Ruredilwork

REFERENCE VOLUME

Projects, work sites, references

2015 EDITION

Structural reinforcements - RureGold e X Mesh

Ruredil: a tradition of excellence in sustainable innovation

Ruredil, active in the building industry for more than sixty years **has always been on the cutting edge of development of new products and technologies for improving the efficacy, dependability and safety of structures**. The company's model of growth harmonizes technical requirements with environmental sustainability, with a focus on the issues of durability of materials, environmental compatibility and human health.

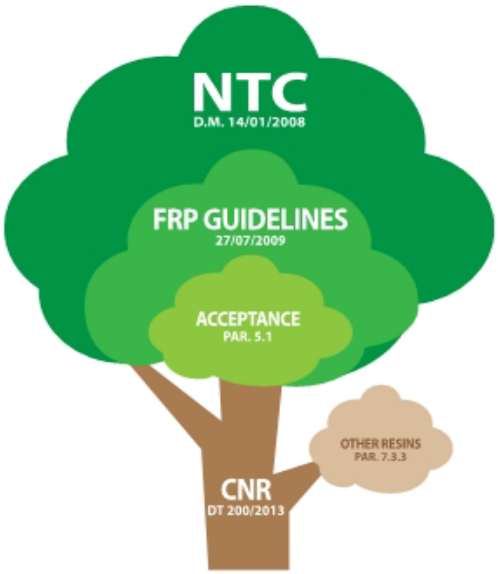
THE REVOLUTIONARY RUREGOLD CEMENTITIOUS STRUCTURAL REINFORCEMENT SYSTEM WITH AC434 CERTIFICATION IN ACCORDANCE WITH ACI 549 GUIDELINES.

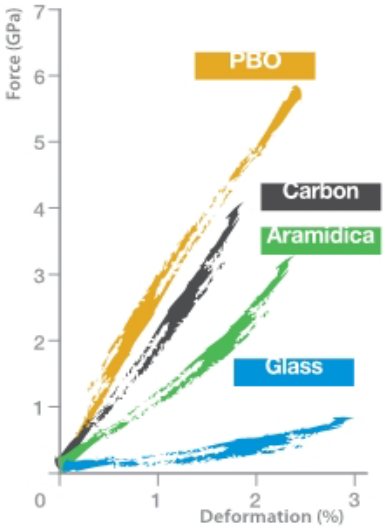
In 2013 Ruredil obtained **product certification for its FRCM Ruredil X Mesh Gold composite**, material containing PBO fibers and **Ruredil X Mesh C10**, containing carbon fibers under standard AC 434: "Acceptance Criteria For Masonry and Concrete Strengthening Using Fiber- Reinforced Cementitious Matrix (FRCM) Composite Systems". Certification was obtained **from the official laboratory of Miami University and issued by the ICC-ES** or International Code Council Evaluation Service: a US organization entitled to issue product technical approval and certification (www.icc-es.org).
As this product certification is obtained in an official laboratory, the document has its own technical value, in the sense that the performance described is applicable wherever structural reinforcement is obtained with Ruredil FRCMs.

RureGold® and Ruredil X Mesh reinforcement systems make use of **two different types of fiber, PBO** (polyphenylene-benzobisoxazole) and **carbon**, both of which are synthetic materials with **high performance mechanical properties capable of absorbing the stress generated by overloads and exceptional events such as earthquakes**. PBO fibers have 40% more resistance to tensile strength than carbon fibers and a 15% higher modulus of elasticity.

Regulations governing use of FRCM systems

Current Italian building design legislation consists of the **Technical Building Standards (Ministerial Decree 14.1.2008). The Guidelines for the Design, Construction and Testing of Structural Reinforcement of Reinforced Concrete, Pre-compressed Reinforced Concrete and Masonry with FRP** became an integral part of the legislation in 2009, with the approval of the Upper Council for Public Works. Point 5.1 of this document, on the topic of "General Information and Regulations" for fiber-reinforcement materials for structural reinforcement, **provides for the possibility of using "unconventional materials"** in compliance with valid legislation and documents such as [. . .] document **CNR-DT 200 R1/2013 - Instructions for the Design, Construction and Testing of Static Consolidation Work using Fiber-Reinforced Composite Materials".** This important specification in effect permits use of cementitious matrixes such as those in the FRCM systems developed by Ruredil. Point 7.3.3, "Other resins", of the latter document specifies that: **"Lastly, we recall inorganic matrixes** (cementitious, metallic, ceramic, etc.), the use of which in construction of fiber-reinforced composite materials for civil use – primarily cementitious materials – is becoming more and more common. Though they are not examined in this document, **their use is considered possible under the condition that it is supported by appropriate technical documentation and experimentation demonstrating that it is at least as effective as the organic matrixes discussed here**:





Specifically, **Ruredil's FRCM systems** have been certified following an experimental campaign conducted by an external body (Venice University), **demonstrating that they are at least as effective as FRP systems**. Moreover, in the spirit of CNR-DT 200 R1/2013, in assessing the efficacy of reinforcement we must take into consideration both mechanical aspects and durability in relation to the operating temperature, the temperature of vitreous transition and the moisture level.

In the **RureGold® and Ruredil X Mesh reinforcement systems, two different types of fiber are used, PBO** (polyphenylene-benzobisoxazole) and **carbon**, both of which are synthetic materials that present **mechanical properties ensuring high performance2 and capable of absorbing the forces generated by overloads and by exceptional events such as earthquakes**. Compared to carbon fibers, PBO fibers have a 40% greater resistance to tensile stress and a 15% greater modulus of elasticity.

Application of Ruredil structural reinforcements ensures the safety of concrete and masonry structures, improving or adapting the earthquake response of:

school buildings ..... page 02
religious buildings ..... page 14
infrastructure ..... page 26
historic buildings ..... page 52

STRUCTURAL REINFORCEMENT
beams and pillars

Maiolati Spontini School · Moje (AN)

The building, made entirely of pre-compressed reinforced concrete with type TT beams and tiles, was adapted following work on the building's cladding (also made of pre-compressed reinforced concrete panels) to **adapt it to the new technical requirements, particularly the connections.**

Steps in installation
preparing the surface
step 1

Steps in installation
applying PBO mesh
step 2

Materials

RureGold Xp CALCESTRUZZO

RureGold mx CALCESTRUZZO

Steps in installation
lining with inorganic matrix

step 3

Technical specifications

Design/Supervision of Work
ing. G. Tittarelli

Builder
GPL Ancona

FRCM Reinforcement Consultants
ing. Roberto Radicchia

Materials
RureGold XP Calcestruzzo +
RureGold MX Calcestruzzo,
RureGold JX Joint +
RureGold MJ Joint

Year 2012

The work involved **consolidation of the existing pillars in accordance with the new project**. The low invasiveness of FRCM systems meant it was not necessary to change the layout of internal spaces or the existing fire load, in view of the fact that FRCM systems, unlike FRPs, are classified **as fire reaction class A2.**

Materials

RureGold JX JOINT

RureGold MJ JOINT

High mechanical performance with very simple installation

REINFORCEMENT UNDER SHEARING STRESS of reinforced concrete dividers

Middle School • Cernusco sul Naviglio (MI)

"Aldo Moro Middle School" in Piazza Unità d'Italia in the town of Cernusco sul Naviglio was built in the late '60s in the style typical of the time. The building has a **layout consisting of three different volumes which are structurally separated by appropriate joints.**

Steps in installation
contructiong the reinforcement
step 1

Improvement of earthquake performance applied to a number of elements considered particularly critical, typically a number of **beam/pillar nodes around the building's perimeter** (initially not designed for horizontal action) **and the reinforced concrete dividers between the stairwells, serving as buttresses which, according to the original static plan, were to absorb most of the horizontal forces transferred by the rigid plane**.

