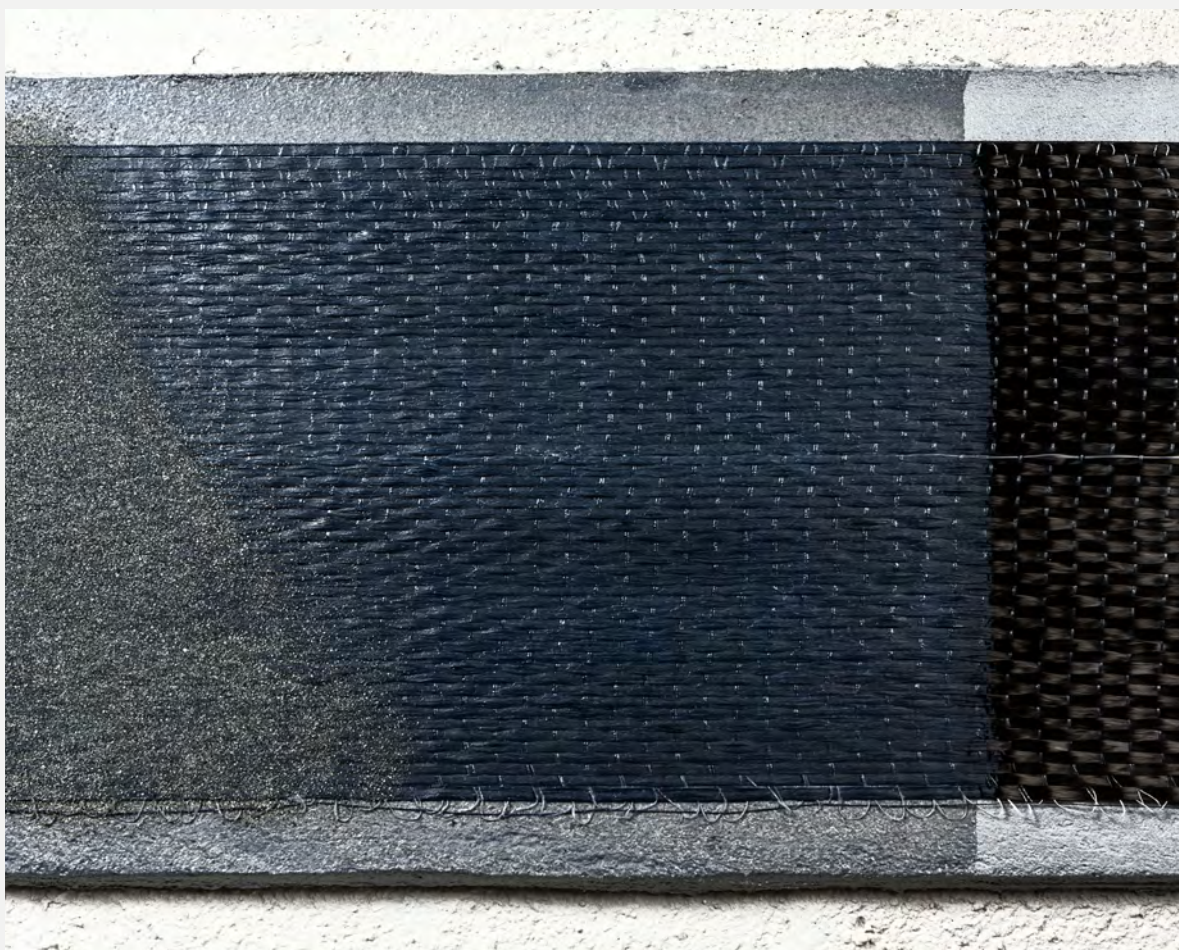


CARBO STRUCTURA

FRP Structural Strengthening System – Class 210C

System Preparation and Installation Manual



For 35 years
a trusted reference in the production
of construction materials.



