TCS

PASSIONE MATERICA

PURE NATURAL LIME | GREEN BUILDING | RESTORATION | STRENGTHENING | FINISHES


DESIGNER
CONTRACTOR
WE CREATE
NETWORK
CLIENT
SUPPLIER

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Safety
requires time,
don’t lose it...

Last 50 years of catastrophic earthquakes in Italy:

14th January 1968, Sicily, between provinces of Trapani, Agrigento e Palermo.
The earthquake caused 360 causalities and 57 thousand evacuated people.

6th May 1976, Friuli, between provinces of Udine and Pordenone.
939 causalities and about 80 thousand homeless people.

23th November 1980, Irpinia Earthquake, province of Avellino.
It caused 2914 deaths and more than 400 thousand homeless.

13th December 1990, Sicily, province of Syracuse.
13 deaths.

26th September 1997, between Umbria and Marche.
11 causalities.

31th October 2002, Molise.
An elementary school in San Giuliano di Puglia, renovated just a few months earlier, collapsed. In this sad circumstance, 27 children and a teacher perished.

6th April 2009, Abruzzo, an earthquake destroyed the city of L’Aquila.
308 deaths.

20th/29th May 2012, provinces of Ferrara, Modena, Mantua and Bologna.
27 people died.

24th, 26th and 30th October 2016, regions of Lazio, Marche and Umbria.
298 people died.

After this kind of disaster, only numbers are certain.
Damages to the economy and the historical, artistic and architectural heritage are inestimable.

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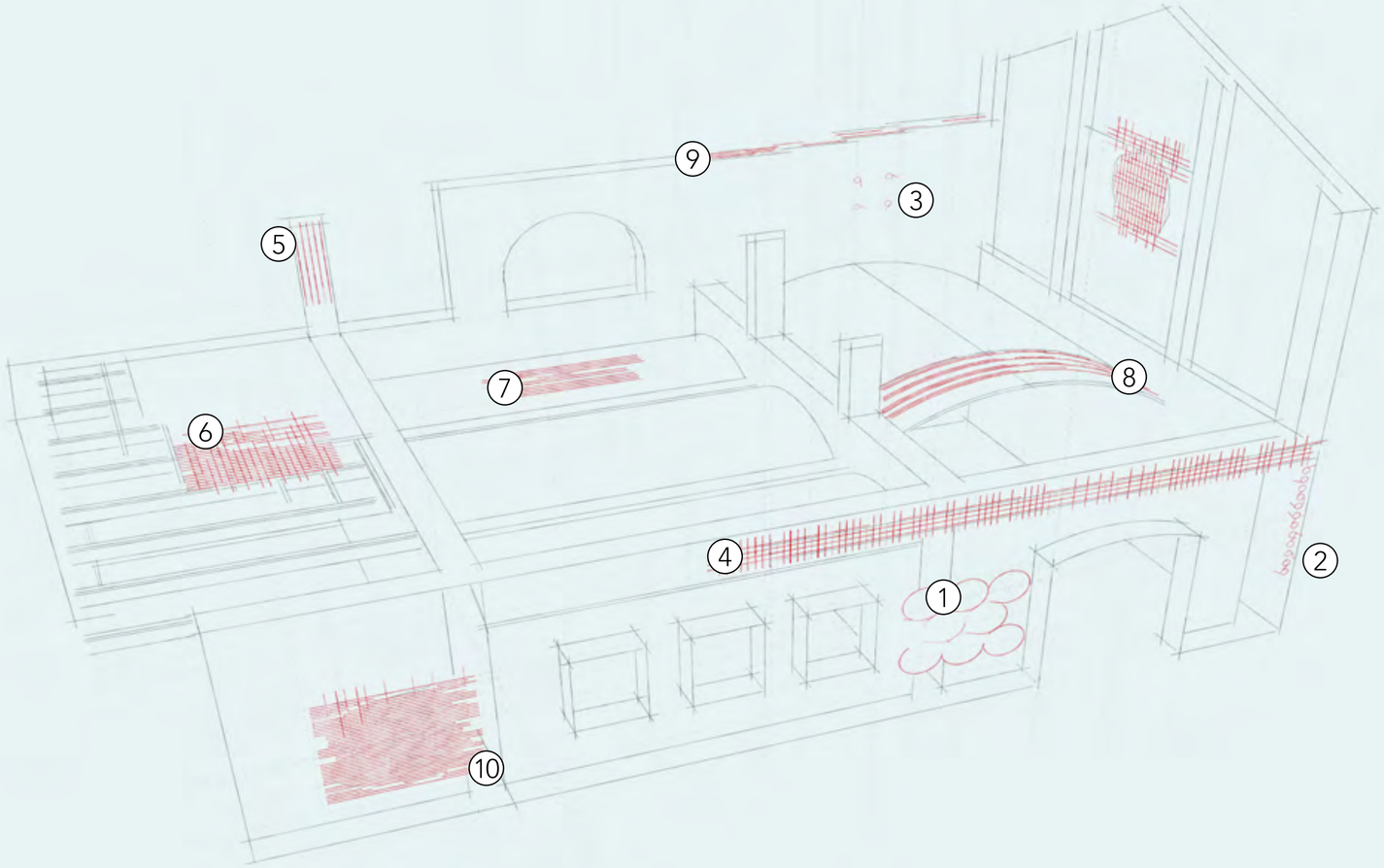
MASONRY STRUCTURES