Technical specifications

Design/Supervision of Work
ing. Pietro Brianza

Builder
Benis Costruzioni Telgate (BG)

FRCM Reinforcement Consultants
ing. Natale Pontiggia
ing. Antonio Trimboli

Materials
RureGold XP Calcestruzzo
RureGold XT Calcestruzzo
RureGold XS Calcestruzzo
RureGold MX Calcestruzzo
RureGold JX Joint
RureGold MJ Joint

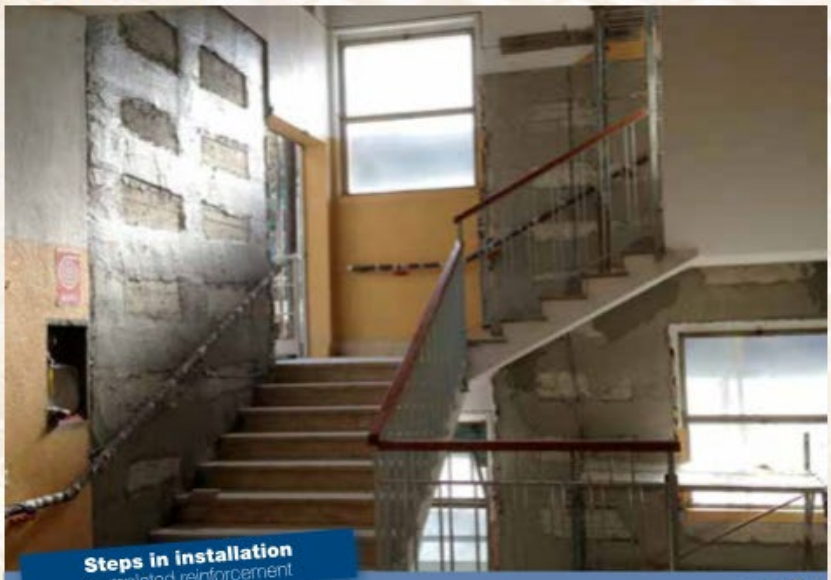
Year 2013

Steps in installation
aplying the mesh

step 2

The purpose of use of these composite materials for seismic reinforcement of reinforced concrete elements is **increasing the resistance of pillars and walls to shearing stress** through application of strips, **increasing confinement at the ends of beams and pillars with application of strips, increasing the flexibility of the ends of beams and pillars and improving the efficiency of joints**.

Depending on the direction of the mesh and the way it is laid, this type of work serves two functions: reinforcing the wall's resistance to shearing stress and to flexing of elements.



Steps in installation
completed reinforcement

step 3

Materials

RureGold® Xp CALCESTRUZZO

RureGold® Xt CALCESTRUZZO

RureGold® Xs CALCESTRUZZO

RureGold® mx CALCESTRUZZO

RureGold® Jx JOINT

RureGold® mJ JOINT

More flexible beams and pillars

STATIC ADAPTATION and seismic upgrading

ITC J. Barozzi · Modena (MO)

The need to improve the building's static and seismic performance and the need for a number of changes in the technical installations as a result of changed layout and functions in the building led to a survey campaign (both documental and instrumental) **to identify the building's structural inadequacies and prepare a plan for improvement in accordance with the provisions of NTC08**.

The problems that emerged from the surveys were poor quality of the concrete on the pillars, resulting in the decision to work on the portion of the pillars bearing the greatest load and the most stress, that is, the pillars between the two lowest levels (in the basement).

Steps in installation
preparing the surfaces

step 1

Materials

RureGold Xp CALCESTRUZZO

RureGold mx CALCESTRUZZO

After reconstructing the elements' original geometries (some of which had been damaged by passageways and anchorage systems for old technical installations) with suitable mortar, it was decided that FRCM composite materials would be used to prevent variations in the rigidity and therefore the overall behavior of the building as a result of the project.

The decision was made to **use the FRCM Ruredil RureGold XP Calcestruzzo (Concrete) system**. The system includes an environmentally compatible cementitious mortar with a bidirectional PBO fabric. To guarantee an appropriate response to bending stress, a 25 cm wide strip with a framework parallel to the axis of the pillar was placed on each side of each pillar. To offer an effect of confinement and improve resistance to shearing stress, "bracket" elements were included in the central part of the pillar (strips 50 cm high and 50 cm apart), while the foot and head of the pillar were wound continuously to ensure greater flexibility at nodes where their might be hinges, which must not be fragile (typically shear).

RureGold was chosen primarily **to ensure greater flexibility** under operating conditions and a **resistance of up to 130°** in the absence of fire protection, which would have significantly reduced the amount of space available in the classrooms with its bulk (panels + insulation).

Technical specifications

Progettista in variante
ing. Emanuele Rava

Supervision of Work
Technical Office Prov. Modena
school buildings division

Builder
SCIANTI spa Modena

Materials
RureGold XP Calcestruzzo +
RureGold MX Calcestruzzo,
RureGold JX Joint,
RureGold MJ Joint

Year 2013

Materials

RureGold JX JOINT

RureGold MJ JOINT

"Flexing" reinforcement of pillars with central brackets

ENSURING SAFETY for structures

Nursery School and Elementary School · Town of Neviano degli Arduini (PR)

The nursery school + elementary school building in the town of Neviano degli Arduini, in the hills of the Appenines near Parma (classified as seismic zone 3 under OPCM 3274/2003) was built in the late '70s in the style typical of the times. The building is rectangular, with four levels above ground and a layout in which spaces are divided over various different levels; specifically, the ground floor contains administrative services and the pillars supporting the upper levels; the nursery school is located on the first floor, while the elementary school occupies the second floor, and the top floor (double height) contains a gym which is used by the school and by other users outside school hours.

Following an earthquake with a magnitude of 5.2 in December 2008 with its epicenter in the municipality, the city government of Neviano degli Arduini ordered a survey of the state of the school buildings.

Detail
facede of the building

Technical specifications

Design/Supervision of Work
Ing. Silvia Zerbini - CST Parma
ing. Franco Zatti

Builder
B.S.F. s.r.l. - Parma

Materials
RureGold XP Calcestruzzo
RureGold MX Calcestruzzo
Exocem FP
RureGold JX Joint
RureGold MJ Joint
Rurecoat 3

Year July 2014

Materials

RureGold® Xp CALCESTRUZZO

RureGold® mx CALCESTRUZZO

Steps in installation
confinement of central node

Steps in installation
confinement of edge node

Steps in installation
shearing reinforcement

The building has a reinforced concrete frame with "incorporated" floor beams, reinforced concrete pillars and concrete and masonry floor slabs; one of the biggest problems is failure to comply with the hierarchy of resistances, with scarce (or absent) confinement of the pillar/beam nodes. The engineers therefore decided to **use the RureGold® reinforcement system** (PBO fibers with a stabilized inorganic matrix) **applied directly onto all the beam/pillar nodes; the work concentrated in particular on the need to improve response to "fragile" breakage mechanisms** (typically shearing) **and create confinement of the beam/pillar nodes, all with limited demolition of floors and curtain walls**.

The RureGold® reinforcement system was also chosen for its ability to guarantee the durability of the reinforcement over time thanks to the properties of the system, which offers not only practical application but **excellent resistance to fire and to high temperatures**, no corrosion and, last but not least, the possibility of finishing with plaster and painting following reinforcement.

Steps in installation
reinforcement of perimeter node

Materials

RureGold® JX JOINT

RureGold® MJ JOINT

RECLAMATION AND CONSERVATION
seismic upgrading

Second level School of Science "BoggioLera" · Catania

This school building situated in the center of Catania was built in stages over the centuries: traces of city walls dating from Roman days have been found, and will be made visible to the public with a transparent cover.

The building is affected by a number of problems, including weaknesses in the response to vertical loads of the masonry on the ground floor (thick but very high walls), requiring **injection with pozzolanic material (Rurewall B1) to make up for the principal problems** and create new wall bays at right angles to ensure earthquake resistance.

The level under the roof is characterized by various types of masonry, many of which are not toothed together, hence the decision to proceed with restraining work on them (with a particular focus on the gables) and **creation of a trestle with the FRCM RureGold XA Muratura system, guaranteeing the breathability of the masonry and permitting improvement of seismic mechanisms resistant to shearing stress and flexing stress on the wall bays under the roof**.

Detail
exsisting masonry

Dettaglio
outer facade

Materials

RureGold Xa MURATURA

RureGold mx MURATURA

RureGold Jx JOINT

RureGold mJ JOINT

Steps in installation
roughing of first layer

Steps in installation
aplliying second layer of mortar

Technical specifications

Progettazione Strutture
ing. Luigi Bosco - ing. R. Costa
Supervision of Work
arch. Giuseppe Sciacca
Builder
D & G costruzioni s.r.l. - CT
Materials
RureGold XA Muratura
RureGold MX Muratura
Rurewall R/Z Rinzaffo
RureGold JX Joint
RureGold MJ Joint
Rurewall B1
Year 2014

Steps in installation
picking up fabric

ANTI-SEISMIC REINFORCMENT masonry building

NURSERY SCHOOL · Zocca (MO)

The nursery school building was subjected to a **seismic vulnerability analysis** which identified a number of problems due to the absence of a cornice on the top level with a roof that is partly overhanging, and in creation of a number of ground floor windows with divider walls which were initially continuous and "squat".

It was therefore decided to correct these problems locally, with **binding/edging of the continuous outer perimeter and the inner perimeter at the corners**, with connections established by JX Joint through tassels.

On the ground floor, **the columns were consolidated up to the springer of the arches** in order to prevent phenomena of instability, using the FRCM RureGold XR Muratura system.