Strengthening

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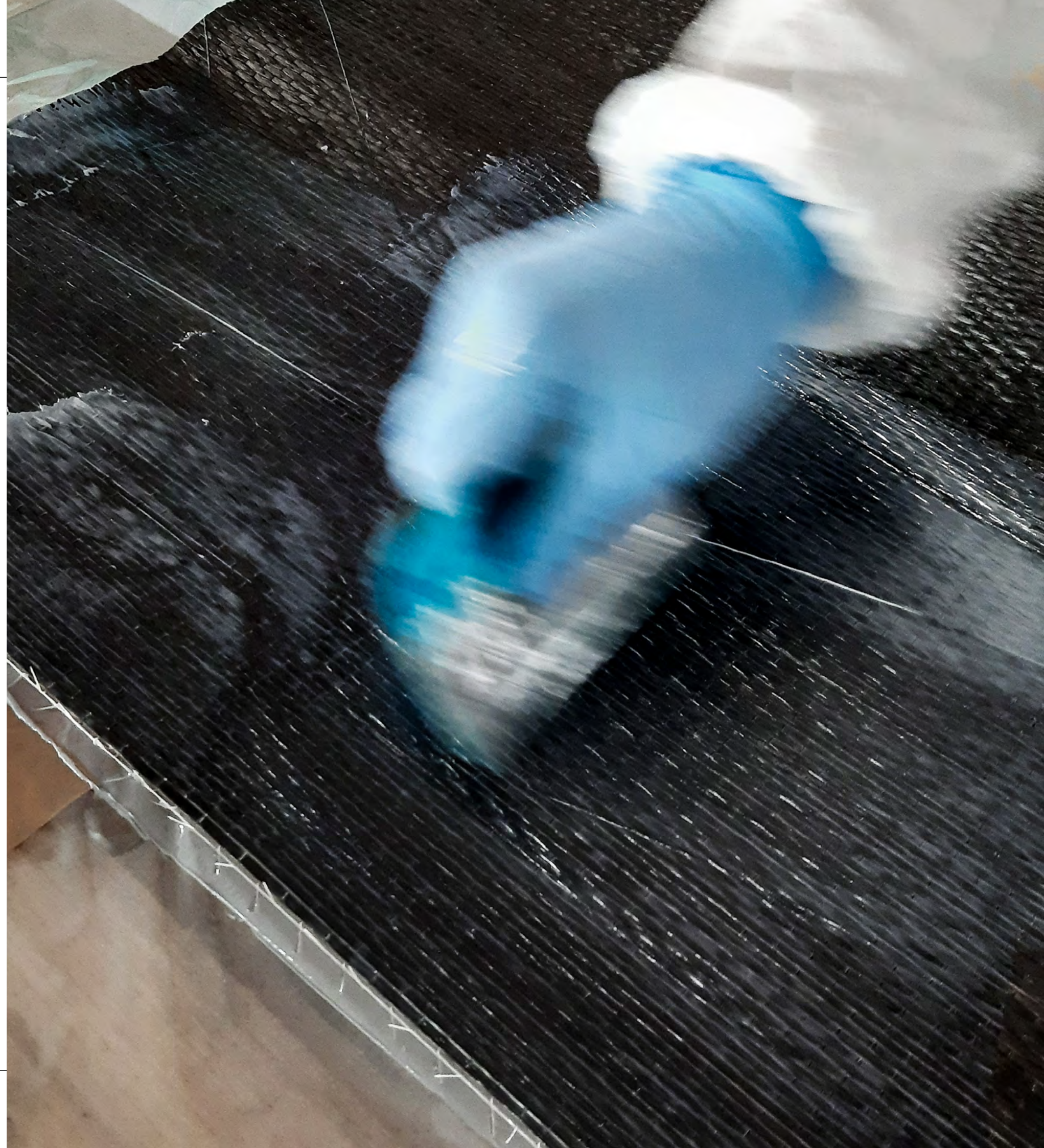
Carbo Structura System

FRP System

CARBO-STRUCTURA is an FRP structural reinforcement system made using long, continuous carbon fibers embedded in a polymer matrix.

This document refers solely and exclusively to the system known as Carbo-Structura.
Do not use this manual for any other reinforcement systems.

