

C-MATRIX SYSTEM C-MATRIX G220N15-M

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



C-MATRIX G220N15-M is an FRCM reinforcement system that combines the effectiveness of a bidirectional dry AR (Alkali Resistant) fiberglass mesh and an inorganic matrix based on natural hydraulic lime (NHL), bonded together by a water-based adhesion promoter. The system offers excellent chemical-physical and elasto-mechanical properties and ensures optimal compatibility with supporting materials, even on architectural heritage subject to protection/restrictions.

System components:

- **FB-VAR220R12:** Bidirectional dry AR fiberglass mesh with a dry weight of 200 g/m², providing good tensile strength for the entire system and ensuring correct distribution of static and seismic stresses
- **EPOCA CALCE CNHL115:** Structural mortar based on natural hydraulic lime (NHL), with a compressive strength ≥ 15 MPa, ensuring proper transfer of stresses through good adhesion between the system and the substrate.
- **FB-IPN01:** A two-component, water-based product composed of interpenetrating resins supported on a microcrystalline inorganic matrix, used for the impregnation of fiberglass or carbon fiber reinforcements as an adhesion promoter.

The AR fiberglass bidirectional dry mesh, characterized by flexibility and adaptability to irregular surfaces, as well as good mechanical resistance, works in synergy with the inorganic matrix, enhanced by the presence of the adhesion promoter, to create a homogeneous and low-thickness reinforcement that does not alter mass distribution or structural rigidity. The system integrates seamlessly with existing masonry, improving both the resistance and ductility of the structure, even in contexts of potential seismic hazard.

C-MATRIX G220N15-M ensures excellent chemical and mechanical compatibility with traditional building materials, making the system suitable for the consolidation of buildings with high historical and artistic value. Interventions made with this reinforcement system are structurally effective and minimally invasive, allowing the architectural value of the existing structures to be preserved.

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 G220N15-M is CE marked for structural consolidation interventions. The components of the system are certified with an EPD for CAM contribution purposes.

APPLICATION FIELDS

- Structural reinforcement and seismic improvement of existing masonry with a high masonry quality index.
- Increase in strength and structural ductility
- Prevention of local and/or global collapses
- Reinforcement of arches and vaults in masonry, even 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 topping beams

MAIN ADVANTAGES

1. **High performance:** the system improves the tensile strength of masonry, ensuring structural safety, even in seismic contexts and under high loads, without increasing the rigidity and mass of the structure
2. **Durability and compatibility:** the matrix-reinforcement system ensures optimal chemical-physical compatibility with the materials constituting historical masonry and a consequent durability of the intervention.
3. **Ease of application:** the bidirectional AR fiberglass mesh is lightweight, flexible, easy to handle, and simple to install. The "fresh-on-fresh" application technique, combined with the characteristics of the mesh, allows for reduced 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 (EPD certification available)
5. **Versatile solution:** suitable for both historic buildings and modern masonry structures, **C-MATRIX G220N15-M** is a thin, non-invasive reinforcement solution suitable for applications on various types of supports, including non-flat ones, such as vaults and arches, columns, etc.
6. **Reversibility of the intervention:** The C-MATRIX G220N15-M system meets the reversibility criteria required for protected architectural heritage, ensuring non-invasive and easily removable interventions.

TECHNICAL DATA OF THE SYSTEM

	<i>Description of the system</i>
Commercial Name	C-MATRIX G220N15-M
Manufacturer	Fibre Net SpA
Type of reinforcement	FB-VAR220R12+IPN Bidirectional dry mesh made of AR glass fiber Water-based bonding agent
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	Average value	Value characteristic	U.M.	Ref.
	Support: brick masonry			
Conventional limit tension $\sigma_{lim,conv}$	803	628	MPa	EAD 340275-00-0104
Conventional limit strain $\varepsilon_{lim,conv}$	1,06	-	%	
Tensile tests	Value average	Value characteristic	U.M.	
Ultimate tension σ_u of the composite	915	805	MPa	
Ultimate strain ε_u of the composite	1,16	-	%	
Stiffness modulus E_1 , in stage A	157	-	GPa	

GEOMETRIC, MECHANICAL, AND PHYSICAL DATA OF THE REINFORCEMENT

Properties	Description	Ref.
Commercial name	FB-VAR220R12	
Weight of the mesh (dry) in warp	100 g/m ²	ISO 11667:1997
Weight of the mesh (dry) in weft	100 g/m ²	
Equivalent thickness of the reinforcement mesh in both directions	0.038 mm	EAD 340275-00-0104
Density of the material constituting the reinforcement mesh	2.65 g/cm ³	
Mesh size	12x12 mm	Internal method