Technical specifications

Design/Supervision of Work
ing. Bonati AIERRE Engineering (Parma)
Builder
L' Edilizia srl di Mirko Manfredini Pavullo nel Frignano
Materials
Rurewall R/Z - Rinzaffo,
RureGold XR Muratura +
RureGold MX Muratura,
RureGold JX Joint + MJ Joint
Year 2013

"Surgical" technology

Steps in installation
PBO mesh

step 2

FRCM systems were chosen because of the **need not to alter the fire load in the nursery school, not to use toxic materials** and, above all, to **encircle the building under the roof with a breathable material that would be capable of withstanding the great temperature excursions characteristic of the mountain climate**.

Materials

RureGold® Xr MURATURA

RureGold® mx MURATURA

Steps in installation
reinforcement of masonry pillars

step 3

RureGold® Jx JOINT

RureGold® mJ JOINT

for work on weight-bearing masonry

CONSOLIDATION of vaults after the 2012 earthquake

Vault of the central nave in Colorno cathedral · Colorno (PR)

Colorno cathedral, built around the year 1500, was damaged in the January 2012 earthquake.

The **quake created major cracks, especially in the cross vault over the central nave**, where cracks about one centimeter wide run right through the masonry.

Following accurate **instrumental study** and **remodeling of the structure** on the basis of an FEM model, a thorough **project was proposed for consolidation and seismic upgrading** including several phases applying to the arches and masonry vaults.

Materials

RureGold® JX JOINT

RureGold® mJ JOINT

Steps in installation
construction of reinforcement

step 1

The FRCM system was used in the vaults for its **ability to absorb tensile stress induced by the horizontal forces generated in an earthquake. The system ensures that the vaults can breathe, preserving the church's existing decorations.**

Technical specifications

Design
prog. Ing. Lorenzo Jurina
Builder
EDILTOR San Polo di Torrile (PR)
Materials
Rurewall R/Z - Rinzaffo,
X Mesh C10 + X Mesh M25,
X Joint + X Joint Inject,
Rurewall B1 - Iniezione
Year 2013

Steps in installation
construction of reinforcement

step 2

REINFORCEMENT OF THE BASILICA
earthquake-proofing of the apse and the central nave

Church of San Bernardino da Siena · Carpi (MO)

The work on the Basilica di San Bernardino da Siena, the patron saint of the town of Carpi, was part of the project for **mitigation and repair of earthquake risk consequent upon the May 2012 quake**.

The church, which has a single nave with an arched vault, was subjected to seismic upgrading consisting of construction of carbon strips using the FRCM X Mesh C10 system, after correcting the support with Rurewall R/Z - Rinzaffo pozzolanic mortar and then connecting the arches to the perimeter walls with tassels with an inorganic matrix. The same work was done on the apse, which also has a semi-spherical masonry vault with stiffening arches.

Technical specifications

Design
Technical Office of the Archbishopric of Carpi

Builder
CMB of Carpi

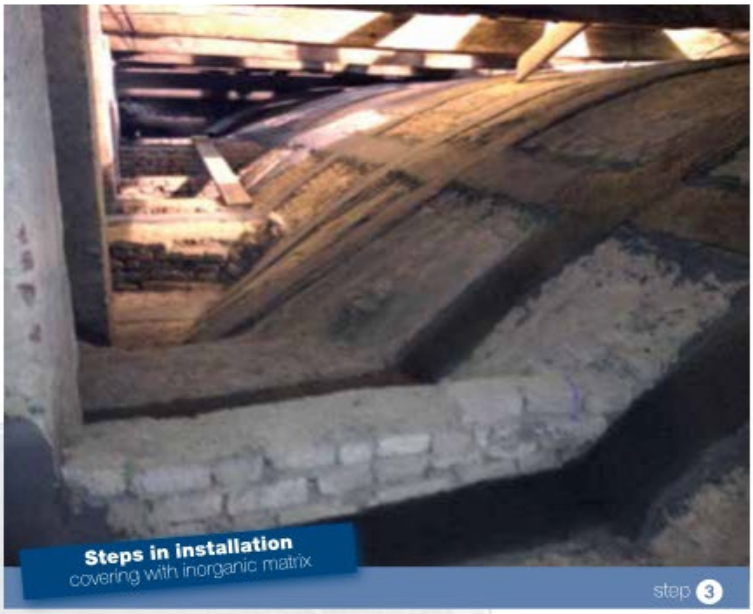
Materials
Rurewall R/Z - Rinzaffo,
X Mesh C10 + X Mesh M25,
X Joint + X Joint Inject

Year 2013

The FRCM system was chosen primarily because of the lack of space between the springer of the vault and the outside walls, which would have exposed workers to excessive risks if they worked with resins, and the difficult conditions on the work site, which would have resulted in excessive waste.

The reinforcement thus applied **guarantees an improvement in the structural behavior of the vaults without compromising their stability and the consequent integrity of the decorations below**.

Steps in installation
application of reinforcement
step 2



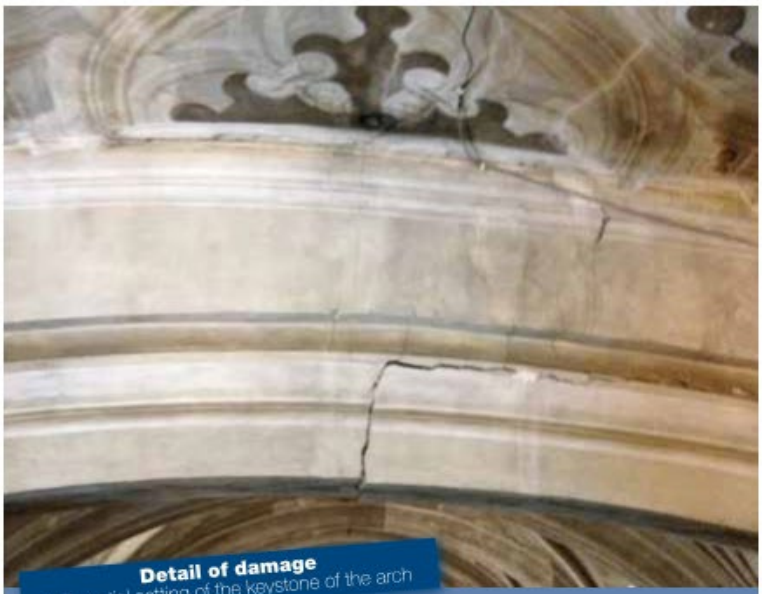
Steps in installation
covering with inorganic matrix
step 3

Use of inorganic matrix improved the "health" of the vault... and the workers

REVERSIBLE REPAIR of the arches and gable

Church of San Bassiano · Pizzighettone (CR)

The church was subjected to a campaign of diagnostics and structural monitoring under the engineer's supervision, and found to be affected by a number of different problems, including differential **settlement of the building's foundations, cracking and detachment of the arches and perimeter walls and incipient tilting out of plane of the gable on the main façade**, the walls of the side naves and the walls of the central nave.



Detail of damage
differential setting of the keystone of the arch

The key criterion in the project was **reversible spot repair work on the basis of the principle of minimum intervention and preservation of the building's history, preserving not only the original materials but above all the building's existing structural behavior, even while making the areas worked on recognizable "after the fact"** (while ensuring significant improvement in their behavior under both vertical and horizontal action).

Intervening while respecting

Steps in installation
detail of "stitched" annexation with carbon joints

step 1

Ruredil mortar and composite reinforcement systems were used because of the need to guarantee not only the necessary mechanical performance and resistance but the necessary **durability of the work in changing climatic conditions** and the necessary and **continual transpiration of the area where the work is performed** in order to guarantee preservation of the decorations below them without affecting their usability in years to come.

Technical specifications

Design/Supervision of Work
ing. Gian Ermes Massetti

Builder
Beltrami spa (CR)

Materials
Rurewall R/Z - Rinzaffo,
X Mesh C10 + X Mesh M25,
X Joint + X Joint Inject,
Rurewall PVA TX - Consolidante

Year 2013

Steps in installation
application of the carbon mesh over the layer of Rurewall R/Z

step 2

the original materials and structural concepts

STRUCTURAL REINFORCEMENT with guaranteed breathability

Church of Bazzano · Traversetolo (PR)

The project included, among other operations, **consolidation of the extrados of the masonry vaults and arches with FRCM and stitching together the perimeter walls,** after cleaning them; **construction and correction of the stiffening arches and supports of the purlins** with similar and reclaimed materials (solid bricks).

The choice of mortar and the Ruredil composite reinforcement system was made taking into account **the need to guarantee** not only the mechanical resistance but t**he durability of the durability of the work in changing climatic conditions** and the necessary and **continual transpiration of the area where the work is performed**.