Carbo-Structura is impregnated on site (manual wet lay-up); therefore, the formation of the composite, intended as the fiber-matrix combination, takes place directly on the construction site.



Scope of Application

CARBO-STRUCTURA composite system can be used for the structural strengthening of existing constructions made of reinforced concrete, prestressed concrete, and masonry.

Reference Document:

- **CNR-DT 200 R2/2025**

“Guidelines for the design, execution, and inspection of structural strengthening interventions using fiber-reinforced composites. Materials, reinforced and prestressed concrete structures, masonry structures.”

Applications are also possible on timber and metal structures.

Reference Document:

- **CNR-DT 201/2005**

“Preliminary studies aimed at drafting guidelines for the structural strengthening of timber structures using fiber-reinforced composites.”

- **CNR-DT 202/2005**

“Preliminary studies aimed at drafting guidelines for the structural strengthening of metal structures using fiber-reinforced composites.”

Ideal for:

- Flexural, shear, compressive, torsional, and combined axial-flexural strengthening
- Confinement and ductility enhancement
- Jacketing and tying of structural elements
- Strengthening of elements with single and double curvature

Specifically applicable for:

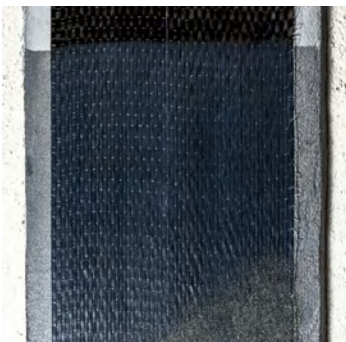
- Changes in static loads
- Changes in dynamic loads
- In-plane and out-of-plane actions
- Correction of strength hierarchy
- Prevention of collapse mechanisms



System Composition and Supply

Supplied as a kit consisting of:

- **TCS CARBON U300 fabric**
(in rolls with variable width according to project specifications, length: 50 m)
- **ELAN-TECH MC256/W256** two-component epoxy system, in 4+2 kg packages



TCS CARBON U300

Fabric: unidirectional 300 g/m² carbon fiber, made of high-strength, heat-set long carbon fibers.



ELANTECH MC256/W256

Matrix: two-component epoxy system for fiber impregnation and adhesion to the substrate

The system is classified as 210C in accordance with the “Guidelines for the identification, qualification, and acceptance control of fiber-reinforced polymer (FRP) composites to be used for the structural strengthening of existing buildings.”

The CARBO-STRUCTURA composite system is supplied as a kit consisting of TCS CARBON U300 fabric, delivered in rolls with variable width according to project specifications and a standard length of 50 meters.

The ELAN-TECH MC256/W256 two-component epoxy resin is supplied in 4+2 kg packages.

Each component is labeled with the batch number and the system name.

The supply must be accompanied by this document, “Preparation and Application Manual of the System,” and the corresponding “Technical Assessment Certificate No. 427.”



PPE and Equipment

Before starting product preparation and subsequent application, the following personal protective equipment (PPE) must be used:

- Protective suit
- Gloves
- Face mask
- Safety goggles

Tools required for product preparation:

- Clean, dust-free work surface
- Measuring tape
- Scissors
- Electronic scale
- Clean containers
- Low-speed mixer

Tools required for product application:

- Roller
- Brush
- Spatula

For cleaning tools:

- Acetone



Substrate Preparation

Substrate preparation is the most delicate and critical phase to ensure the proper performance of the FRP system.

This manual addresses the preparation of concrete and masonry substrates.
For applications on wood or metal substrates, more specific analyses are required.

Assessment of Substrate Quality

If the substrate is deteriorated, it must be restored using appropriate repair products with mechanical properties at least equivalent to those of the existing material.

The substrate must have homogeneous characteristics to ensure uniform fracture behavior.
The surface roughness should not be less than 0.3 mm.

In the case of plaster or paint coatings, these must be removed. If removal is limited to the application area, a “track” must be cleared equal to:
50 mm + reinforcement strip width + 50 mm.