Buildings in Italy are mostly made either of load-bearing walls or of reinforced concrete. In city centres, one can find countless complex architectural types, heterogeneous and unable to withstand earthquakes.
Innovative techniques and materials are available, able to boost structural capabilities and secure these buildings. **TCS** FRP (Fibre Reinforced Polymer), FRCM (Fibre Reinforced Cementitious Matrix) and CRM (Composite Reinforced Mortar) systems, combined with NHL lime and helicoidal connections, can render masonry monolithic, enabling it to withstand both out-of-plane and in-plane action or, in other words, make it seismically resistant.
The objective is to obtain a BOX effect, thanks to:

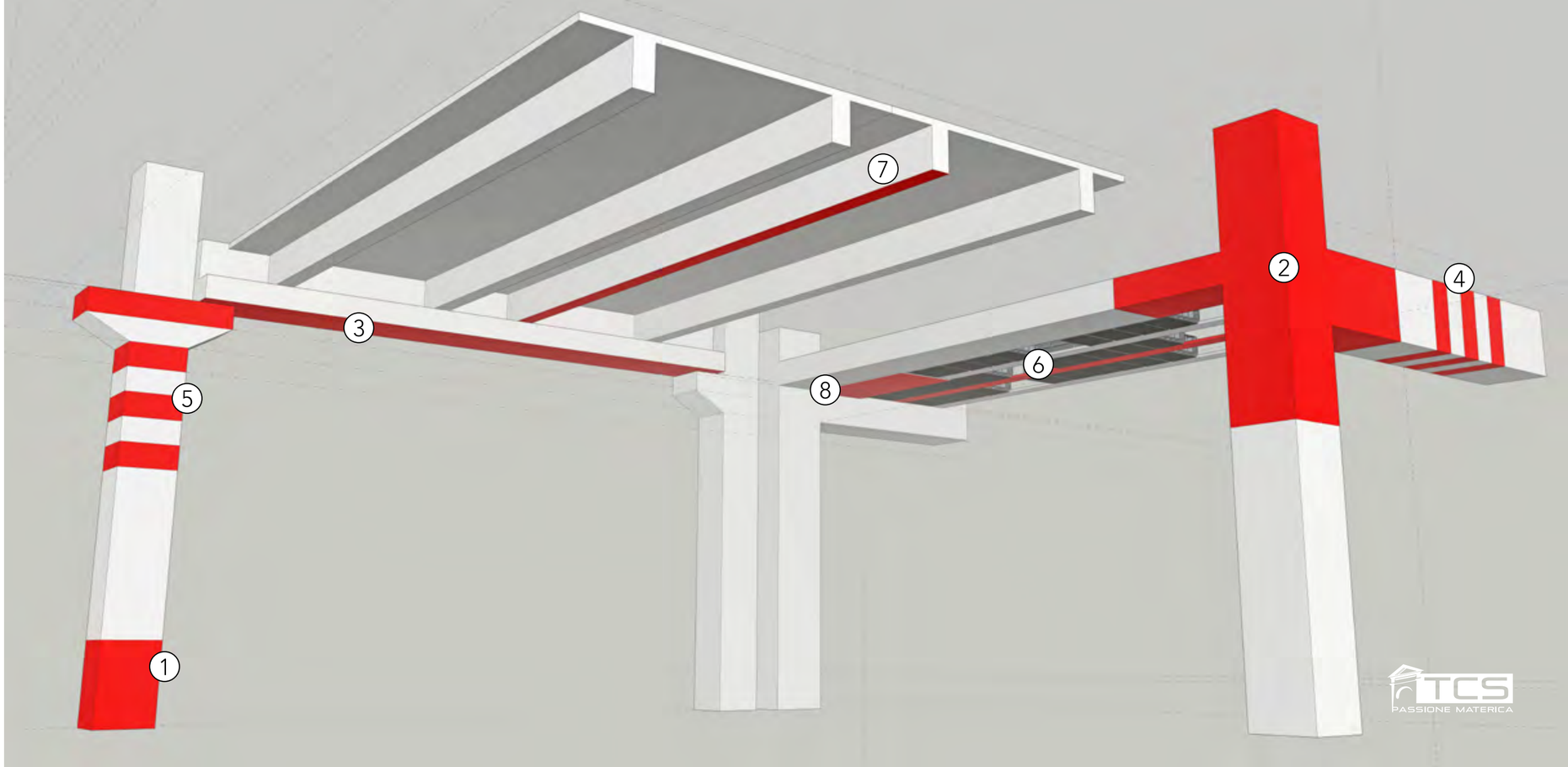
1. Injection of lime binders;
2. Stitching and connections;
3. Ties;
4. Reinforcements;
5. Column wrapping;
6. Slab reinforcement;
7. Complete vault strengthening;
8. Discontinuous vault strengthening;
9. Innovative ring beams;
10. Reinforcement against shear and buckling of masonry walls.