Steps in installation
application of carbon filter
step 1

Steps in installation
covering with cementitious mortar
step 2

Technical specifications

Design/Supervision of Work
studio arch. Rossi Bordi Zarotti (PR)
studio ARTEC ing. Landini (PR)

Builder
BSF Parma

Materials
Rurewall R/Z - Rinzaffo,
X Mesh C10 + X Mesh M25,
X Joint + X Joint RS,
X Bar + X Bar Inject

Year 2012

CONSOLIDATION
of arches and vaults

Church of Bannone · Valsamoggia (PR)

Consolidation of the extrados of the masonry vaults and arches was performed with FRCM by stitching them to the perimeter walls.
Ruredil mortars and composite reinforcement systems were chosen because of t**he need to guarantee** not only mechanical resistance but **the durability of the work in varying climatic conditions** and the **continued breathability of the areas where the work is performed**.
The stiffening arches and the supports of the purlins were constructed and corrected using similar and reclaimed materials (solid bricks).

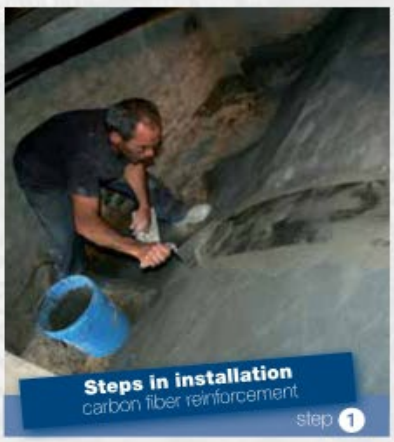
Technical specifications

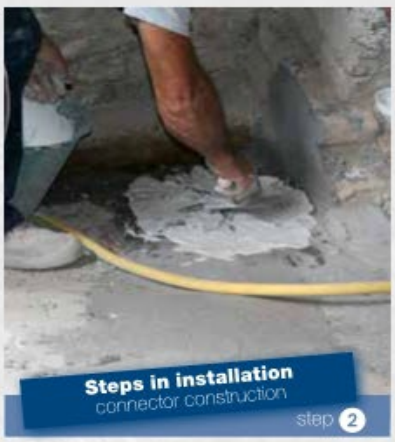
Design
studio arch. Rossi Bordi Zarotti (PR),
studio ARTEC ing. Landini (PR)

Builder
BM Costruzioni Cavriago (PR)

Materials
Rurewall R/Z - Rinzaffo,
X Mesh C10 + X Mesh M25,
X Joint + X Joint Inject

Year 2013





SEISMIC UPGRADING
of the intrados of the crypt

Church of San Marcellino · Parma (PR)

The church of San Marcellino in Parma, dating back to around the year 1500, was deconsecrated in 1928 and is now used as an exhibition space for temporary exhibitions and installations.

To host an exhibition of the work of artist Claudio Parmigiani, it was necessary to **reinforce the floor slab which formed the roof over the crypt**, which was to support the weight of a 14 meter sailboat with its supporting base.

Detail
previous state

Materials

RureGold Xp CALCESTRUZZO

RureGold mx CALCESTRUZZO

Steps in installation
applying PBO mesh

step 1

The floor slab consisted of a structure with lowered reinforced concrete beams and a concrete and masonry floor slab; in view of the very severe moisture conditions, **it was decided that both the beams and the cross beams in the floor slab should be reinforced for resistance to shearing and flexing stress**, choosing an FRCM system to ensure durability.

Technical specifications

Design/Supervision of Work
ing. Paolo Landini (Parma)

Materials
Exocem FP,
Rurecoat 3,
RureGold XP Calcestruzzo +
RureGold MX Calcestruzzo

Year 2010

Steps in installation
covering with inorganic matrix

step 2

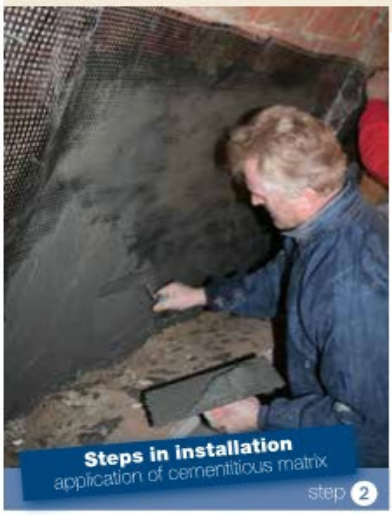
REINFORCEMENT OF APSE AND NAVE
after an earthquake

Oratorio of S Francesco · Rolo (RE)

The oratorio is located in the historic center of the town of Rolo, in a series of buildings with arcades built up against them.
Work began in March 2012 on consolidation of the nave and the apse of the oratorio, with application to the entire surface of the FRCM X Mesh C10 system with inorganic matrix M25.

In May 2012 the structural work had been completed and repainting and restoration of the decorations on the vault were underway **when an earthquake occurred with the town right in the "crater" and the adjacent buildings in the "red zone"**. The building was declared usable, and as the photos demonstrate, it suffered no appreciable damage.

Steps in installation
application of carbon mesh
step 1



Steps in installation
application of cementitious matrix
step 2

Detail
completed project

Detail
completed project

Technical specifications

Design/Supervision of Work
ing. Poli (RE) - studio ESATECNA

Builder
Boccaletti Costruzioni srl

Materials
X Mesh C10 + X Mesh M25

Year 2012

The project was completed two months before the 2012 earthquake, and was not damaged

STATIC CONSOLIDATION and restoration for conservation

Santa Maria Bridge · Torcello (VE)

The bridge, affected by a series of **structural problems in the weight-bearing structure**, a brick arch with lime-based mortar, and **excessive deformation of the side walls**, required major consolidation work to maintain the original arch.

Use of the FRCM X Mesh C10 system made it possible maintain the bridge's original shape and structure, guaranteeing not only the required mechanical performance but **significant durability** in view of the conditions to which the bridge is exposed.

The work involved plating of the extrados aided by anchorage of the intrados with tassels.

Steps in installation
emptying out the perimeter of the bridge

step 1

Technical specifications

Design/Supervision of Work
ing. Andrea Marescalchi

Builder
Restoration Area/Tiozzo Gianfranco

Materials
Rurewall R/Z - Rinzaffo,
X Mesh C10 + X Mesh M25,
X Joint + X Joint RS

Year 2012

Reinforcement in a marine environment

Steps in installation
application of carbon strips

step 2

Steps in installation
detail of cross strips

step 3

SEISMIC UPGRADING
of reinforced concrete trusses

Città della Musica · Marghera (VE)

This heritage building, subject to restrictions as an example of **industrial archeology**, was built shortly after the second world war and had to be preserved as part of a new service and retail center. In the interior (with its own disconnected structure), a glass roof was to be installed on the arched frame, and the architectural plan specified that frame was to remain visible.

Steps in installation
reinforced concrete trusses

The need to **consolidate the portals and upgrade their seismic performance**, while adding bracing on the level with metal structural work, led to a need to **reinforce the resistance to shearing and flexing stress of the zone subject to the greatest stress from the portals.** The requirement was that the shape of the portals not be altered with masking or lining, and above all, the constructions' fire resistance must not be compromised.
Thus the decision was made to consolidate the nodes "at the foot" and the maximum cutting sections and/or inversion of momentum with the FRCM X Mesh Gold system.

Technical specifications

Design/Supervision of Work
ing. A. Rossato

FRCM reinforcement consultant
ing. Emanuele Rava

Materials
Exocem FP,
Rurecoat 3,
X Mesh Gold + M750

Year 2011

Steps in installation
applying PBO fiber

step 1

Steps in installation
covering with cementitiou mortar

step 2

Work compatible with heritage building status

STATIC REPAIR
gridwork deck

Biddemi Bridge · Marina di Ragusa (RG)

The bridge consists of a gridwork deck with main and secondary beams and deck all made of reinforced concrete.
The guidelines underlying the plan for the consolidation work was **reinforcement of structural elements requiring increased weight-bearing capacity without altering the static regime on the foundation soils and without altering the mechanical behavior of the resistant elements**.

The work involved reinforcement of the beams' resistance to shearing and flexing stress using FRCM technology, which **permits maximum speed** (with no need to wait for curing of the mortar used to repair the concrete) **and maximum durability in the presence of the continually changing temperature and moisture conditions** to which the construction is subject

.

