of the exposure conditions of the structure, to be evaluated as described in § 4.6.1;

Table 4-1 - Values of the factors η_T and η_a under different exposure conditions of the structure

Exposure condition	**Exposure class***	η_T	η_a
1 (indoor dry environment)	X0, XC1 dry	1.0	GFRP: 0.85 CFRP: 0.95
2 (outdoor dry environment)	XS1	1.0: for elements not directly exposed to solar radiation 0.9: for elements directly exposed to solar radiation	GFRP: 0.85 CFRP: 0.95
3 (permanently or cyclically humid environment)	XC1 humid, XC2, XC3, XC4 XD1, XD2, XD3 XF1, XF2, XF3, XF4 XS2, XS3 XA1, XA2, XA3	1.0: for elements not directly exposed to solar radiation 0.9: for elements directly exposed to solar radiation	GFRP: 0.70 CFRP: 0.85

*The exposure classes are defined in EN 1992-1-1 (2023). For completeness, the same nomenclature used for RC structures with steel reinforcement has been adopted

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

DESIGN PRINCIPLES – long term effect conversion factor (static fatigue = creep)

- $\eta_{c,l}$ is a conversion factor accounting for static fatigue effects (*creep rupture*) under long-term loads, to be evaluated as described in § 4.6.2.

(1) The effects of static fatigue (*creep rupture*) in FRP bars under long-term loads have to be considered both at SLE verifications, limiting the tensile stress in the bars under the quasi-permanent load combination, and at the SLU, adopting a reduced value of the tensile strength in the FRP bars that depends on the stresses in the bars under quasi-permanent load combination.

(2) For verifications at the Ultimate Limit State (ULS), the effects of static fatigue produced by long-term loads are accounted for by defining the conversion factor for long-term loads $\eta_{c,l}$, reported in Equation (4.3) and defined as follows:

$$\eta_{c,l} = 1 - (1 - \eta_c) \cdot \frac{\sigma_{f,qp}}{f_{ftk,c}} = 1 - \left(\frac{1}{\eta_c} - 1 \right) \cdot \frac{\sigma_{f,qp}}{f_{ftk0}} \qquad (4.4)$$

where

- $\sigma_{f,qp}$ is the current stress acting in the FRP bar under the long-term loads, , calculated with reference to the quasi-permanent combination of actions;

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

DESIGN PRINCIPLES – long term effect conversion factor (static fatigue = creep)

- $f_{\mathrm{ftk,c}}$ is the characteristic value of the tensile strength of the FRP bar due to creep rupture at a time corresponding to the reference service life of the bars, conventionally taken as 100 years according to the definition given in *EAD-FRP bars*;
- $\eta_c = \dfrac{f_{\mathrm{ftk,c}}}{f_{\mathrm{ftk0}}}$ is the conversion factor for static fatigue (*creep rupture*) at 100 years, where f_{ftk0} is the characteristic value of the tensile strength of the FRP bar in the absence of environmental, temperature, or long-term load effects.

MAKE
MORE
POSSIBLE™

CNR-DT 203R1/2026

DESIGN PRINCIPLES – long term effect conversion factor for Static Fatigue

Equation (4.4) shows that, in the combination of actions at ULS, and in the case of relevant long-term stresses, the tensile strength of FRP bars is reduced compared to the characteristic strength f_{ftk0}. In particular, the conversion factor $\eta_{c,l}$ lies between η_c and 1. It is generally greater than η_c and coincides with it only if the level of quasi-permanent stress $\sigma_{f,qp}$ is precisely equal to the creep rupture strength $f_{ftk,c}$. For safety, it is possible to assume $\eta_{c,l} = \eta_c$ in the checks regarding ULS load combinations.

(3) The *EAD-FRP bars* indicates how to experimentally obtain the strength $f_{ftk,c}$ to be introduced in equation (4.4). In the absence of specific experimental indications for the strength $f_{ftk,c}$, the conversion factor for *creep rupture* at 100 years, η_c, may be assumed as the values given in Table 4-2, and consequently, $f_{ftk,c} = \eta_c \cdot f_{ftk0}$.