R.C.andP.C. STRUCTURES

In Italy, reinforced concrete buildings are heterogeneous and old, mostly because 60% of them were erected between the end of WW2 up until the Seventies.
Only after this period were technical guidelines issued to regulate buildings in seismic areas, so many of the structures built in these zones are only able to resist gravitational stresses.
Sometimes these buildings need to be stabilized before being seismically reinforced, due to negligence, lack of maintenance and material decay, while often being of poor quality to begin with.
TCS FRP (Fibre Reinforced Polymer) and FRCM (Fibre Reinforced Cementitious Matrix) systems are ideal for:

1. Column confinement;
2. Beam–column joints;
3. Beam flexural strengthening;
4. Beam shear strengthening;
5. Column shear strengthening;
6. Concrete-clay floor blocks slab flexural strengthening;
7. Pre-stressed concrete (P.C.) slab strengthening;
8. Anti-detachment of clay blocks.



INNOVATIVE and ANCIENT MATERIALS

Sheets, grids and connectors for consolidation and structural strengthening of buildings, be they made of R.C. or P.C..
Fibreglass, carbon fibre, aramid, UHTSS or INOX steel, PBO or basalt sheets or grids.
Fibre connectors and helicoidal bars.
Pure natural hydraulic lime mortar and fluid mixture for injection.
Epoxy resins for structural bonding.
The combination of one or more of these materials creates FRP (Fibre Reinforced Polymer), FRCM (Fibre Reinforced Cementitious Matrix) and CRM (Composite Reinforced Mortar) systems for structural strengthening.
Thanks to its new production line, **TCS** can supply its client with a new series of cutting-edge FRP grids, varying in weight, mesh, and resistance.
All **TCS** systems are non-invasive and completely compatible with all kinds of restoration work, thanks to the combination of high durability materials and natural hydraulic lime NHL.

LIME INJECTIONS

The injection technique was created to improve the compactness and mechanical behaviour of masonry.
This technique can be used to repair the bond between the elements of the wall surface and achieve monolithic behaviour.
Thanks to thirty years of experience in lime and restoration, TCS developed different formulations for injectable products.

These mixtures consist completely of NHL 2, 3.5 or 5, totally free of cement binders of any kind.
This choice guarantees full architectural and structural compatibility, while avoiding the addition of any damaging salt (usually contained in cementitious mixtures) which could cause deterioration of the plaster and/or decorative apparatus through surfacing.

B-STRUCTURA INIEZIONE

B-STRUCTURA INIEZIONE

Top quality product for structural injection, made of natural hydraulic lime NHL. Without any damaging salt, highly compatible with masonries and frescoes. Never forget that the injection technique is irreversible.

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REPOINTING OF MORTAR JOINTS - NSM

The technique of sealing a joint consists of an initial stage called stripping, i.e. the removal of the existing joint.
The deep mortar sealing of joints is necessary for distributing the contact forces between wall sections. This value can be very high.
The new mortar must be as chemically and mechanically homogeneous as possible with the existing one.
The efficiency of this technique increases with the increase of the depth of joint removal.
If necessary, it is possible to increase the connection and the shear strength of wall surfaces by reinforcing joints with helicoidal bars of the NSM system.
The mortar can be conveniently pigmented.

B-STRUCTURA

B-STRUCTURA

Structural lime mortar, developed after the 2009 earthquake of L'Aquila. A biocompatible and at the same time structural mortar, it is designed for application on historical and Heritage buildings.

TCS TWIST 6A2

Cracked walls can be strengthened by stitching with the NSM technology of helicoidal stainless steel connections