Previous conditions
gridwork deck

Materials

RureGold Xp CALCESTRUZZO

RureGold mx CALCESTRUZZO

Steps in installation
reinforcement of resistance to shearing stress

Detail
completed project

Seismic upgrading in an aggressive environment

Technical specifications

Design
ing. Giovanni Giuffrida

Supervision of Work
ing. Di Martino (Provincia di RG)

Builder
Schininà Giovanni di Modica (RG)

FRCM reinforcement consultant
Ing. Antonio Trimboli

Materials
RureGold XP Calcestruzzo +
RureGold MX Calcestruzzo

Year 2013

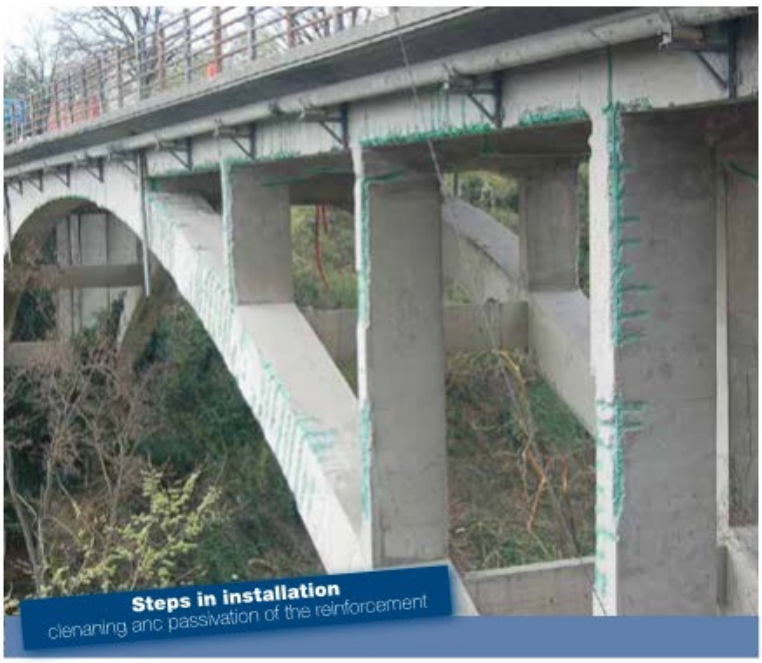
STATIC CONSOLIDATION of a road bridge

Road bridge · Urbania (PU)

The bridge was built in 1950 entirely out of reinforced concrete, and is affected by a number of structural weakness, both static and seismic (not having been designed to withstand an earthquake).
The need for action is a result of in-depth survey of the condition of the construction, which **reveals a number of instances of expulsion of reinforcement covers and corrosion of reinforcement bars**. This phenomenon is due not only to the bridge's age but to the incorrect scaling and positioning of the rainwater drainage system, which channel rainwater directly onto the arches and piers supporting the bridge, resulting in additional damage (and poor functioning of the existing Gerber's beams).

The first phase in the project, with the goal of **static upgrading to suit today's traffic loads by restoring the original sections of the arches and piers** and reinforcing them, involved reconstruction of their geometry and confinement using FRCM systems which also add resistance to axial and shearing stress in the areas under the most stress, all without adding to the loads on the foundations.

Steps in installation
repairing the concrete



Steps in installation
clenaning anc passivation of the reinforcement

Steps in installation
applying PBO mesh

The FRCM system meets the need for rapid repair required in order to work by the **"bay-bridge"** method, and above all makes it unnecessary to wait for mortar to be cured before applying the actual reinforcements. **X Mesh Gold reinforcements guarantee durability** in the presence of severe conditions such as rain, leaching and the presence of water with salt residues from the deck, and **great variation in temperature and moisture conditions** in view of the bridge's location in a gulley in the hills.

Technical specifications

Design
prof. ing. Luigino Dezi (AN)
ing. geol. Diego Talozzi (Urbania)

Supervision of Work
ing. geol. Diego Talozzi (Urbania)

Builder
Gambini Mario Pesaro

FRCM reinforcement consultant
ing. Emanuele Rava

Materials
Rurecoat 3,
Exocem FP,
X Mesh Gold + X Mesh M750

Year 2012

Detail
work near completion

FUNCTIONAL CONVERSION for new use

Former railway dormitory (now seniors' residence) · Paola (CS)

This early 20th century building was a railway workers' dormitory built using Hennebique technology with reinforced concrete pillars and a grid of reinforced concrete beams below a solid concrete floor slab.

Conversion of the building into a seniors' home **made it necessary to adapt the load-bearing structures for new accidental overloads** and, to ensure earthquake safety, upgrading and confinement of beam/pillar nodes.
All this lead to the decision to use FRCM systems, which **do not alter the original structural system but make up for its biggest faults**; moreover, the technology did not add to the building's fire load, an important factor in view of its new use.

Previous condition
pre-exixsting situation

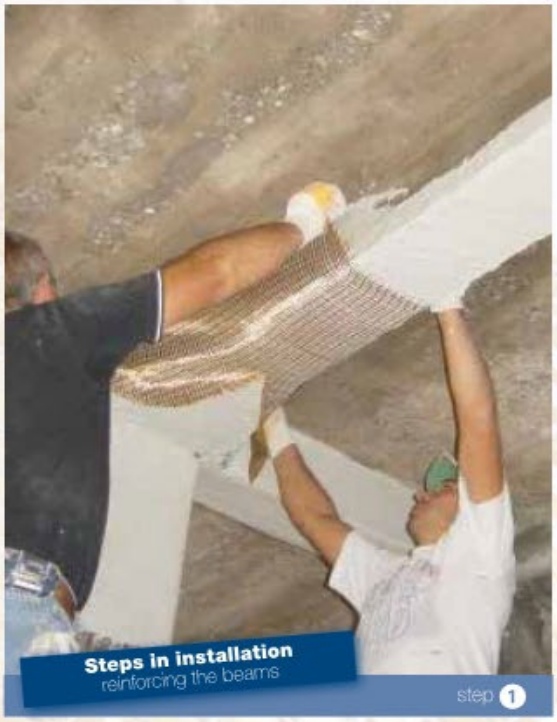
In order to test the efficacy of the FRCM system with full-scale tests, a pair of twin beams with a span of 3.8 m were taken from the site and **subjected to breakage load tests**, one with application of a conventional FRP system and the other with the FRCM X Mesh Gold system. The tests demonstrated that the two systems were largely equivalent in terms of mechanical performance, but the FRCM system offered benefits for durability.

Technical specifications

Design/Supervision of Work
ing. Antonio Trimboli

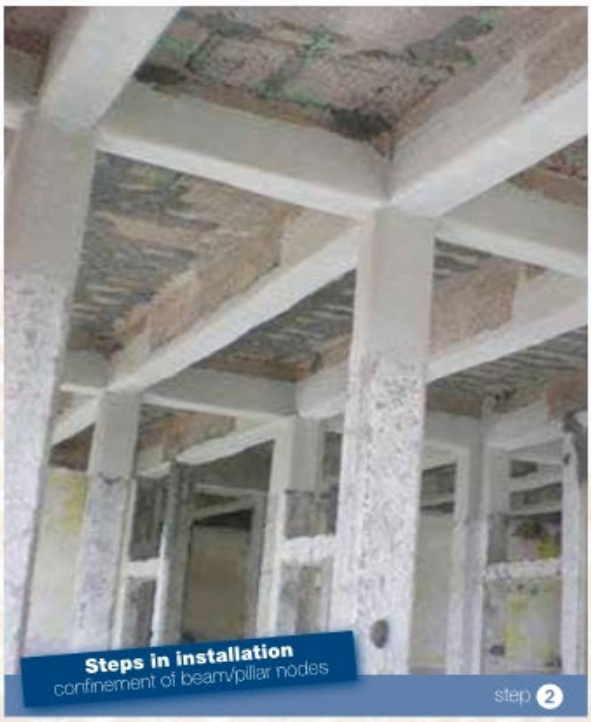
Materials
Rurecoat 3,
Exocem FP,
X Mesh Gold + X Mesh M750

Year 2008



Steps in installation
reinforcing the beams

step 1



Steps in installation
confinement of beam/pillar nodes

step 2

Full-scale breakage test on reinforcements

SPECIAL RENOVATION of buildings

Railway station · Cosenza (CS)

The project involved static and seismic upgrading of vertical elements with various different geometries in the railway station building in Cosenza, on the Cosenza – Sibari railway line.

The special renovation project for the station building **involved wrapping with the FRCM system to add to the building's resistance to vertical and shearing loads**.

Steps in installation
detail

Detail
completed project

Steps in installation
stratigraphy of FRCM reinforcement

Technical specifications

Design
ing. E. Volontè

Builder's consultant
ing. Antonio Trimboli

Builder
Morfù s.r.l. - Rossano (CS)

Materials
RureGold XP Calcestruzzo +
RureGold MX Calcestruzzo

Year 2013

Materials

RureGold® Xp CALCESTRUZZO

RureGold® mx CALCESTRUZZO

Seismic reinforcement with rapid resumption of service

CONVERSION
confinement of pillars and prevention of detachment

Modena hospital · Modena (MO)

In the context of conversion of spaces in the hospital in Modena, work was also done to mitigate/reduce/eliminate seismic risk, very important in crowded and therefore sensitive areas.
One of the projects performed involved confinement of the brick pillars in the former appointment booking area, a foyer which had been subjected to several renovations over the years. The pillars were confined using the FRCM RureGold XR Muratura system and linked with the reinforced concrete wall behind them through a series of connections with JX Joint tassels and an inorganic matrix. The system was chosen for its compatibility with the original brick substrate and the need not to alter the fire load in the space, without requiring invasive protection systems that would alter the existing architecture.

