



C-MATRIX SYSTEM

C-MATRIX C225N15-H

FRCM (FIBER REINFORCED CEMENTITIOUS MATRIX) REINFORCEMENT SYSTEM FOR THE RESTORATION AND STRUCTURAL STRENGTHENING OF HISTORIC AND MODERN MASONRY BUILDINGS

C-MATRIX C225N15-H is an FRCM reinforcement system that combines the effectiveness of a bidirectional high-strength carbon fiber mesh impregnated with an inorganic matrix based on natural hydraulic lime (NHL). This system offers excellent chemical-physical and elastomechanical properties, ensuring optimal compatibility with supporting materials, even in architectural assets under preservation or protection constraints.

System components:

- **FB-RC225-TH12S:** A bidirectional high-strength carbon fiber mesh impregnated with an organic matrix, with a dry weight of 206 g/m². This provides high tensile strength for the entire system and ensures proper distribution of both static and seismic stresses.
- **EPOCA CALCE CNHL115:** A structural mortar based on natural hydraulic lime (NHL), with a compressive strength of ≥ 15 MPa, ensuring effective stress transfer through strong adhesion between the system and the substrate.

The bidirectional high-strength carbon fiber mesh, characterized by flexibility and adaptability to irregular surfaces, as well as high mechanical resistance, works synergistically with the inorganic matrix to create a homogeneous, low-thickness reinforcement. This reinforcement does not alter the mass distribution or structural stiffness. The system integrates seamlessly with the existing masonry, thereby enhancing the resistance and ductility of the structure, even in seismic hazard contexts.

C-MATRIX C225N15-H ensures excellent chemical and mechanical compatibility with traditional building materials, making it suitable for the consolidation of buildings of high historical and artistic value. Interventions carried out with this reinforcement system are structurally effective while minimizing impact, thereby preserving the architectural value of the existing structures.

In compliance with the provisions of EAD 340275-00-0104 "Externally bonded composite systems with inorganic matrix for strengthening of concrete and masonry structures," **C-MATRIX C225N15-H** is CE marked for structural consolidation applications.

APPLICATION FIELDS

- Structural reinforcement and seismic enhancement of existing masonry with a high quality index
- Increase in structural resistance and ductility
- Prevention of local and/or global collapses
- Reinforcement of arches and vaults in masonry, including those of reduced thickness
- Confinement and reinforcement of masonry columns
- Anti-overturning protection and reinforcement of non-structural elements (NSEs) (e.g., infill walls on framed structures)
- Reinforced masonry coping walls.

MAIN ADVANTAGES

1. **High performance:** The system improves the tensile strength of the masonry, ensuring structural safety even in seismic contexts and under high stress, without increasing the rigidity and mass of the structure.
2. **Durability and compatibility:** The matrix-reinforcement system ensures optimal chemical-physical compatibility with masonry and the durability of the intervention.
3. **Ease of application:** The bidirectional high-tensile carbon fiber mesh is lightweight, flexible, manageable, and easy to install. The "fresh on fresh" application, combined with the characteristics of the mesh, helps reduce reinforcement installation time.
4. **Environmental sustainability and living comfort:** Thanks to the use of a matrix based on natural hydraulic lime, the system is breathable, eco-friendly, and has a low environmental impact.
5. **Versatile solution:** Suitable for both historical buildings and modern masonry structures, **C-MATRIX C225N15-H** is a thin, non-invasive reinforcement solution, ideal for use on various types of supports, including non-flat ones like vaults and arches, columns, etc.
6. **Reversibility of the intervention:** The **C-MATRIX C225N15-H** system meets the reversibility criteria required for listed architectural heritage, ensuring non-invasive and easily removable interventions.

TECHNICAL DATA OF THE SYSTEM

	Description of the system
Commercial Name	C-MATRIX C225N15-H
Manufacturer	Fibre Net SpA
Type of reinforcement	FB-RC225-TH12S Bidirectional carbon fiber mesh high tenacity impregnated
Type of matrix	EPOCA CALCE CNHL115 Lime-based NHL mortar
Nominal thickness of the reinforcement system	8 mm