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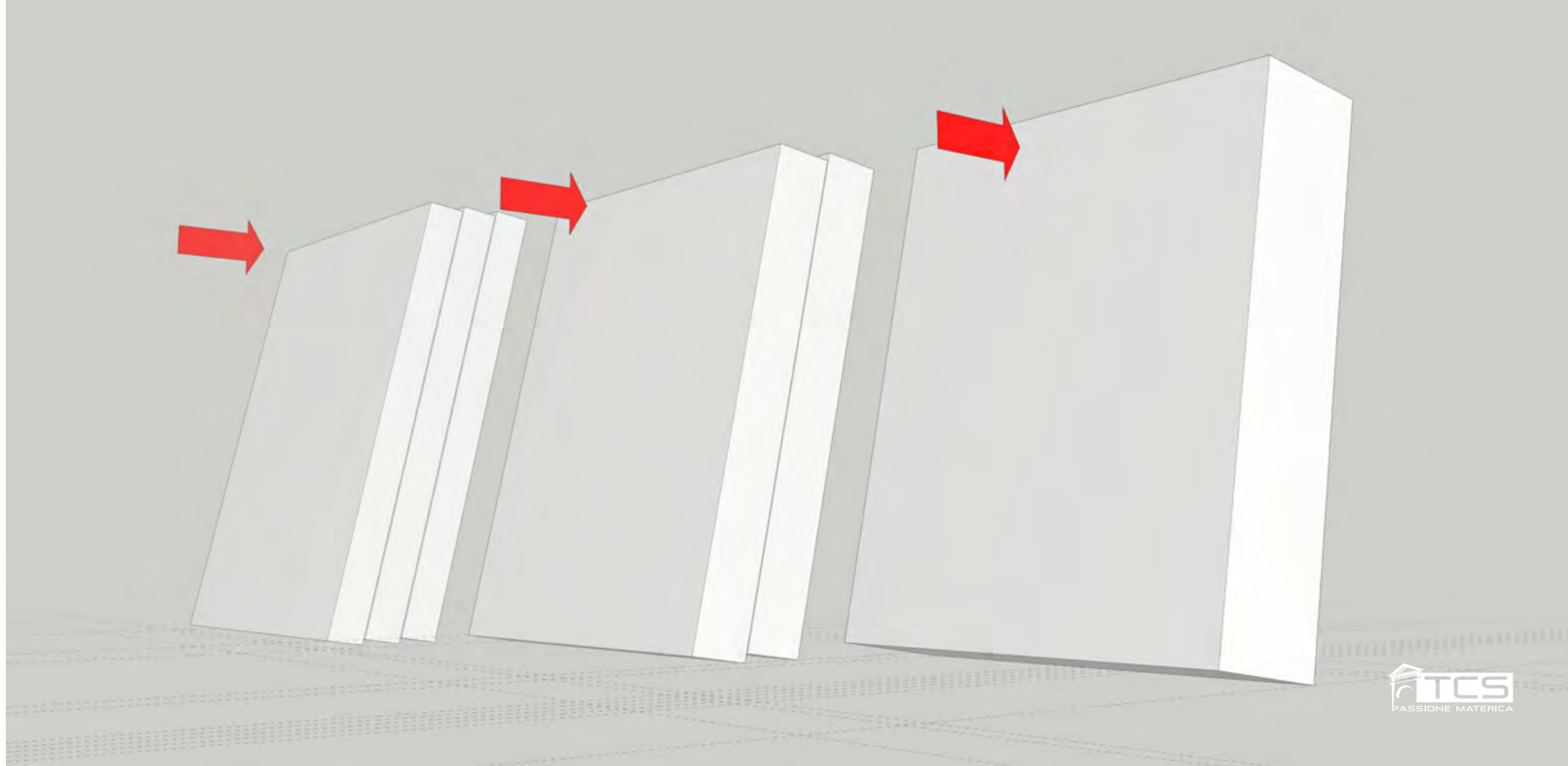
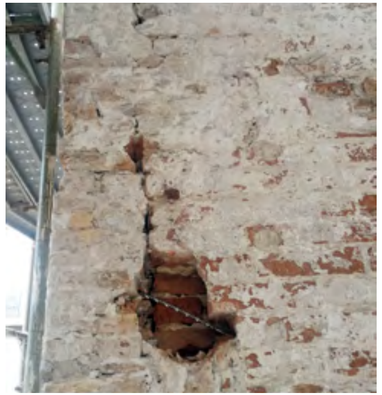
DIATONI and CONNECTIONS

The term "diatoni" identifies a connection perpendicular to the masonry plane (tie). Imagine, for example, a masonry wall without through stones.
The objective of this technique is to create a continuous, monolithic wall, with a rotation centre at its bottom.
To create this connection system, it is possible to use helicoidal bars, either without any bonding agent or by pre-injecting the area with an injection mixture.



TCS TWIST



TCS TWIST 9A2

TCS TWIST 12A4

Cutting-edge artificial diatoni and helicoidal stainless steel connections with a diameter of 9 or 12 mm. They can be inserted without any bonding agents with the appropriate chuck.