The brick and stone floor was reconstructed laying **PBO fiber mesh to prevent detachment**, providing passive protection against falling tiles.

Previous condition
gridwork deck

step 1

Steps in installation
reinforcement for resistance to shearing stress

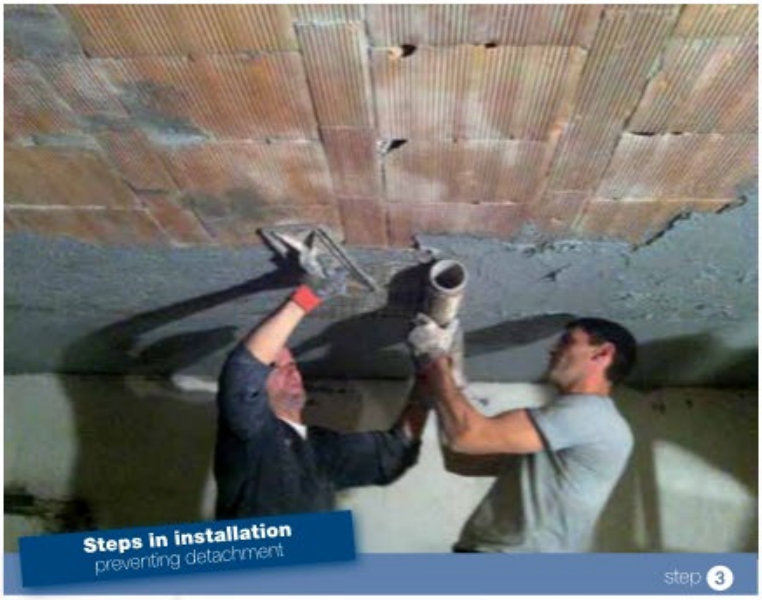
Technical specifications

Design/Supervision of Work
ing. Luca Melegari (Parma)

Builder
AeC di San Possidonio (MO)

Materials
RureGold XR Muratura,
RureGold XA Muratura +
RureGold MX Muratura,
RureGold JX Joint + RureGold MJ Joint

Year 2013



Steps in installation
preventing detachment

step 3

Detail
detail of PBO mesh

step 4

Materials

RureGold® Xr MURATURA

RureGold® Xa MURATURA

RureGold® mx MURATURA

RureGold® mJ JOINT

Reducing earthquake risk in crowded places

STRUCTURAL REINFORCEMENT in a thermoelectric power plant

Cooling towers in a power plant · Bergheim (Germania)

The project involved special maintenance work on the reinforced concrete cooling tower of Bergheim power plant in Germany, choosing FRCM technology as an alternative to the conventional reinforced concrete slabs with grouting used in the past.

The FRCM system made it possible to work using mobile platforms, without shutting down the plant, and guaranteed **greater durability in view of the plant's exposure to atmospheric agents and the high of the fumes in contact with the concrete substrate**.

Steps in installation
double layer of PBO mesh

step 1

Technical specifications

Design
ing. Felix Altmeyer

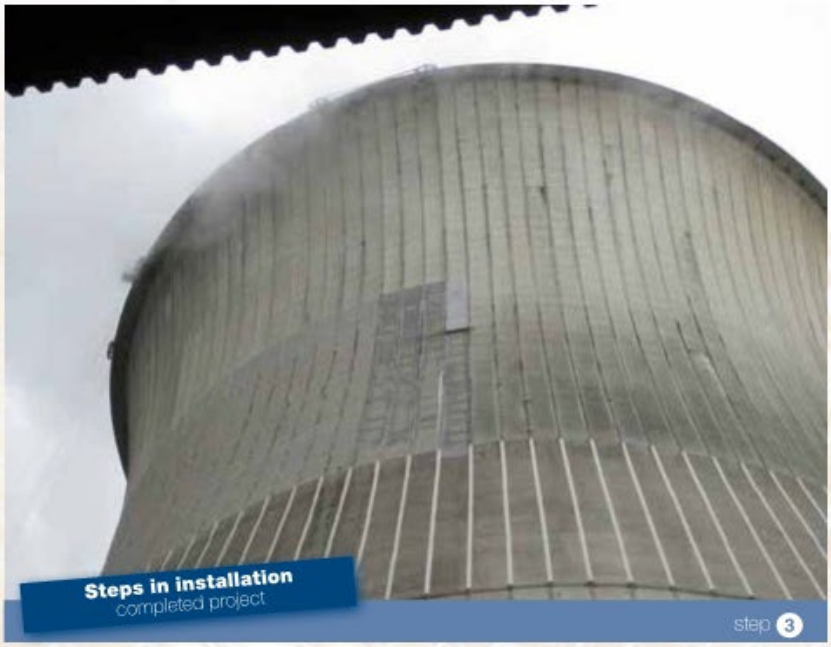
Builder
Stromberg - Massemberg

Materials
X Mesh Gold + Mesh M750

Year 2012

Steps in installation
covering with inorganic matrix

step 2



Steps in installation
completed project

step 3

The only type of reinforcement applicable in the presence of high temperatures

VARIANCE SURVEY
Sports Center

Sports Center · Amantea (CS)

The need to complete work on the sports center, suspended following partial completion of the reinforced concrete frame, required complete design for upgrading of existing structures to comply with the provisions of NTC.08, particularly confinement of beam/pillar nodes, and **reinforce the resistance to flexing stress of a number of beams in the frame**.

The **choice of the RureGold system** turned out to be very **important to avoid compromising the structure's performance in response to the requirements for fire loads on the structure, and to avoid aggravating the loads on the foundations with the addition of reinforcements**, leaving the building's original resistance mechanism unaltered.

Steps in installation
existing reinforced concrete frame

Steps in installation
covering with inorganic matrix

Steps in installation
reinforcing the pillars

Technical specifications

Design/Supervision of structural work
ing. Maurizio Salis (CS)

Builder
Imm. Costruzioni De Marco
Maierà (CS)

Materials
RureGold XP Calcestruzzo
RureGold XT Calcestruzzo
RureGold MX Calcestruzzo
Rurecoat 1
Rasocem RA

Year 2014

Steps in installation
reinforcing the beams

Materials

RureGold® Xp CALCESTRUZZO

RureGold® Xt CALCESTRUZZO

RureGold® Mx CALCESTRUZZO

STRUCTURAL RESTORATION AND REPAIR
Piazza Ghiaia bridge

Piazza Ghiaia Bridge · Parma

The project was part of the plan for urban redevelopment of the Piazza Ghiaia area in the historic center of the city of Parma, where a market has been held since the early 19th century.

The site is close to the bed of the Parma River, and the work was made necessary by the severe degradation of concrete structures (the concrete deck is a roadbed on a traffic bridge) in view of the particularly aggressive environment (aggression by salt used for the prevention of ice formation on a bridge deck which was not waterproof) and the significant **presence of moisture due to surface water and rising moisture from the ground**.

The ancient Roman masonry bridge underneath had to be left visible.

In view of the severity of degradation of the concrete structures, **in order to restore the bridge's original conditions and increase its durability under such aggressive conditions, FRCM RureGold systems were chosen** for use both on the lowered beams and the taut area under the bridge deck.

Steps in installation
reinforcing primary beams

Technical specifications

Design
ing. Paolo Sorba - Studio AIERRE (PR)

Supervision of Work
ing. Paolo Sorba - Studio AIERRE (PR)

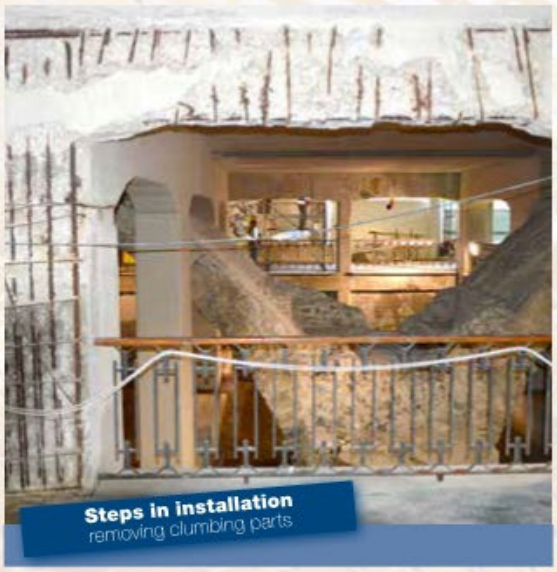
Builder
Progetto Ghiaia srl, impresa Bonatti,
impresa Comandatore Emanuele

Materials
RureGold XP Calcestruzzo
RureGold MX Calcestruzzo
Exocem FP
Rurecoat 3
Exocem G3 PVA

Materials

RureGold® Xp
CALCESTRUZZO

RureGold® mx
CALCESTRUZZO



Steps in installation
removing clumbing parts

Steps in installation
passivating reinforcement rods

SEISMIC UPGRADING OF SENIORS' RESIDENCE

Former hospital pavilion · Senigallia (An)

A number of hospital pavilions were to be converted into a seniors' residence.