For sound or new substrates, ensure there are no release agents, dust, grease, hydrocarbons, or surfactants present.

For shear, torsion, or confinement reinforcements, all edges must be rounded with a minimum curvature radius of 20 mm.
The substrate area to be reinforced must be flat and even—any convex surfaces must be corrected.

Note on Masonry

Special attention must be given to masonry affected by salt efflorescence and rising damp, as these conditions can degrade the substrate. Therefore, the long-term effectiveness of the reinforcement system must be carefully evaluated.

Substrate deterioration may lead to detachment of the reinforcement system.

In such cases, the use of alternative reinforcement systems with an inorganic matrix, such as CRM systems like FORTIUS, is recommended.

Product Preparation



1. REINFORCEMENT FABRIC

The fabric is ready for use.
It is recommended to pre-cut it into strips of the lengths specified in the project to optimize application time.
Cut the fabric on clean, dust-free work surfaces.
Roll up the pre-cut strips. Always store the fabric indoors in a dry, dust-free environment.



2. EPOXY SYSTEM

The epoxy system used for impregnation and structural bonding is two-component:

Component A: white, 4 kg
Component B: dark gray, 2 kg

Always verify that both components have a very dense consistency.



3. MIXING

Pour Component B (hardener) into the container of Component A (resin). For partial mixes, always maintain a 2:1 weight ratio using an electronic scale.
Mix mechanically at low speed or manually until the two components are completely blended.

The contrasting colors help verify thorough mixing, resulting in a homogeneous, thixotropic, light gray mixture.



4. POT LIFE

The product reacts more quickly when mixed in bulk. Therefore, after mixing the supplied packages, transfer the product into a larger, shallow container to increase working time.

Pot life of the epoxy system (6 kg batch in a 4 cm thick container):

- At +10°C: 85–95 minutes
- At +20°C: 35–40 minutes
- At +30°C: 20–25 minutes

FRP System Installation



1. APPLICATION OF THE FIRST RESIN LAYER

Before application, ensure the substrate is completely dry.
The application temperature should be between +10°C and +30°C. For temperatures outside this range, the intervention area must be conditioned accordingly.
Apply the first layer of epoxy resin system (approximately 300 g/m²) using a roller, brush, or spatula.
No primer is required.



2. FABRIC APPLICATION

Lay the fabric onto the first resin layer. Gently pat the fabric with your fingers to ensure adhesion.
Use a short-nap painter's roller to remove any wrinkles and verify proper impregnation of the fabric.
Avoid using metal spiked rollers (bubble breakers) as they may damage the fibers.



3. APPLICATION OF THE SECOND RESIN LAYER

Apply the second layer of epoxy resin (approximately 300 g/m²). Roll continuously along the fiber direction to fully impregnate the fibers and eliminate any air bubbles, ensuring proper saturation.
For additional reinforcement layers after the first, repeat the above steps wet-on-wet.



4. SPRINKLE SILICA SAND

If a protective or finishing plaster is to be applied, after lamination is complete, sprinkle silica sand with a minimum particle size of 1 mm onto the fresh resin layer (wet-on-wet).

On-Site Acceptance Control

On-site acceptance testing is carried out through destructive tests on specimens. For the number and type of tests, please refer to the Guidelines for the Qualification and Acceptance Control of Fiber-Reinforced Polymer (FRP) Composites for Structural Strengthening of Existing Buildings.

On-site acceptance tests:

- Are mandatory and fall under the responsibility of the Site Manager (Construction Supervisor)
- Are exclusively mechanical tests