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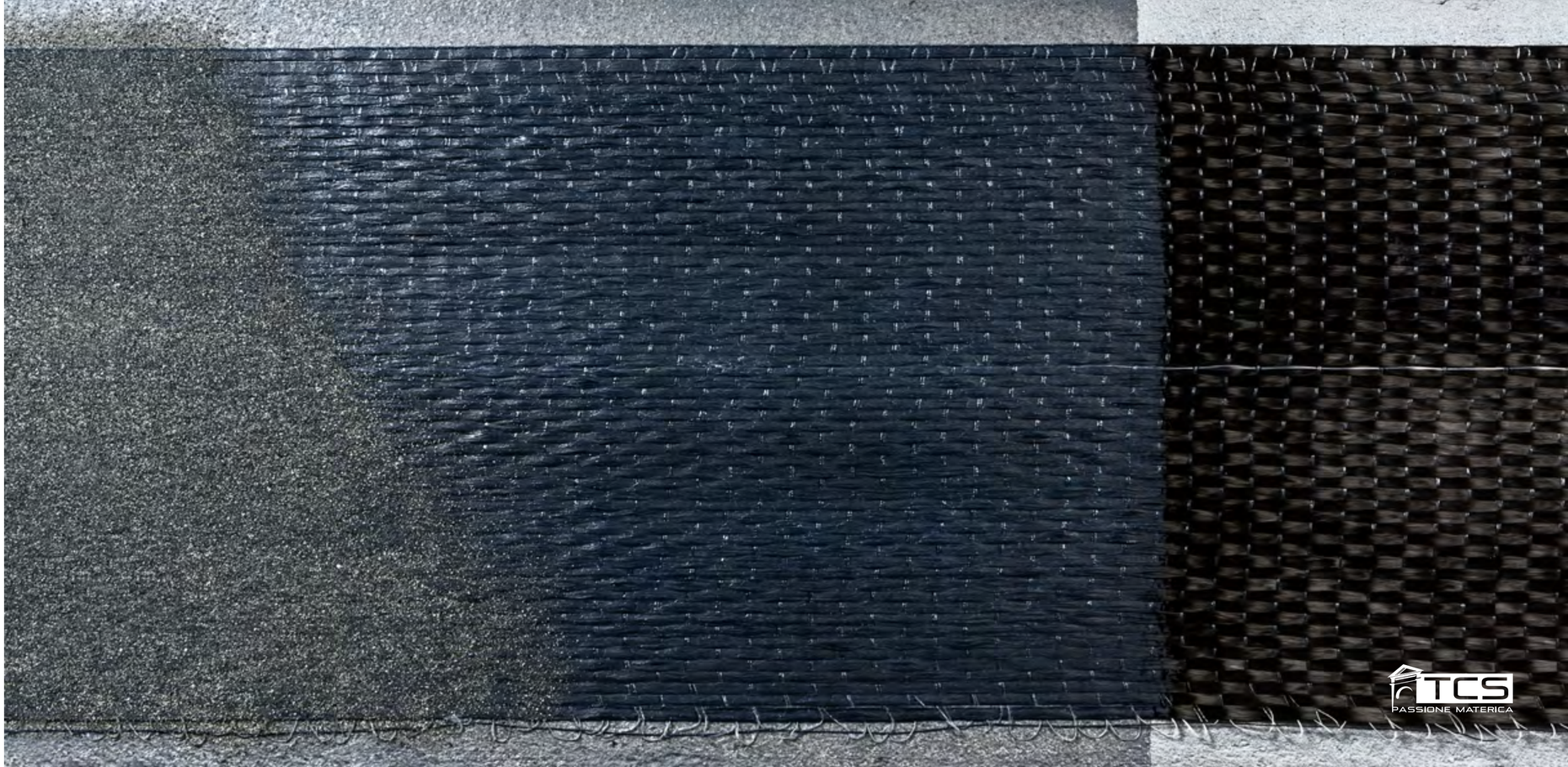
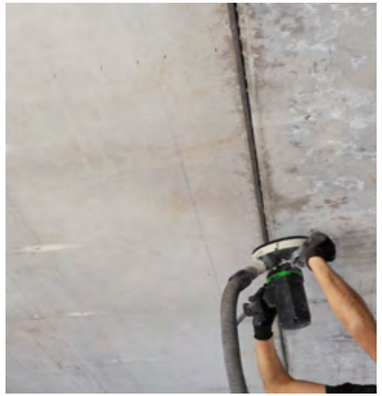
FRP

FRP, or Fiber Reinforced Polymer, is a system of long fibers coated with an organic matrix. Usually fibers are unidirectional, bidirectional or quadriaxial, and combined with an epoxy resin.
It is possible to use either prefabricated elements or cast-in-situ elements, through impregnation and creation of composites on the work site (manual wet lay-up). **TCS** proposes the employment of this kind of system directly on reinforced concrete (R.C.) or precast/prestressed concrete (P/C), especially FRP made of high-resistance carbon fibre (CFRP).
This system can be used on masonry, but it is more advisable to use less invasive materials, more appropriate for moist locations.