The buildings, constructed in the 1930's, have a reinforced concrete frame with lowered beams and brick and cement floor slabs; it became necessary to **perform seismic upgrading of the existing structure**, the principal problems of which involved confinement of beam/pillar nodes.

Technical specifications

Design
ing. Roberto Ortolani
Studio Tec. Ass. Landi

Supervision of Work
ing. Landi - Studio Tec. Ass. Landi

Builder
IMPRETEKNA s.r.l.

Materials
RureGold XP Calcestruzzo
RureGold MX Calcestruzzo
Exocem PVA - TX
RureGold JX Joint
RureGold MJ Joint
Rurecoat 3

Steps in installation
two-way PBO fabric

Steps in installation
passivating reinforcement rods

Steps in installation
applying Exocem PVA-TX

The need to perform the work in the least invasive way possible, with only localized demolition of masonry, and **the need to ensure the fire resistance of the load-bearing structures with no significant impact on finishes led to use of flexible Exocem PVA-TX mortars with the RureGold XP system**, a choice that also saved time as it was not necessary to wait for complete drying of the mortar used to restore the pre-compressed reinforced concrete in view of the compatibility of the inorganic matrix.

Materials

RureGold® XP
CALCESTRUZZO

RureGold® MX
CALCESTRUZZO

RureGold® JX
JOINT

RureGold® MJ
JOINT

SAFETY AND RESTORATION WORK
reinforced concrete viaduct

"SS-4 Salaria" concrete viaduct · Roma

The arched bridge on which the work was performed was constructed around the year 1960, entirely out of ordinary reinforced concrete, with the exception of the shoulders and wing walls, which were originally made of brick and subsequently plated with reinforced concrete.

The goal of the project was to restore the original static conditions following degradation of the concrete and the beginning of corrosion of the bars, without addition of metal reinforcements but using the properties of FRCM systems with flexible Exocem PVA-TX mortars.

In addition to static aspects linked primarily with the degradation consequent upon the action of poor control of rainwater draining off the bridge deck, it was necessary to **decrease the construction's vulnerability to earthquakes by improving confinement of column/arch nodes, which had no confinement because of the original open brackets**.

Steps in installation
reinforcing the uprights

Steps in installation
removing crumbling parts

Steps in installation
reinforcing the arch

Technical specifications

Design

I.R. ingegneri riuniti

ing. Giuseppe Barbagallo, ing. Vito Piemonte (CT)

Supervision of Work

ing. Antonio Aurelj

FRCM Reinforcement Consultant

ing. Antonio Trimboli

Builder

Acquaviva s.r.l - IS

Materials

RureGold XP Calcestruzzo
RureGold XT Calcestruzzo
RureGold MX Calcestruzzo
Exocem PVA - TX
RureGold JX Joint
RureGold MJ Joint
Rurecoat 3

Steps in installation
applying Exocem PVA-TX

RESTORATION AND CONSOLIDATION six-bay railway bridge

Railway bridge on the Eccellente - Rosarno line - km 54 (+594) · Tropea (VV)

The bridge, which has 6 bays with piers, shoulders and arches made entirely out of brick, was built in the early 20th century and supports two railway tracks.

The high degree of degradation of the arches, visible on the intrados, and their leaching as a consequence of rainwater on the railway (not waterproofed) and the sides required restoration of the bridge's initial static conditions in accordance with moving, dynamic railways loads under the regulations.

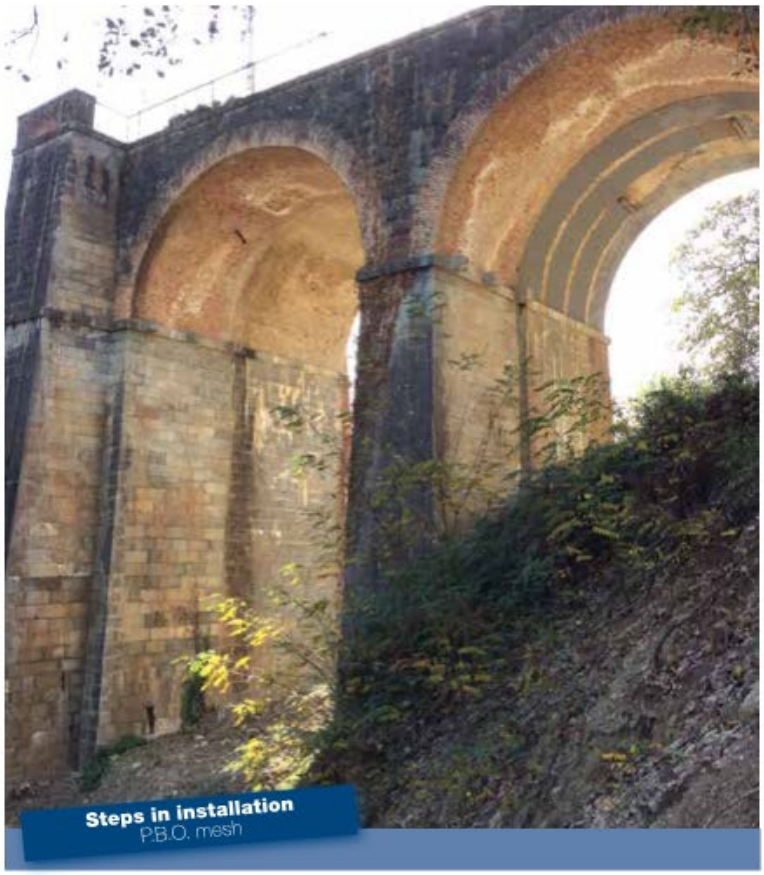
Technical specifications

Client/Supervision of Work
R.F.I - direzione terr.le RC

Design
ing. Vincenzo Malatacca

Builder
Morfù srl - Rossano (CS)

Year 2014



Steps in installation
P.B.O. mesh

Panoramic view

The FRCM system was applied to the intrados, not only correcting and sealing the damaged parts but **creating a mesh of spot anchorage points using the RureGold JX joint tassel system cast on the element with an appropriate inorganic matrix to prevent the phenomenon of "empty thrust" that occurs with application of reinforcements underneath arches**.

A grid was then created with the **RureGold system**, which is not only chemically compatible with the masonry substrate but **guarantees the durability required for the useful lifespan of the construction thanks to the inorganic matrix, which will not compromise the efficacy of the system even when the substrate is damp**.

Degradation
arch intrados

RECLAMATION
for residential and public use

"Villa Baroni" building · Loria (TV)

The building, constructed in stages, consists of a "slat" along the road characterized by a highly uncoordinated series of changes to the building's internal layout.

The heritage authorities demanded reclamation of the building, making it necessary to **correct the building's structural problems, consisting of voids inside some of the dividing walls** (injected with pozzolanic mixtures) and scarce resistance to cutting of the wall bays, as well as vulnerability of the arches at the existing entrances.

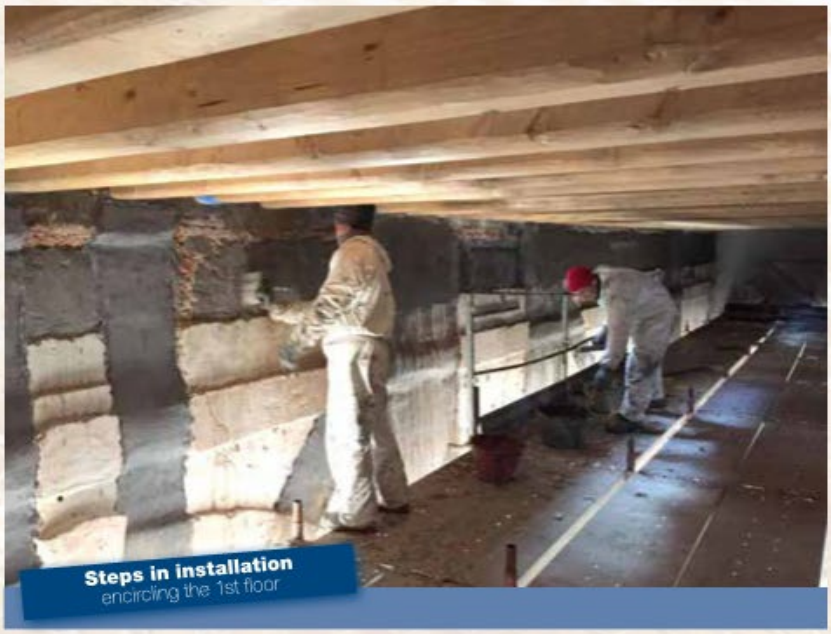
It was therefore decided to **correct these problems using an FRCM system compatible with the existing masonry so as to prevent phenomena of efflorescence and degradation, and the pozzolanic matrix ensured correction of these problems**.