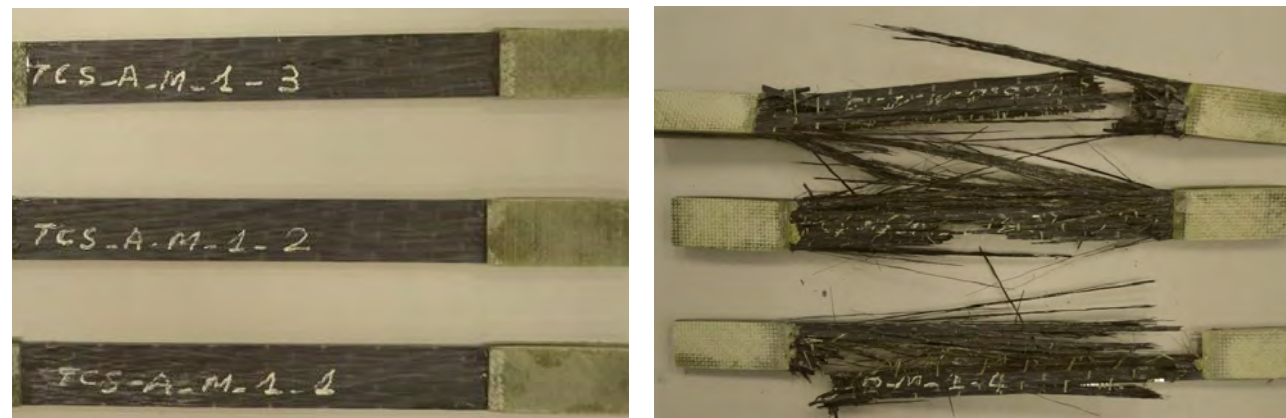
Tests must be performed on samples taken from laminates produced on-site using the supplied base materials and following the installation procedures prescribed by the supplier, employing the same site personnel.

Mechanical tests must be conducted by a laboratory authorized according to Article 59 of DPR 380/2001, within a timeframe deemed appropriate by the Site Manager for verifying the quality and compliance with project specifications of the supplied reinforcements, and in any case, no later than 30 days after sampling.

Environmental conditions during testing must match those of the installation site.

Laminates must be produced for each class of reinforcement system to be installed, also considering the possible presence of multiple suppliers. Each laminate must consist of 3 layers.

From each laminate, 3 samples must be extracted for each shipment batch and for every 500 m² or fraction thereof of reinforcement system, provided that the marking and accompanying documentation prove that the reinforcement system originates from the same supplier.



Checks for Proper Installation

Semi-destructive tests (such as tensile or shear pull-off tests) are primarily indicative for the mechanical characterization of the installed reinforcement system.

Any defects in the installation can instead be detected through non-destructive testing methods, including acoustic, ultrasonic, thermographic, and dynamic tests.

For the number and types of tests, please refer to the document CNR-DT 200 R2/2025.



Protection of the Reinforcement System

Protection of the CARBO-STRUCTURA reinforcement system must comply with the provisions of the document CNR DT 200 R2/2025, paragraphs 4.9.2.3 and 5.9.2.3, excerpted below:

1. For applications in outdoor environments, it is advisable to protect the reinforcement system from direct solar radiation, which can cause chemical-physical alterations in the epoxy matrix.

This can be achieved by applying protective acrylic paints, either water-based or solvent-based, after cleaning the composite surface with a sponge soaked in soapy water.

2. Alternatively, higher protection can be ensured by applying plasters or mortars on the composite

These plasters, with thicknesses generally recommended by manufacturers and/or suppliers, must be applied after preparing the surface with an epoxy resin layer, followed by a fresh-on-fresh broadcast of silica sand.

3. For fire protection, two different techniques may be used: intumescent panels or protective plasters.

In both cases, manufacturers and/or suppliers must specify the degree of protection relative to the coating thickness.

Maintenance

The reinforcement system must be monitored throughout the service life of the structure to assess its condition.

Inspection methods and frequency should be established case by case, based on the type of reinforced structure.

Special attention should be given following:

- Seismic events
- Exceptional structural loads
- Impacts or damage to the structure
- Work activities near the reinforcement system

Initially, a visual inspection with tapping on the intervention areas is recommended to detect any detachment. Subsequently, a non-destructive diagnostic cycle can be considered, including:

- Thermography
- Ultrasonic testing
- Dynamic testing

If any detachment and/or damage of the reinforcement system is detected, prompt restoration must be carried out.

Operating Temperature Limits of the Composite

The CARBO-STRUCTURA system has undergone durability testing, including freeze-thaw cycles, where specimens were subjected to temperature ranges from -18°C to +38°C.