Table 4-2 - Conversion factor for static fatigue (*creep rupture*) at 100 years, η_c, for FRP bars

Loading mode	Fiber type	η_c
Quasi-permanent	Glass	0.50
	Carbon	0.80

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

DESIGN PRINCIPLES – long term effect conversion factor for Dynamic Fatigue

(6) With regard to the effect of repeated cyclic loads, which for number of cycles and amplitude of the stress variation may cause fatigue phenomena in the materials, the performance of FRP bars is generally excellent. Among the different types, glass fiber bars are the most susceptible to the effects of cyclic loads. Lacking experimental data on the tensile strength of the FRP bars under fatigue loads (i.e., the mechanical characteristic f_{fatigue} defined in E*AD-barre FRP* at §2.2.7 and in *LG-barre FRP* in Tab. 3), it is possible to carry out the verifications at ULS under cyclic actions that produce fatigue effects adopting the Eq. (4.3) for calculating the tensile strength in the FRP bars and assuming, on safety side, that $\eta_{c,l}$ is substituted by η_c that have the value listed Table 4-2.

MAKE
MORE
POSSIBLE™

CNR-DT 203R1/2026

DESIGN PRINCIPLES – Bond anchorage length

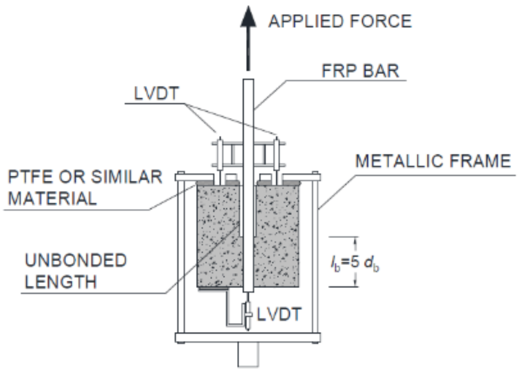


Figure 5-3 – Scheme of a pull-out test for the experimental characterization of the bond model of FRP bars.

Two bond performance classes has been defined based on the results of the testing performed according to EAD and certified in ETA:

Class 1: $\tau_{bm} > 15.0$ MPa
Class 2: $7.0 \text{ MPa} \leq \tau_{bm} \leq 15.0$ MPa

For FRP rebars with bond performance in class 1:

$$\ell_a = k_{cp} \cdot k_\ell \cdot d_b \cdot \left(\frac{\sigma_{fd}}{500}\right)^2 \cdot \left(\frac{25}{f_{ck}}\right)^{4/5} \cdot \left(\frac{d_b}{20}\right)^{2/5} \cdot \left(\frac{1.5 d_b}{c_d}\right)^{1/2}$$

With $k_t = 30$

For FRP rebars with bond performance in class 2:

$$\ell_a = k_{cp} \cdot k_\ell \cdot d_b \cdot \left(\frac{\sigma_{fd}}{500}\right)^{3/2} \cdot \left(\frac{25}{f_{ck}}\right)^{3/5} \cdot \left(\frac{d_b}{20}\right)^{3/10} \cdot \left(\frac{1.5 d_b}{c_d}\right)^{1/2}$$

With $k_t = 65$

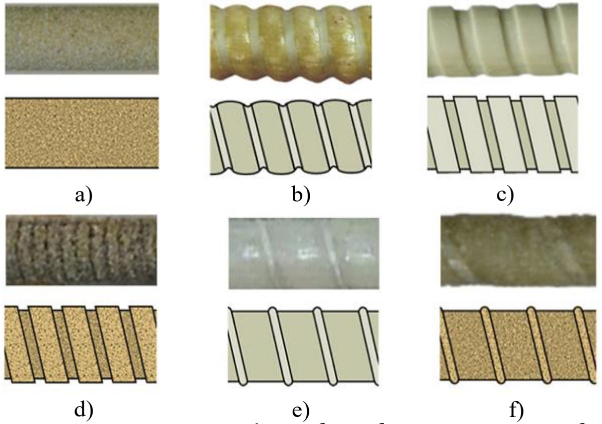


Figure 5-1 – Examples of surface treatment for enhancing bond with concrete

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

DESIGN PRINCIPLES – BOND BEHAVIOUR

where:

- k_{cp} is a coefficient accounting for the position of the bar during casting and its effect on bond (equal to 1.0 or 1.2 for good or poor bond conditions, respectively, as specified in EN 1992-1-1:2023);
- $c_d = \min(c_{geom,x}, c_{geom,y}, 0.5c_i, 3.75d_b)$, where $c_{geom,x}$ and $c_{geom,y}$ are the geometrical cover measured in the horizontal and vertical direction, respectively, c_i is the spacing between adjacent FRP bars, and d_b is the nominal diameter of the FRP bars.

The term $\left(\frac{1.5d_b}{c_d}\right)^{1/2}$ is considered in (5.2) only if it is greater than 1.

The exponents and the coefficient k_ℓ of these expressions were obtained through statistical analyses and regression of experimental results.

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

DESIGN PRINCIPLES – BOND BEHAVIOUR

(3) To ensure that anchorage is provided for an FRP bar subjected to a tensile stress level σ_{fd}, the anchorage length, given by (5.2a, b) and measured from the section beyond which the bar is no longer considered effective but only anchored, shall not be less than the greater of 300 mm or 20 d_b, regardless of bar diameter or bond quality class. Therefore, the design value of anchorage length, ℓ_{ad} shall be taken as:

$$\ell_{ad} = \max\left(\ell_a, 300\,\text{mm}, 20d_b\right) \tag{5.3a}$$

(4) For exposure condition 3, the design value of anchorage length, ℓ_{ad}, in Eq. (5.3a) shall be increased considering the environmental reduction factor η_a from Table 4-1, as follows:

$$\ell_{ad} = \frac{1}{\eta_a}\max\left(\ell_a, 300\,\text{mm}, 20d_b\right) \tag{5.3b}$$

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

DESIGN PRINCIPLES – Anchorage length with bent bars

(6) If it is not possible to assure the design anchorage length ℓ_{ad} required by (5.3), anchorage of straight bars may be achieved by overlapping with additional FRP bars of the same nominal diameter, bent at 90° at their ends (Figure 5-4). The lap length of the straight portion of the additional bent bar shall be:

$$\ell_s = 1.25 \cdot \ell_{ad} \quad (5.4)$$

This anchorage method, often used to simplify reinforcement detailing (since it allows the main reinforcement bars to remain straight), shall be carefully considered in heavily reinforced sections, as significant reinforcement congestion may result. After bending at 90°, the hooked bar shall have a straight extension at least equal to 10 times the nominal bar diameter d_b: $L_t \geq 10 d_b$ (Figure 5-4).

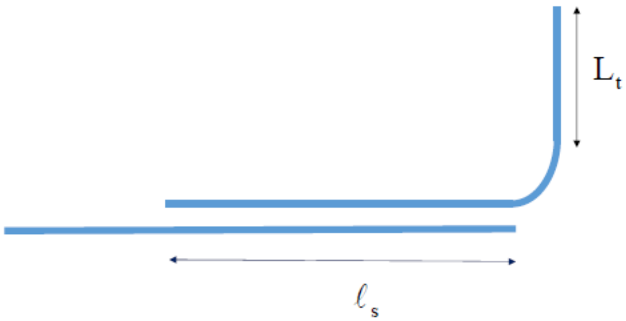


Figure 5-4 – Anchorage of FRP bars by overlapping with 90° bent bars

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

DESIGN PRINCIPLES – Lap splices

(5) The lap splicing of tensile FRP bars shall be carried out only in regions where the stress in the bars is less than 80% of the design tensile strength evaluated at the Ultimate Limit State, f_{ftd}. The minimum lap splice length, ℓ_{s}, shall be taken as:

$$\ell_{\mathrm{s}} = 1.25 \cdot \ell_{\mathrm{ad}} \tag{6.33}$$

where ℓ_{ad} is given by Equation (5.3).