CARBO-STRUCTURA



CARBO-STRUCTURA

Strengthening FRP (Fibre Reinforced Polymer)system certified according to CSLP (Consiglio Superiore dei Lavori Pubblici - Superior Council of Public works) for structural reinforcement made of carbon fibre with CIT (Certificato di Idoneità Tecnica - Certificate of Technical Suitability) for masonry and reinforced concrete elements.

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FRCM

FRCM systems, or Fibre Reinforced Cementitious Matrix, are applied with an inorganic matrix.
Usually it is advised that the fibres be used in the form of dry fabric, and rendered with natural hydraulic lime NHL.
TCS suggests the employment of this kind of system directly on masonry, stone or tuff, especially if the FRCM system is combined with AR fibreglass or unidirectional INOX steel sheets.
This system can be used with reinforced concrete (R.C.) or precast or prestressed concrete (P/C), but a polymer-modified cementitious mortar would be more advisable.

FRCM

TCS GLASS R220AR

TCS GLASS N350

Fibreglass grid appropriate for realizing TRM (Textile-reinforced mortar) and FRCM (Fibre Reinforced Cementitious Matrix) composite systems in combination with an inorganic matrix. Ideal for breathable strengthening in moist environments.

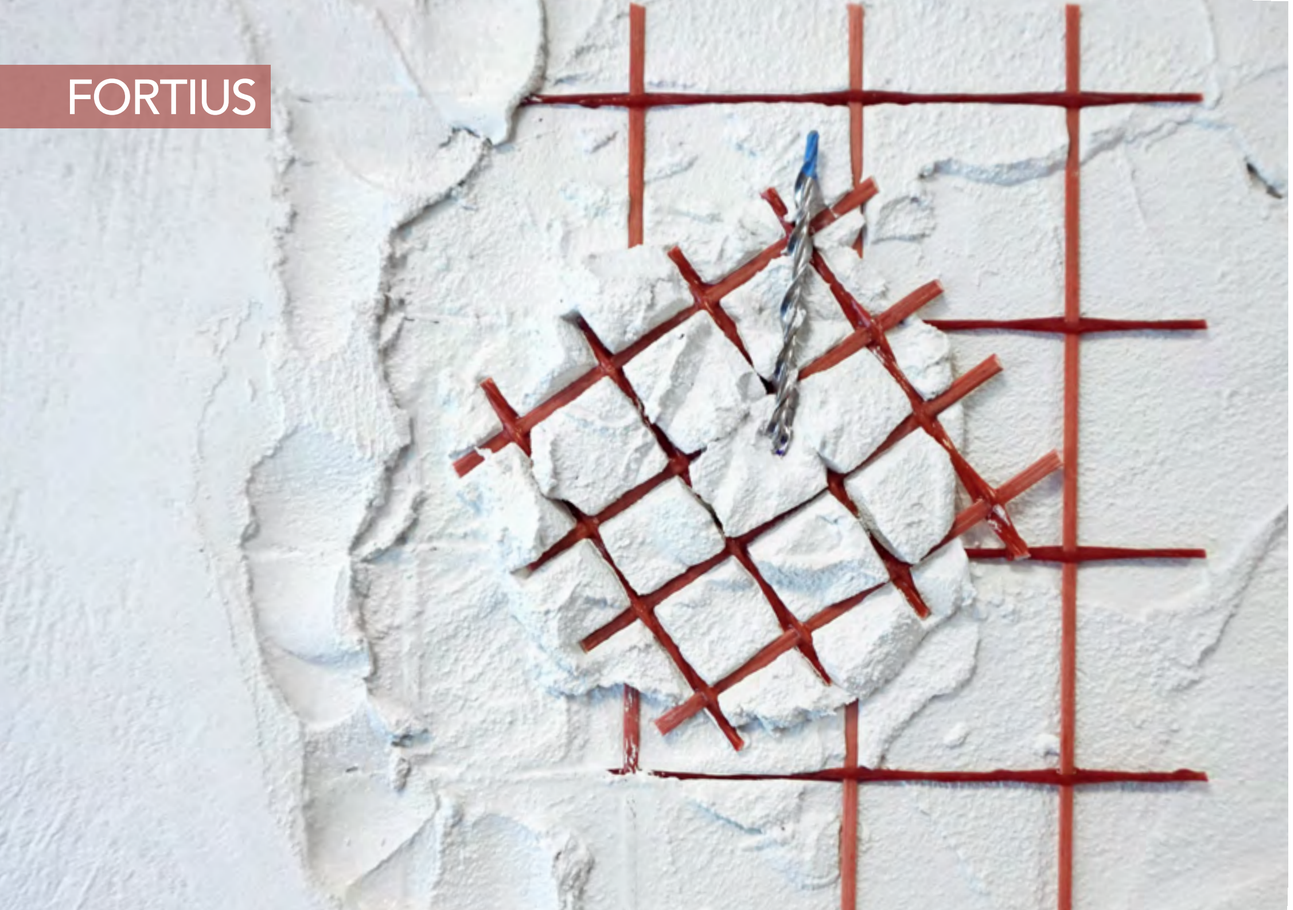
TCS STEEL X800-A4

Innovative stainless or galvanized steel tape for strengthening, structural reinforcement and static or seismic upgrades.