MECHANICAL CHARACTERISTICS OF THE SYSTEM

Pull-off tests	Support: brick masonry		U.M.	Ref.
	Value average	Value characteristic		
conventional limit tension $\sigma_{lim,conv}$	2104	1460	MPa	EAD 340275-00- 0104
conventional limit strain $\varepsilon_{lim,conv}$	1,05	-	%	
	Support: stone masonry			
conventional limit tension $\sigma_{lim,conv}$	1291	942	MPa	
conventional limit strain $\varepsilon_{lim,conv}$	0,65	-	%	
	Support: tuff masonry			
conventional limit tension $\sigma_{lim,conv}$	977	710	MPa	
conventional limit strain $\varepsilon_{lim,conv}$	0,49	-	%	
Tensile tests	Value average	Value characteristic	U.M.	
ultimate tension σ_u of the composite	2189	999	MPa	
ultimate strain ε_u of the composite	1,31	0,82	%	
stiffness modulus E_1 , in stage A	1187	-	GPa	
effective lap tension (l=250mm) σ_{lap}	-	> 90% $\sigma_{u,k}$	-	LG 2022 FRCM quali- fication

GEOMETRIC, MECHANICAL AND PHYSICAL DATA OF THE REINFORCEMENT

Properties	Description	Ref.
Commercial name	FB-RC225-TH12S	
Grammage of the (dry) mesh in warp	103 g/m ²	ISO 11667:1997
Grammage of the (dry) mesh in weft	103 g/m ²	
Equivalent thickness of the reinforcement mesh in both directions	0.058 mm	EAD 340275-00-0104
Density of the material constituting the reinforcement mesh	1.78 g/cm ³	
Mesh size	16 x16 mm	Internal method

Tensile tests	Value average	Value characteristic	U.M.	Ref.
Ultimate tension σ_{uf} of the mesh	2386	1444	MPa	EAD 340275-00- 0104
Elastic modulus E_f of the mesh	200	160	GPa	

Ultimate tensile strain ϵ_{uf} of the mesh	1,20	-	%	
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MECHANICAL CHARACTERISTICS OF THE MORTAR

Properties	Description	Ref.
Commercial name	EPOCA CALCE CNHL115	
Class	M15	EN 998-2
Compressive strength at 28 days	≥ 15 MPa	EAD 340275-00-0104
Elastic modulus at 28 days	≥ 10 GPa	
Adhesion to the brick substrate	≥ 0.5 MPa (FP: A)	EN 1015-12
Percentage by weight of organic components	< 10 %	-
Vapor permeability	15 / 35	EN 998-2

System qualified with **CE Marking** and performance consistency evaluation and verification **AVCP 2+**

GUIDELINES FOR SYSTEM APPLICATION

The application of the **C-MATRIX C225N15-H** system follows a process designed to ensure maximum performance in any application context, whether historical or modern, working on masonry with an adequate quality index. Proper execution of all operational phases is essential to achieve effective and durable reinforcement.

ENVIRONMENTAL CONDITIONS

Application temperature: The system must be applied in environmental conditions ranging from +5°C to +35°C. Direct exposure to sunlight or excessive humidity should be avoided to ensure optimal curing of the mortar and proper adhesion of the mesh.

SUBSTRATE PREPARATION

Substrate preparation is crucial to ensure the full effectiveness of the C-MATRIX C225N15-H system. It is necessary to work on a healthy, compact, and mechanically resistant surface to ensure perfect adhesion of the mortar and reinforcement.

Removal of surface layers and preparation of the substrate: For interventions on load-bearing masonry, arches, or vaults, it is recommended to completely remove the existing plaster and/or surface coatings, either manually or with the aid of mechanical tools. All inconsistent or detached parts should be eliminated until reaching the healthy masonry.

Scarifying, where possible, should also be carried out on the mortar joints to a depth of ≥ 5 mm. In the presence of stubborn or particularly cohesive surface coatings or plasters that could compromise the integrity of the support if removed, a consultation with Fibre Net technicians for a specific evaluation is advised.

For interventions on vaults, mechanically remove the existing plaster until reaching the masonry. If reinforcing the extrados, check the consistency of the infill before removal and follow the steps outlined in the project.

In the presence of voids or large cracks, the support must be restored using materials compatible with the original ones, such as stones, bricks, or tuff, to maintain structural consistency and compatibility with existing materials.

Any edges where the system will be applied should be rounded with a curvature radius of at least 20 mm. After removal and the aforementioned operations, thoroughly clean the surface of dust, grease, efflorescence, and other substances using low-pressure water washing. Allow excess water to evaporate, ensuring the surface is saturated but dry (s.s.a.) before applying the mortar.