Tensile tests	Value average	Value characteristic	U.M.	Ref.
Ultimate tensile strength σ_{uf} of the mesh	910	740	MPa	EAD 340275-00-0104
Elastic modulus E_f of the mesh	75,6	64,7	GPa	
Ultimate strain in tension ε_{uf} of the mesh	1,20	-	%	

MECHANICAL CHARACTERISTICS OF THE BONDING AGENT

Properties	Description	Ref.
Commercial name	FB-IPN01	
Catalysis ratio of components A / B	0.5 : 1	-
Compressive strength at 28 days	> 15 MPa	EN 1542
Flexural strength at 28 days	> 5 MPa	EN 1015-11

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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** with assessment and verification of performance consistency **AVCP 2+**

APPLICATION GUIDELINES FOR THE SYSTEM

The application of the C-MATRIX G220N15-M system follows a process designed to ensure maximum performance in any application context, whether historical or modern, and is suitable for masonry with an adequate quality index. Proper execution of all operational stages is essential to achieve effective and long-lasting reinforcement.

ENVIRONMENTAL CONDITIONS

Application temperatures: The system must be applied in environmental conditions ranging from +5°C to +35°C. Avoid direct solar radiation or excessive humidity to ensure optimal curing of the mortar and proper adhesion of the mesh.

SURFACE PREPARATION

Surface preparation is crucial to ensure the full effectiveness of the C-MATRIX G220N15-M system. Work must be carried out on a sound, compact, and mechanically resistant surface to guarantee perfect adhesion of the mortar and reinforcement.

Removal of surface layers and surface preparation: 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 help of mechanical tools. All inconsistent or detached parts must be eliminated until reaching the sound masonry.

Where possible, the surface should also be scarified, including mortar joints, to a depth of ≥5 mm. If there are tenacious surface coatings or plasters that are tightly bonded to the masonry, whose removal would compromise the integrity of the support for the subsequent reinforcement application, it is advisable to consult Fibre Net technicians for a specific assessment.

In the case of interventions on vaults, the existing plaster must be mechanically removed until the masonry is reached. For reinforcement on the exterior surface, check the consistency of the backing before removing it and follow the steps outlined in the project. In the presence of voids or large cracks, the support should be restored using materials compatible with the original ones, such as stones, bricks, or tuff, to maintain structural coherence and compatibility with the existing materials.

Any edges where the system will be applied must be rounded with a curvature radius of at least 20 mm. After the removal and the above operations, the surface should be thoroughly cleaned of dust, grease, efflorescence, and other substances through low-pressure water washing. Excess water should be allowed to evaporate, ensuring the surface is saturated but dry (s.d.s.) before applying the mortar. The prepared surface must be flat, rough (not smooth), with a roughness index ≥ 1 mm to ensure proper adhesion of 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 plastered supports or substrates with low cohesion. For details on the most suitable consolidating materials, please contact the company.

PREPARATION OF THE MORTAR

The **EPOCA CALCE CNHL115** mortar must be prepared by adding clean water according to the specifications outlined in the corresponding technical data sheet. The mixing and preparation of the mix should be done using the appropriate tools and methods, as specified in the same technical data sheet.

APPLICATION OF THE FIRST LAYER OF MORTAR

On the properly roughened surface, thoroughly washed using low-pressure hydro cleaning, and with a saturated but dry surface (s.d.s.), 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, float, or spraying. Allow this first layer to harden for 18-24 hours.

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

APPLICATION OF THE FIRST LAYER OF ADHESION PROMOTER

While the mortar is still damp, approximately 15-20 minutes after its application, proceed with the application of the first layer of the adhesion promoter **FB-IPN01** using a brush or roller, at a rate of approximately $600\text{g}/\text{m}^2$ of the surface to be treated.

It is important to apply the adhesion promoter on the surface of the mortar while it is still damp, but not within the water film.

INSTALLATION OF THE REINFORCING MESH

While the adhesion promoter is still fresh, proceed with the application of the dry bidirectional fiberglass mesh **AR FB-VAR220R12**. The mesh must be carefully positioned and gently pressed with a flat trowel to ensure it is completely embedded in the mortar and adhesion promoter layer. At the joints between mesh sheets, both longitudinally and transversally, proper overlap must be ensured according to **CNR-DT 215/2018**, thus guaranteeing the continuity and effectiveness of the structural reinforcement. In the absence of laboratory tests, a minimum overlap of **300 mm** is required.

