



Ruregold PBO-MESH

**Proven, Innovative Composite Strengthening System
for the Reinforcement of Concrete Structures**
with PBO fibres and without epoxy resins





Ruregold PBO-MESH

An innovative composite system designed specifically for concrete structures that can be applied on damp substrates and at high Relative Humidity (RH). Lightweight, it is fast and easy to install.

It does not require protection to fire since it does not alter the response to fire of concrete elements. It increases shear, flexural or compressive strength

of concrete structural elements, while improving their ductility. It allows recovering loss of efficiency of concrete reinforcement. It supplements reinforcing steel in refurbishment projects or projects that entail change of use.

**Proven, Innovative,
Composite Strengthening System
for the Reinforcement
of Concrete Structures.**

**Certified Performance,
Easy to Use,
Effective Long-term.**

Ruregold PBO-MESH

Proven, Innovative Composite Strengthening System for Concrete Structures

Combining Unique Properties

PBO MESH Composite system comes from the **combination of PBO very high performance fibers with a cementitious matrix**, which works as an adhesive, transferring stress and strain from the structure to the fibers.

The **unique mechanical properties of the PBO fibers** allow significant increase of the structural capacity of concrete elements.

The **specifically designed cementitious matrix** is compatible with the concrete substrate in the response to stress and deformation.

PBO-MESH 70/18 was used to restore the Montedison former plant in Assisi (PG) - Italy



A Proven Record

Ruregold is the first company to have developed a **composite strengthening system that does not rely on epoxy resins**. This system goes under the name of **Fabric Reinforced Cementitious Matrix (FRCM)** and is specified by ACI 549.4R-13: "Guide to Design and Construction of Externally Bonded Fabric-Reinforced Cementitious Matrix (FRCM) Systems for Repair and Strengthening Concrete and Masonry Structures".

The first FRCM System "C-Mesh" was launched on the Italian market in 2001. Since then **several million sq.ft have been applied worldwide**. This is now a preferred market solution to reinforce masonry structures.

PBO-MESH FRCM System stems from the experience gained in masonry applications with the C-MESH system. In addition to the advantages of using a **cement-based adhesive**, it offers the exclusive benefits of **PBO fibers, instead of carbon fibers**.

PBO-MESH is the ideal system for the **structural reinforcement of concrete elements** such as girders, slabs and columns for buildings and infrastructures, whenever **heat and/or fire resistance is required** along with an **easy and fast application**.

This system is **internationally patented** being one of the Ruregold's exclusive structural engineering solutions.

Limits of FRP Systems based on Epoxy Resins

PBO MESH use a cementitious adhesive, to glue PBO Fabric to the substrate.

Conventional Fiber Reinforced Polymer (FRP) strengthening systems instead make use of epoxy resins to glue the fabric to the structure. However, **epoxy resins, due to their chemical nature, have well-known limitations**, such as the need of a dry substrate and to be protected from fire. They also have limited heat resistance and they are combustible.

Tg (glass - transition temperature) is the of temperature when epoxy resins change from a glassy to a visco-elastic state, thus no longer providing the designed bond. Tg of epoxy resins used in commercially available FRP systems typically ranges from 140 to 180 °F (60 to 82°C).

In a dry environment ACI 440.2R recommends that FRP service temperature not exceed $T_g - 27\text{ °F}$ ($T_g - 15\text{ °C}$). At a temperature of 113 °F (45°C) it is therefore possible that an FRP system no longer provides the designed reinforcement.

Limitations of Epoxy Resins

- Cannot be applied on damp substrates
- Cannot be applied when the temperature of the substrate, or the environment, comes close to their Tg value.
- FRP systems based on epoxy resins needs to be protected from fire. Once epoxy resins harden, they typically melt at temperatures between 230°F (110°C) and 300°F (150°C) when the fibers detach from the structure and the strengthening reinforcement stops working.
- Must be protected from UV rays
- Hazardous delivery, can contaminate the soil



effective • resistant • versatile • innovative • safe •

Ruregold



What are the PBO Fibers?

PBO (Polyparaphenylene Benzobis Oxazole) fibers are a new generation of ultra-high performance fibers. Compared with carbon fibers normally used in FRP composite reinforcement systems, PBO fibers have 20% greater tensile strength, and 15% greater modulus of elasticity.

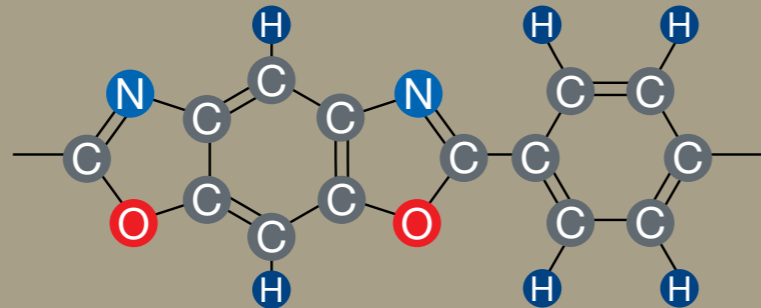
- **Tensile Strength:** 841 ksi (5.8 GPa) of PBO Vs. 595 ksi (4.1 GPa) of carbon fibers
- **Modulus of Elasticity:** 39,160 ksi (270 GPa) of PBO Vs. 34,809 ksi (40 GPa) of carbon fibers.

In comparison with high modulus aramidic fibres, PBO has 210% higher tensile strength and 250% higher modulus of elasticity.

In addition to superior performance properties, another important element of innovation **of the PBO fiber** lies in its formulation that **creates a chemical bonds with the Ruregold cement-based matrix in which it is embedded.**

This chemical bond assures adhesion between the two components, PBO fiber and cementitious matrix, thus assuring the excellent, long-lasting performance properties of the composite system.