The prepared surface should be flat, but not smooth, rather rough, with a roughness index ≥ 1 mm, sufficient to ensure proper adhesion for the subsequent mortar.

For highly absorbent or mechanically weak masonry, it is recommended to apply a consolidating primer to improve mortar adhesion. This step is particularly recommended for plaster supports or substrates with low cohesion. For details on the most suitable consolidation materials, contact the company.

MORTAR PREPARATION

The **EPOCA CALCE CNHL115** mortar should be prepared by adding clean water according to the specifications in the relevant technical data sheet. Mixing and preparing the compound should be done with suitable tools and methods as outlined in the same technical data sheet.

APPLICATION OF THE FIRST LAYER OF MORTAR

On the appropriately roughened surface, thoroughly washed with low-pressure water cleaning, and with the support saturated but the surface dry (s.s.a.), proceed with the following steps. Before applying the reinforcement system, and in the presence of irregular surfaces, it is possible to level the masonry by applying a layer of **EPOCA CALCE CNHL115** mortar using a trowel, spatula, or spray application. Allow this first layer to harden for 18-24 hours.

Then, apply a first uniform layer of **EPOCA CALCE CNHL115** mortar, with a thickness of 3 to 5 mm, ensuring that the material is evenly distributed across the entire surface to be treated.

INSTALLATION OF THE REINFORCED MESH

While the mortar is still fresh, proceed with the application of the bidirectional high-tensile carbon fiber mesh, **FB-RC225-TH12S**. The mesh should be carefully positioned and gently pressed with a flat trowel to ensure it is fully embedded in the mortar layer.

At the junction points between the mesh sheets, both longitudinally and transversally, adequate overlap must be ensured as specified by **CNR-DT 215/2018**, thus ensuring the continuity and effectiveness of the structural reinforcement. In the absence of laboratory tests, a minimum overlap of **300 mm** is required. In this specific case, the system is qualified for an overlap length of **250 mm**.

APPLICATION OF THE SECOND MORTAR LAYER

Once the mesh has been positioned, apply a second layer of mortar, fresh on fresh, with a uniform thickness of about 3 to 5 mm, ensuring a total thickness of **8 mm**. This layer should completely cover the mesh and provide adequate protection to the reinforcement.

APPLICATION OF CONNECTORS (OPTIONAL)

In specific situations where a mechanical connection of the reinforcement to the supporting structure is required, high-tensile carbon fiber connectors such as **FB-TUP10-CHT** or **FB-TUF_CHT** can be used. These connectors are inserted into the masonry thickness through pre-drilled holes and embedded in the mortar layer, ensuring an effective connection between the reinforcement system and the existing structure. The installation of the connectors must be carried out according to the project's technical specifications and the guidelines provided by the company. In particular, for extrados reinforcement of arches or vaults, it is advisable to use connection systems on the reinforcement system turned at the imposts for approximately **200 mm**.

CURING AND PROTECTION

Once the reinforcement system has been applied, the surfaces must be adequately protected during the curing phase for at least **24 hours**. In particularly dry, hot, or windy climatic conditions, it is recommended to cover the surfaces with tarps or use wet curing techniques, spraying water to prevent the mortar from drying too quickly, which could compromise the quality of the reinforcement. In particularly aggressive environments or areas exposed to moisture or water, it is advisable to apply an additional protective layer with an appropriate product to ensure greater durability of the system. In these cases, it is recommended to consult the Technical Office to define the most suitable protective treatment for the specific conditions.

HANDLING AND STORAGE CONDITIONS

The system is provided in two distinct phases: the matrix (single-component hydraulic lime-based mortar) and the reinforcement (high-tensile bidirectional carbon fiber mesh).

The **FB-RC225-TH12S** meshes are available in rolls with the following dimensions:

- 100 – 150 – 200 cm (H) x 50 – 100 (L) m

The meshes should be stored in a dry, dust-free location. Direct exposure to light and heat sources should be avoided.

The **EPOCA CALCE CNHL115** mortar is supplied in the following format:

- 25 kg bag

The mortar should be stored in its original, well-sealed packaging in a dry place, protected from freezing, high temperatures, excessive sunlight, and wind during the curing period.