CRM

CRM systems, or Composite Reinforced Mortar, are FRP (Fibre Reinforced Polymer) meshes applied with an inorganic matrix made of lime NHL.
Strictly speaking, it is not possible to classify them as composite systems because their use falls outside that of composite materials; instead, they are more related to reinforced plaster.
Thanks to the new production site, **TCS** can offer a cutting-edge technologically advanced product.

FORTIUS



TCS GLASS MR 44

TCS GLASS MR 48

TCS GLASS MR 88

The innovative MR family of FRP meshes, ideal for CRM (Composite Reinforced Mortar) systems. These meshes, combined with a natural hydraulic lime matrix B-STRUCTURA, create the FORTIUS system.

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FRCM MASONRY

In partnership with the POLYTECHNIC UNIVERSITY OF MILAN, different types of strengthened masonry were tested.
The testing was conducted in Finale Emilia on four building boards from a midspan wall of a warehouse.
Tests were made to evaluate the actual achievable reinforcement and its application on adjacent buildings,whichweremechanically, geometrically, and physically identical. These buildings had already been secured and structurally reinforced.
The first sample was strengthened with an FRCM (Fibre Reinforced Cementitious Matrix) system on both sides, made of a dry, alkali resistant fibreglass mesh (R220AR), helicoidal stainless steel connections as diatoni, and pure lime NHL as matrix.
The second sample was reinforced with an FRCM system on both sides, made of impregnated fibreglass mesh, helicoidal stainless steel connections, and fibre-reinforced matrix.
The third sample was unreinforced.
One side of the fourth sample was strengthened like the first one, while the other side was reinforced with helicoidal stainless steel connections within the joint (NSM) to resemble a fair-faced panel.

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MILANO 1863

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FRCM

TCS TWIST 9A2

TCS TWIST 6A2

Substrate preparation, joint removal and washing. The helicoidal stainless steel connections can be inserted without any bonding agent or with mortar, made of hydraulic lime NHL, directly into the joint.

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FRCM

TCS TWIST 6A2

TCS GLASS N350 + TCS TWIST 9A2

TCS GLASS R220AR + TCS TWIST 9A2

Strengthening with fair-faced systems or low-thickness strengthening systems.

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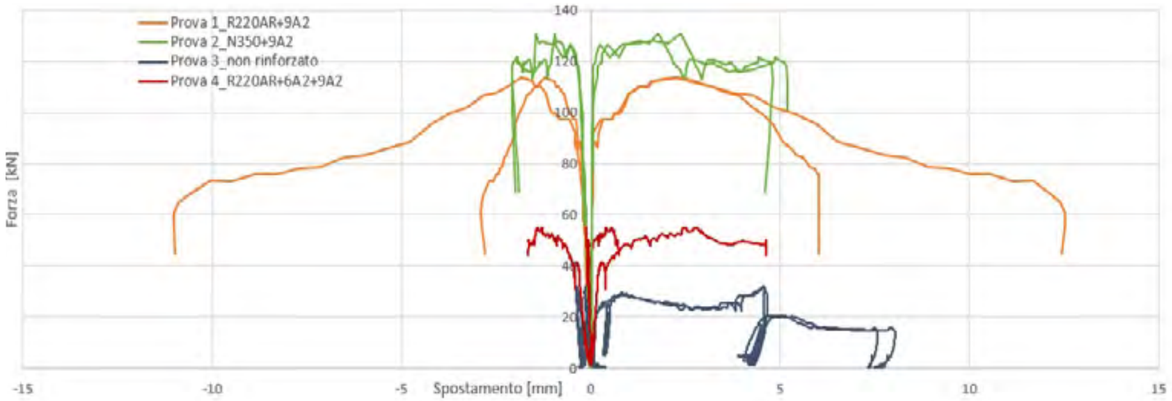
FRCM



EXPERIMENTAL RESULTS

Increase of wall resistance for masonry with very low-strength mortar beds.

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FRP-FRCM ARCHandVAULT

In partnership with the POLYTECHNIC UNIVERSITY OF MILAN, tests with different kinds of reinforcements were made on masonry arches and vaults.
The experiment was conducted in Novi Ligure, and was focused on a vault with two ribs, called arches.
Tests were made to evaluate the actual achievable reinforcements of a vault which was going to be demolished, and which was mechanically, geometrically and physically identical to others already secured and structurally reinforced.
The first sample was an unreinforced arch.
The second sample was a section of the vault strengthened with FRP (Fibre Reinforced Polymer), carbon mesh and organic matrix.
The third sample was an unreinforced section of the vault.
The fourth sample was a section of the vault with FRCM (Fibre Reinforced Cementitious Matrix), AR fibreglass grid and inorganic lime NHL matrix.
The fifth sample was an arch with FRCM, unidirectional stainless steel mesh and inorganic lime NHL matrix.