At the end of the conditioning tests, the specimens were found to be in excellent condition, showing no signs of damage or degradation.

Mechanical tests conducted on these specimens revealed ultimate strength and elastic modulus values consistent with those of unconditioned specimens.

Therefore, the following operating temperature limits are established:

- Lower temperature limit: -18°C
- Upper temperature limit: +43°C (Glass transition temperature, T_g, 2nd heating cycle: -15°C)



The following tables present the main values obtained from tests conducted for the qualification of FRP composite materials in accordance with the “Guidelines for the Identification, Qualification, and Acceptance Control of Fiber-Reinforced Polymer (FRP) Composites to be Used for the Structural Strengthening of Existing Buildings” issued by the Italian Superior Council of Public Works (Consiglio Superiore dei Lavori Pubblici), approved in May 2019.

This document updates and replaces the previous Guidelines published with DP No. 220 on July 9, 2015. The document is available for download on the website of the Superior Council of Public Works.

Proprietà meccaniche FRP

TYPE OF LAMINATE CLASS 210C		FAILURE LOAD (kN)	FAILURE STRESS (MPa)	ELASTIC MODULUS (GPa)
MECHANICAL TESTS (UNI EN 2561)				
3 LAYERS of 300 g/m²	(average)	42,47	4032,56	250,55
	CoV [%]	7,43	6,01	2,70
	Characteristic value	36,16	3547,51	237,03
ULTIMATE STRAIN [%] ϵ_{fib}		1,42 (Assumed linear elastic behavior, $\epsilon_{fib} = f_{fib} / E_f$)		
MECHANICAL TESTS (UNI EN 2561)				
5 LAYERS of 300 g/m²	(average)	63,09	3527,67	241,44
	CoV [%]	6,44	5,90	2,20
	Characteristic value	54,94	3111,24	230,79
ULTIMATE STRAIN [%] ϵ_{fib}		1,29 (Assumed linear elastic behavior, $\epsilon_{fib} = f_{fib} / E_f$)		
MOISTURE RESISTANCE				
3 LAYERS of 300 g/m²	(average)	37,29	3560,15	245,43
ALKALINE ENVIRONMENT RESISTANCE				
3 LAYERS of 300 g/m²	(average)	43,59	4332,8	259,96
SALINE ENVIRONMENT RESISTANCE				
3 LAYERS of 300 g/m²	(average)	42,51	4237,6	258,96
FREEZE/THAW CYCLE RESISTANCE -18°C / +38°C				
3 LAYERS of 300 g/m²	(average)	41,51	4121,1	258,48

Geometric and Physical Properties

PROPERTY	VALUE
Fiber density [g/cm³]	1,822
Fabric mass per unit area [g/m²]	319,17 (300 nominal)
Equivalent area [mm²/m]	165
Equivalent thickness [mm]	0,165
Resin density [g/cm³]	1,31
Mixing ratio (by weight)	2:1
Fiber weight fraction in the composite [%]	31,22
Fiber volume fraction in the composite [%]	24,17
Glass transition temperature – three samples (UNI EN ISO 11357) [°C] – First heating cycle	42,10
Glass transition temperature – three samples (UNI EN ISO 11357) [°C] – Second heating cycle	58,50
Application temperature range [°C]	+10 / +30
Service temperature range [°C]	-18 / +44
Fire resistance	-
Reaction to fire	Class F

For additional information, technical support, and/or practical demonstrations regarding the system, please contact our technical service.



The images, colors, coverage values, and information presented in this catalog are for illustrative purposes only and do not constitute a binding reference. They are intended solely to help better understand the application of the products or systems.

For all technical data, always refer to the most recent versions of the technical data sheets available on our website.

For additional product information and practical demonstrations, please consult our technical department.

For all goods supplied by TCS, a technical data sheet, a safety data sheet, and the relevant certifications are always available.

The company reserves the right to make any changes it deems necessary at any time and without prior notice. Therefore, always ensure that the documents in your possession are up to date.

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