MAKE
MORE
POSSIBLE™

6.8.1 Concrete cover

(1) The relatively high values of transverse thermal expansion of FRP bars compared with concrete, together with the Poisson effect in the case of compressed reinforcement, may induce significant circumferential tensile stresses in the concrete around the bar, initiating radial cracking (Figure 6-3). These cracks can damage the bond at the concrete–FRP bar interface, with adverse effects on the structural behavior under both service and ultimate conditions, as well as on the structure's durability.

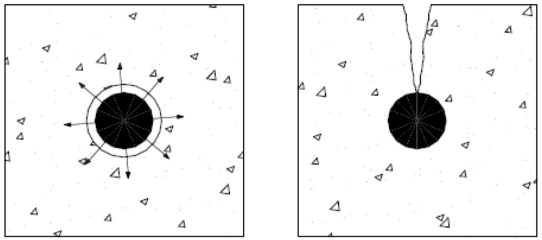


Figure 6-3 - Cracking induced by FRP transverse expansion and consequent normal stresses in the concrete surrounding the bar.

CNR-DT 203R1/2026

DESIGN PRINCIPLES – CONCRETE COVER

(2) To prevent the formation of radial cracks around the bars, it is recommended to adopt a sufficiently large geometric concrete cover c_{geom} (i.e., the distance from the outer face of the bar to the element surface), whose minimum value is given by the following relationship:

$$c_{geom} \geq c_{min,b} + \Delta c_{dev} \tag{6.28}$$

where Δc_{dev} is the additional cover allowance accounting for construction tolerance, defined in accordance with Eurocode 2 (Table 6.7, EN 1992-1-1: 2023) and $c_{min,b}$ is a minimum value related to the bond shear stresses transferred by the bar to the surrounding concrete that shall be: $1.5d_b \leq c_{min,b} \leq 50\text{mm}$, being d_b the nominal diameter of the FRP bar.

When FRP stirrups are presents, c_{geom} is the distance of the outer face of the stirrup to the element surface and shall be calculated according to Eq. (6.28), but adopting the following indication: $\min(1.5d_b;10\text{mm}) \leq c_{min,b} \leq 38\text{mm}$.

It has to be noted that in concrete elements reinforced with FRP bars, in Eq. (6.28) there is no term related to the durability, that on the contrary for steel bars is present and depends on the exposure environmental conditions and on the design service life of the structure.

MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

LIMIT STATE DESIGN – ULS & SLS

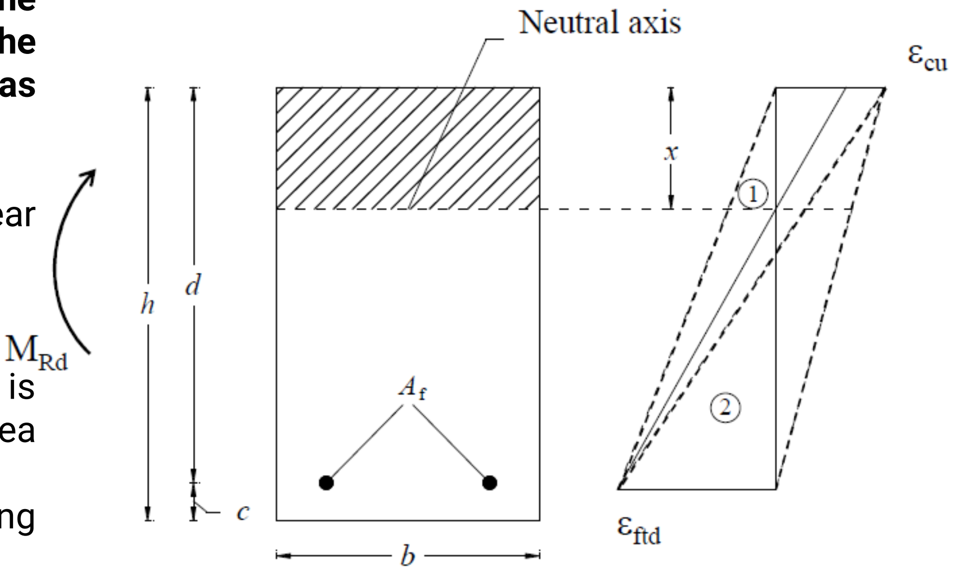
MAKE
MORE
POSSIBLE™

CNR-DT 203R1/2026

LIMIT STATE DESIGN – ULS & SLS

The fundamental assumptions underlying the calculation of the design flexural resistance M_{Rd} at the ultimate limit state for a RC section with FRP bars are as follows

- Sections remain plain up to failure, with a linear distribution of normal strains in both compressed;
- Concrete and FRP tensile reinforcement;
- The tensile strength of concrete is neglected;
- The contribution of FRP bars in compression is neglected, but it is permitted not to deduct the area of concrete corresponding to them.
- The constitutive law for concrete is taken according to the current Code;
- The constitutive law for FRP bars is assumed to be linear-elastic up to failure.



MAKE MORE POSSIBLE™

CNR-DT 203R1/2026

DESIGN PROVISIONS IN SEISMIC AREAS

MAKE
MORE
POSSIBLE™

CNR-DT 203R1/2026

DESIGN PROVISIONS IN SEISMIC AREAS

(1) The lack of ductility and the limited energy dissipation capacity are inherent characteristics of FRP bars and shall be carefully considered in situations where seismic actions may be significant. Consequently, it is not possible to directly apply the seismic design criteria established for RC structures with steel reinforcement to structures reinforced with FRP bars. However, in many cases, it is still possible to design such structures without requiring ductility from the reinforcement, at least for some structural elements. Moreover, there are several potential applications of FRP-RC in which static design requirements are more demanding than seismic ones; in these cases, the design approach may follow the provisions described in Chapter 6 of these Guidelines. Additionally, in prefabricated construction, certain elements that do not belong to the primary seismic-resisting system may also be reinforced with FRP bars.

(2) In general, structural elements made of FRP-RC constituting the primary seismic-resisting system shall not be used in high-seismicity zones, defined as those where, at the Life-Safety Limit State, the anchoring acceleration of the design spectrum exceeds $S\, a_g > 0.375g$ ([1]). This limitation stems from the current lack of sufficient experimental research on the behavior of FRP-RC structures subjected to seismic actions that may induce large displacements. In this context, potential applications of concrete structures with non-metallic reinforcement can be grouped into the following three categories:

a) Structures in which seismic actions cause only limited variations in internal forces compared with those evaluated under non-seismic load combinations, as well as structures not belonging to the seismic-resisting system.
b) Structures forming part of the seismic-resisting system and designed as non-dissipative systems, with a behavior factor $1 \leq q \leq 1.5$.
c) Structures forming part of the seismic-resisting system and designed to exhibit dissipative behavior in accordance with ductility-based design principles. In this case, it is necessary to adopt hybrid reinforcement, i.e., to use both steel and FRP bars.

CNR-DT 203R1/2026

EXECUTION REQUIREMENTS

MAKE
MORE
POSSIBLE™

The Original Composites Company™

ONE PRODUCT, MULTIPLE APPLICATIONS, QUALITY GUARANTEED AND CERTIFIED...ONE PARTNER IN EU: MATEENBAR BY OCF.

MAKE
MORE
POSSIBLE™

Eng. Ph.D. Paolo Casadei
Business Developer Leader - Europe
paolo.casadei@owenscorning.com
+39-340 1637482