Previous condition
wall facing road

Technical specifications

Client
Agenzia Territoriale Veneto
Design/Supervision of Work
arch. E. Zangrando / L. Zanatta
ATER (TV)
Structural design
ing. Gianfranco Baldan
(Venezia Mestre)
Builder
ATI ANDREOLA costruzioni Loria (TV)
SECIS srl Marcon (VE)
Materials
Ruredil X Mesh C10
Ruredil X Mesh M25
Ruredil X Joint Inject
Ruredil X Joint
Rurewall R/Z Rinzaffo
Year 2015

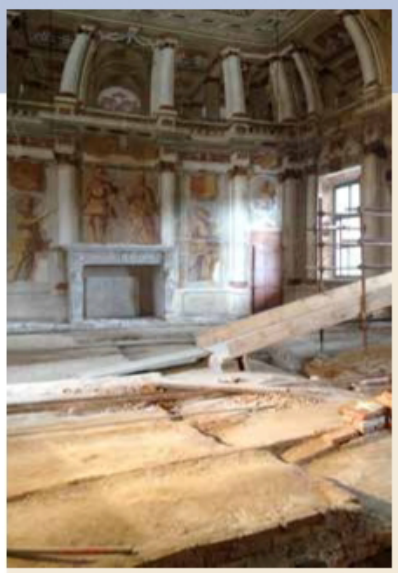
Steps in installation
Ruredil X Mesh C10 on facade on short wall



Steps in installation
encircling the 1st floor

STATIC CONSOLIDATION AND SEISMIC UPGRADING of Parella Castle

Parella Castle · Torino



Static consolidation and seismic upgrading work was required on the castle in Parella (TO), a complex of buildings with a long history, built in the 13th to 17th centuries.
The complex being worked on had been in very poor condition, partially abandoned. The structure is the focus of a major project for enhancement of the area around the castle and promotion of agriculture in the area, and is characterized by the presence of spaces containing important paintings and stucco decorations (above all, the so-called "Sala di Giove" or Jupiter Room).

The buildings, affected by a number of **structural weaknesses, both static and seismic** (not having been designed, of course, to withstand earthquakes), the latter being particularly important as the rooms will sometimes be full of large numbers of people (whereas the building was previously residential).

The criterion shared by all decisions made in the project was to work on one room at a time, performing the minimum amount of work necessary and ensuring it was reversible, demonstrating respect for the building's history and preserving not only the original materials but, above all, its original structural behavior, even while making the areas worked on recognizable (while guaranteeing significant improvement in reaction to vertical and horizontal stress). The project includes various different types of work, including **construction of edging on the extrados** (of varying widths) **with the FRCM Ruredil X Mesh C10 system, following creation of "tracks" for regularizing them with Rurewall R/Z Rinzaffo pozzolanic mortar**.

The extrados of the main arches was also reinforced (also using the Ruredil X Mesh c10 system), dismantling the existing brick stiffening arches (no longer toothed onto the dividing walls in the main nave) which were then rebuilt using the original brick with better toothing into the walls at right angles to them.

Technical specifications

Structural design
prof. ing. Paolo Napoli - Sintecna TO

Supervision of structural work
prof. arch. Walter Ceretto - Sintecna TO

Builder
MGC srl - Ivrea (TO)

Materials
Rurewall R/Z Rinzaffo
Rurewall PVA - TX
Rurewall B1
Ruredil X Mesh C10
Ruredil X Mesh M25
Ruredil X Joint
Ruredil X Joint Inject

Year 2014

FRCM edging with the Ruredil X Mesh C10 system and complementary **edging of the springers of the vaults/arches with Rurewall PVA-TX fiber-reinforced pozzolanic mortar were supported by a series of "flourishes"** connecting the arch/pier springer **with Ruredil X Joint embedded carbon tassels cast in place with Ruredil X Joint Inject pozzolanic casting mortar.**

Injection with Rurewall B1 pozzolanic grout for wall bays affected by insufficient resistance to vertical loads as a consequence of the presence of voids in them. The choice of Ruredil mortars and composite reinforcement system takes into account the need to guarantee not only the necessary mechanical performance and resistance but the required durability in the presence of changing climatic conditions and the necessary continued breathability of the areas worked on in order to ensure conservation of the decorations above it without affecting the usability of the building in the years to come.

RESTORATION AND STRUCTURAL CONSOLIDATION
Palazzo Malenchini

Palazzo Malenchini · Parma

The building, constructed in the historic center of Parma in the 17th century, is a stately home with an inner courtyard and a ballroom on the middle level with frescoes by Bibbiena.

The project involved removal of additions to the building made over the years and conversion into private residences, even while maintaining the building's original unitary character.

The **planned work**, above all on the frescoed vaults, concentrated on the extrados and **served to ensure seismic upgrading and static consolidation,** particularly improving toothing with the walls around the perimeter of the building, also with use of connections, **with the intention of guaranteeing breathability so as not to create problems for the prestigious paintings in the building**.

The work also included consolidation of overhanging cornices, with construction of through "brackets" to support the overhangs on the eaves under the roof.

Exsisting decorations

Technical specifications

Structural design
ing. Giuseppe Stefanini

Supervision of Work
arch. Paola Morandi
geom. Lucia Brindani

Builder
Consortile Malenchini Scarl
coop Buozzi / coop Edile Artigiana

Materials
RureGold XA Muratura
RureGold MX Muratura
Rurewall R/Z Rinzaffo
RureGold JX Joint
RureGold MJ Joint

Year 2014

Steps in installation
reinforcing the inside of the eaves

Steps in installation
clenaring the extrados of the vaults

Steps in installation
apllying P.B.O. mesh to the extrados of e vaults

Materials

RureGold® Xa
MURATURA

RureGold® mx
MURATURA

RureGold® Jx
JOINT

RureGold® mJ
JOINT

LOCAL REPAIR AND IMPROVEMENT of a single-family home

Single-family home · San Prospero (MO)

This project was conducted on a typical example of traditional local construction, a 19th century manor house.

The work involved repair of damage suffered in the 2012 earthquake and improvement of the building's earthquake resistance with a series of stringcourses guaranteeing linking of the wall bays, preventing them from overturning off the plane, while also **ensuring confinement and reinforcement of the shoulders and vaults of the windows and construction of tie-rods using the FRCM system on the internal wall bays in the inside corridor** (toothed onto the walls at right angles to them).

The **Ruredil X Mesh system was chosen for its chemical compatibility with the binders existing in the masonry and in order to ensure breathability of the masonry** while guaranteeing significant improvement of the building's structural behavior without altering its original resistance mechanism.

Steps in installation
applying Ruredil X Mesh C10

Technical specifications

General design/Supervision of Work
arch. Claudio Fornaciari (MO)

Structural design
ing. Roberto Radicchia (Perugia)

Builder
Bellucci Ernani
di geom. Roberto Bellucci

Materials
Ruredil X Mesh C10
Ruredil X Mesh M25
Ruredil X Joint inject
Rurewall R/Z Rinzaffo

Year 2013

Steps in installation
encircling the floor

Steps in installation
adding tie rods to internal diaphragms

Steps in installation
reinforcing windows

Services (design assistance)

Ruredil has always aimed to be of assistance to designers, providing **customized design** consulting services drawing on the assistance of professionals with extensive experience in structural reinforcement work. The company also offers **a series of supporting tools** for choosing **materials and technical solutions**, defining technical **specifications and calculating the reinforcement** required.

RINFORZISTRUTTURALI.IT

A WEB site about design of structural reinforcement with composite materials, offering useful information for design and technical and safety data sheets for materials, instructions for installation and numerous references in Italy and abroad.

RUREDIL X MESH C10 DESIGN

Special software designed to calculate and scale structural reinforcements for masonry using the Ruredil XMesh C10 system. The program refers to standard CNR DT 200/2013 for scaling of reinforcement to shear stress and flexing stress of vertical masonry walls in structures with normal forces on the plane.

TECHINICAL SPECIFICATIONS AND PRICING

A tool for completing projects in the executive stage. Technical specifications include a complete description of all the work to be performed and a detailed breakdown of prices, divided between the cost of materials, labor, equipment rental, general costs and the builder's profits. Available in printed and digital form, in the latter case including not only the content of the volume in PDF format (which may also be downloaded from the web site), but all analysis tables in Excel and Primus format, for customization to meet design requirements.

STRUCTURAL REINFORCEMENT CALCULATION MANUAL

A document providing instructions for design, execution and testing of static and seismic reinforcement work with use of FRCM inorganic composite matrix systems. The design methods and sample applications presented offer designers an opportunity to compare their work with the calculations proposed by CNR-DT 200/2013. The volume may be downloaded from www.ruredil.it in the RuredilLAB area.

Notes

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Commercial Manager: Federico Bellinato
Sales Manager: Carlo Luisi
Structural Reinforcement Manager: Bernie Baietti
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