The new P.B.O. fibre: more effective bond with inorganic matrix



PBO's molecular structure establishes strong chemical bonds with the specially formulated MX-PBO Concrete, cement-based adhesive. This bond plays a crucial role on the final performances of the FRCM composite, made of P.B.O. MESH + MX-PBO Concrete adhesive.

PBO-MESH 70/18 Advantages

- Reliable, long-lasting performance properties, certified by ICC-ES (see last page)
- Easy and fast apply without the need of specially skilled workers
- Lightweight; the PBO fabric is extremely light and easy to manage
- No significant added volume or weight; the composite thin structural layer is not thicker that 1/3 in. (8 mm) when one ply of PBO is applied
- Easy to clean, as all tools can be cleaned simply with water
- Applicable to damp substrates and in conditions of high RH
- Permeable to vapor, does not entrap moisture
- Durable at high ambient/substrate temperature and presence of alkali
- Does not require fire protection since it does not alter the response to fire of concrete elements
- Does not require to be painted for UV protection.
- Its light gray color blends well with concrete.
- Provides visual prediction of potential failure
- Level of reinforcement comparable to FRP

PBO-MESH: the FRCM System for Structural Reinforcement of Concrete Construction

PBO-MESH is a composite system consists of:

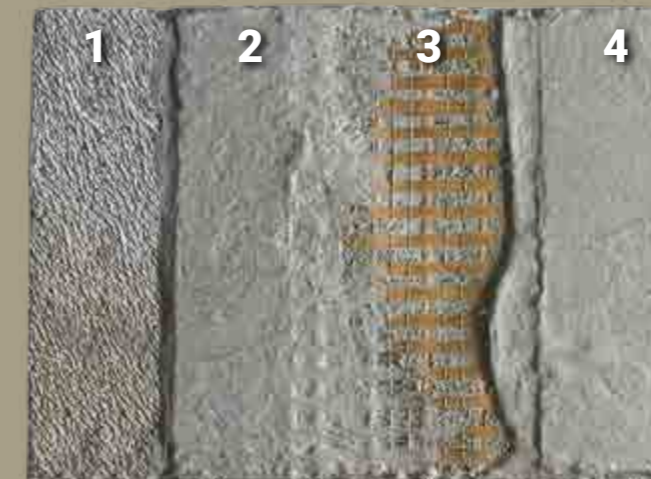
- a mesh woven with high performance PBO fiber
- a specially designed water-based cementitious adhesive

The mechanical properties of the PBO fiber allow the fabric to absorb forces generated by overloads and exceptional circumstances (such as severe weather conditions and earthquakes).

The specially designed cementitious adhesive acts as the matrix of the system, bonding the high performance PBO fibers to the concrete substrate of the structure to be strengthened.

Due to its unique formula, the cementitious adhesive creates a chemical bond with the PBO fibers thereby considerably improving the system's mechanical behavior and its ultimate performance properties.

The adhesive provides a strong bond to the concrete substrate without requiring primer. It contains fibers to heavily reduce / eliminate the risk of shrinking.



Typical application sequence

1. Concrete substrate
2. First layer of MX-PBO Concrete
3. PBO-MESH 70/18
4. Second layer of MX-PBO Concrete

certified • clean •

advantageous

PBO-MESH

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Ruregold PBO-MESH

Testing and certification

The **PBO-MESH 70/18** systems have been tested extensively by the University of Miami and approved research Laboratories, which have certified their effectiveness based on approved testing procedures.

The comparison of Ruregold's FRCM with commercially available FRP (based on epoxy resins) structural composite strengthening systems, reveals similarity in the ultimate tensile strength and greater ductility upon breakage, so that stress continues to be absorbed for a longer time.



According to European fire reaction standard **EN 13501-1**, **PBO-MESH** structural strengthening system has been classified as follows:

Classification fire reaction:

A₂ = no contribution to fire
s₁ = low smoke emission
d₀ = no flaming droplets/particles

Ruregold PBO-MESH 70/18
according to the Guidelines
AC434 issued by ICC - ES

PBO-MESH 70/18 composite strengthening system, composed of a Polyparaphenylene Benzobis Oxazole (PBO) bidirectional (0°/90°) fiber mesh embedded in a specially formulated cement-based adhesive, meets the criteria of AC 434: "Acceptance Criteria For Masonry and Concrete Strengthening Using Fiber-Reinforced Cementitious Matrix (FRCM) Composite Systems".

Tests required for product certification were performed at the accredited Laboratory of the University of Miami and relative certification was issued by the International Code Council Evaluation Service (ICC-ES).

ICC-ES is an international association dedicated to "developing model codes and standards used in the design, build and compliance process to construct safe, sustainable, affordable and resilient structures".

Performance properties of Ruregold PBO-MESH 70/18 composite strengthening system, as reported in the ICC-ES certifications, can be specified for any FRCM structural strengthening reinforcement project.



Certification of product given by: International Code Council Evaluation Service USA.



Guidelines for the project and placement of cement-based reinforcement systems (FRCM) for the repair and reinforcement of concrete and masonry structures.



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Laterlite Group

Thanks to the recent acquisition of the company, Ruregold is now the fourth company in the Laterlite Group, which combines the Leca brand with the company LecaSistemi and 40% of the associated company Gras Calce. The Laterlite Group in this way demonstrates its willingness to expand and strengthen its offer of technical solutions for the building industry, confirming its vocation as a 360-degree partner in sustainable construction and renovation projects.



Ruregold S.r.l.

Piazza Centro Commerciale, 43 - 20090 San Felice di Segrate (MI) - Italy
Phone +39 0283590006 | Fax +39 0283590007
info@ruregold.it | www.ruregold.it