SAFETY INSTRUCTIONS

During all phases of preparation and application of the products, the operator must use the required Personal Protective Equipment (PPE) for the specific use of the meshes and mortars (work clothing, protective goggles, gloves, and dust mask). For specific instructions, refer to the relevant technical and safety data sheets. Avoid contact with skin and eyes; in case of contact with skin, wash with water and soap; in case of contact with eyes, rinse with water and consult a doctor.

If applying in enclosed spaces, ensure sufficient ventilation to guarantee proper air circulation.

ENVIRONMENTAL DECLARATIONS

The **EPOCA CALCE CNHL115** mortar is certified for a minimum recycled content, issued by ICMQ.

CERTIFICATIONS

The C-MATRIX C225N15-H system is CE marked in accordance with ETA no. 22/0865.

SPECIFICATION VOICE**BRICK SUPPORT**

Structural reinforcement intervention on existing brick masonry using the **FRCM C-MATRIX C225N15-H** system by Fibre Net SpA, in accordance with **EAD 340275-00-0104**, CE marked with AVCP2+ control system and compliant with CAM systems. The intervention includes the application of a first layer of **EPOCA CALCE CNHL115** mortar by Fibre Net, based on natural hydraulic lime (NHL) with compressive strength ≥ 15 MPa, followed by the application of the bidirectional high-tensile carbon fiber mesh **FB-RC225-TH12S** by Fibre Net, with a mesh size of 16x16 mm, weight of 206 g/m², equivalent thickness of 0.058 mm, characteristic conventional ultimate tensile strength of the composite of 1460 MPa, and an average elastic modulus of the mesh of 200 GPa.

Subsequently, a second layer of **EPOCA CALCE CNHL115** mortar will be applied until a total intervention thickness of 8 mm is achieved.

The following are excluded from this scope: removal of existing plaster, remediation of degraded areas, surface preparation through washing and saturation with water of the application surfaces, connectors (if required), any finishing products, and acceptance tests for materials.

All materials must comply with the technical specifications and be certified according to current regulations.

STONE SUPPORT

Structural reinforcement intervention on existing stone masonry using the **FRCM C-MATRIX C225N15-H** system by Fibre Net SpA, in accordance with **EAD 340275-00-0104**, CE marked with AVCP2+ control system and compliant with CAM systems. The intervention includes the application of a first layer of **EPOCA CALCE CNHL115** mortar by Fibre Net, based on natural hydraulic lime (NHL) with compressive strength ≥ 15 MPa, followed by the application of the bidirectional high-tensile carbon fiber mesh **FB-RC225-TH12S** by Fibre Net, with a mesh size of 16x16 mm, weight of 206 g/m², equivalent mesh thickness of 0.058 mm, characteristic conventional ultimate tensile strength of the composite of 942 MPa, and an average elastic modulus of the mesh of 200 GPa.

Subsequently, a second layer of **EPOCA CALCE CNHL115** mortar will be applied until a total intervention thickness of 8 mm is achieved.

The following are excluded from this scope: removal of existing plaster, remediation of degraded areas, surface preparation through washing and saturation with water of the application surfaces, connectors (if required), any finishing products, and acceptance tests for materials.

All materials must comply with the technical specifications and be certified according to current regulations.

TUFF SUPPORT

Structural reinforcement intervention on existing tuff masonry using the **FRCM C-MATRIX C225N15-H** system by Fibre Net SpA, in accordance with **EAD 340275-00-0104**, CE marked with AVCP2+ control system and compliant with CAM systems. The intervention includes the application of a first layer of **EPOCA CALCE CNHL115** mortar by Fibre Net, based on natural hydraulic lime (NHL) with compressive strength ≥ 15 MPa, followed by the application of the bidirectional high-tensile carbon fiber mesh **FB-RC225-TH12S** by Fibre Net, with a mesh size of 16x16 mm, weight of 206 g/m², equivalent mesh thickness of 0.058 mm, characteristic conventional ultimate tensile strength of the composite of 710 MPa, and an average elastic modulus of the mesh of 200 GPa.

Subsequently, a second layer of **EPOCA CALCE CNHL115** mortar will be applied until a total intervention thickness of 8 mm is achieved.

The following are excluded from this scope: removal of existing plaster, remediation of degraded areas, surface preparation through washing and saturation with water of the application surfaces, connectors (if required), any finishing products, and acceptance tests for materials.

All materials must comply with the technical specifications and be certified according to current regulations.

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