APPLICATION OF SECOND LAYER OF ADHESION PROMOTER

Once the mesh is in place, apply the second layer of adhesion promoter **FB-IPN01** on the still-damp reinforcement using a brush or roller, at a rate of $400\text{g}/\text{m}^2$ of the surface to be treated. Care should be taken to roll with the special grooved steel roller to expel air from the fabric and ensure good impregnation of the fibers.

APPLICATION OF THE SECOND LAYER OF MORTAR

Apply a second layer of mortar on the final layer of adhesion promoter while it is still fresh, with a uniform thickness of approximately $3 \div 5$ mm, ensuring that the total thickness reaches 8 mm. This layer should completely cover the mesh and provide adequate protection for the reinforcement.

APPLICATION OF CONNECTORS (OPTIONAL)

In specific situations where a mechanical connection of the reinforcement to the load-bearing structure is required, high-strength fiberglass connectors such as **FB-TUP10-VAR** or **FB-TUF_VAR** can be used. These connectors are inserted into the thickness of the masonry through pre-drilled holes and embedded within the mortar layer, ensuring an effective connection between the reinforcement system and the existing structure. The installation of the connectors must follow the technical specifications of the project and the guidelines provided by the company. Specifically, for external reinforcement of arches or vaults, it is recommended to use connection systems on the reinforcement system turned back at the supports for approximately **200 mm**.

CURING AND PROTECTION

Once the reinforcement system application is completed, the surfaces must be adequately protected during the curing phase for at least **24 hours**. In particularly dry, hot, or windy conditions, it is recommended to cover the surfaces with tarps or use wet curing techniques, such as misting water, to prevent the material 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 using an appropriate product to ensure greater durability of the system. In these cases, it is recommended to consult the Technical Department to determine the most suitable protective treatment for the specific conditions.

HANDLING AND STORAGE CONDITIONS

The system is supplied in two distinct phases: the matrix (monocomponent mortar based on NHL hydraulic lime) and the reinforcement (dry bidirectional fiberglass mesh AR)

The **FB-VAR220R12** meshes are available in rolls with the following dimensions:

- 100 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 must be stored in the original, properly sealed packaging in a dry location, and protected from freezing, high temperatures, excessive sunlight, and wind during the curing period.

SAFETY INSTRUCTIONS

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

In case of application in enclosed spaces, ensure adequate ventilation of the area to guarantee proper air exchange.

ENVIRONMENTAL DECLARATIONS

The **FB-VAR220R12** mesh is equipped with an EPD (Environmental Product Declaration) for contributing to CAM criteria.

Similarly, the **EPOCA CALCE CNHL115** mortar is certified for its minimum recycled content by ICMQ.

CERTIFICATIONS

The **C-MATRIX G220N15-M** system is CE marked according to ETA no. 22/0865.

SPECIFICATION VOICE

Structural Reinforcement Intervention on Existing Brick Masonry Using the **FRCM C-MATRIX G220N15-M** System by Fibre Net SpA

The intervention involves the application of the FRCM C-MATRIX G220N15-M system by Fibre Net SpA, in compliance with EAD 340275-00-0104, CE marked with AVCP2+ control system, and meeting CAM system criteria. The procedure includes the application of a first layer of **EPOCA CALCE CNHL115** mortar by Fibre Net, based on natural hydraulic lime (NHL), with a compressive strength ≥ 15 MPa. While the mortar is still damp, the first layer of the water-based adhesion promoter **FB-IPN01**, consisting of interpenetrated resins, is applied. This is followed by the placement of the dry bidirectional fiberglass mesh AR **FB-VAR220R12** by Fibre Net, with a mesh size of 12x12 mm, weight of 200 g/m², an equivalent mesh thickness of 0.038 mm, characteristic conventional limit tensile strength of 628 MPa, and an average elastic modulus of 75.60 GPa.

Subsequently, a second layer of adhesion promoter **FB-IPN01** is applied, followed by a final layer of **EPOCA CALCE CNHL115** mortar to achieve a total intervention thickness of 8 mm.

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

All materials must comply with the technical specifications and be certified in accordance with applicable regulations.

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