POLITECNICO MILANO 1863

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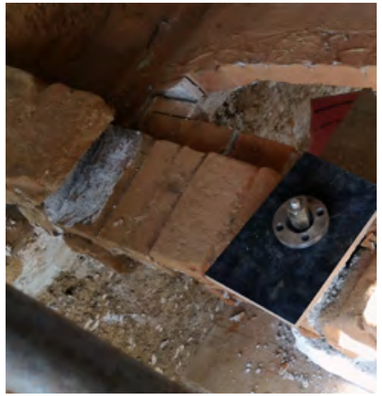
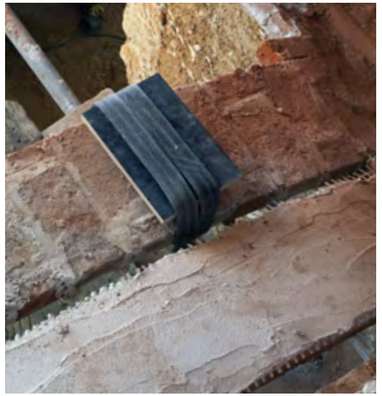
FRP-FRCM

CARBO-STRUCTURA



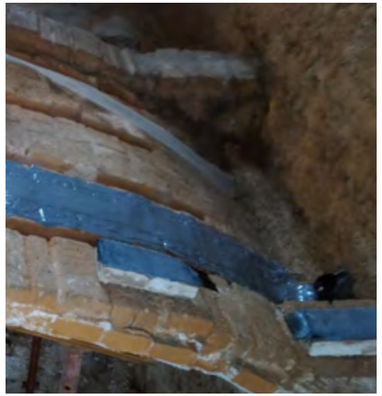
TCS STEEL



TCS GLASS

The vault was divided into five sections; three parts of the vault and two arches. The load was applied at point L/4.

FRP-FRCM



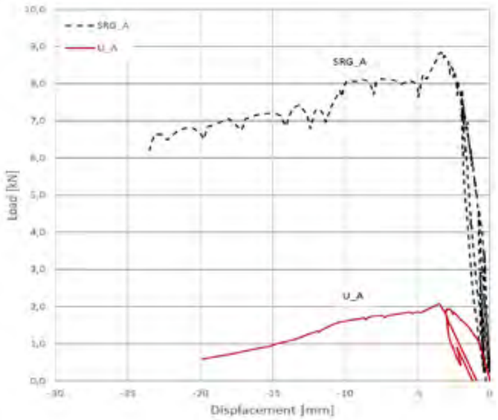
CARBO-STRUCTURA

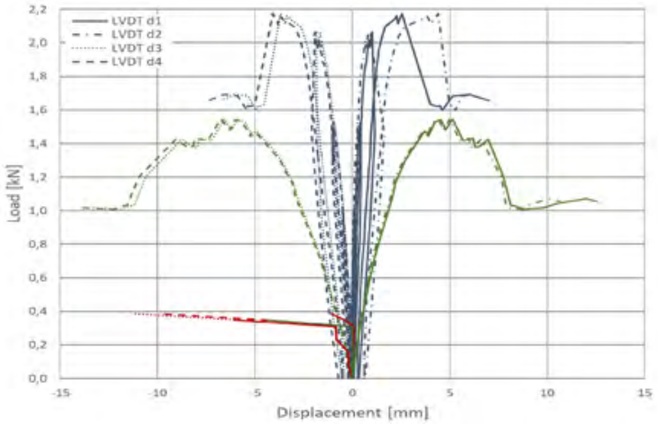
TCS GLASS R220AR

TCS STEEL X800-A4

Strengthening of extrados with FRP system (Carbo-Structura system) and FRCM system (stainless steel and fibreglass meshes).

FRP-FRCM





EXPERIMENTAL RESULTS

Resistance and deformation increased. Thanks to the composite materials applied to the extrados, the formation of the fourth plastic hinge is delayed.

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CRM MASONRY

In partnership with the POLYTECHNIC UNIVERSITY OF MILAN, lab tests were conducted on masonries with different reinforcement types. The experiment was conducted in Milan, and was focused on eight walls made of reused brick (same bricks as in Finale Emilia) with lime mortar for the joints.
Panels are divided into two types. The first case has two connected headers, while the second one is composed of two parallel walls. The first type was reinforced with CRM (Composite Reinforced Mortar) and inorganic NHL matrix. The second one was reinforced with CRM, helicoidal bars and inorganic NHL lime matrix. For each tested type, one sample was not reinforced, and three were.
Deformations were analysed with the innovative DIC (Digital Image Correlation) system.

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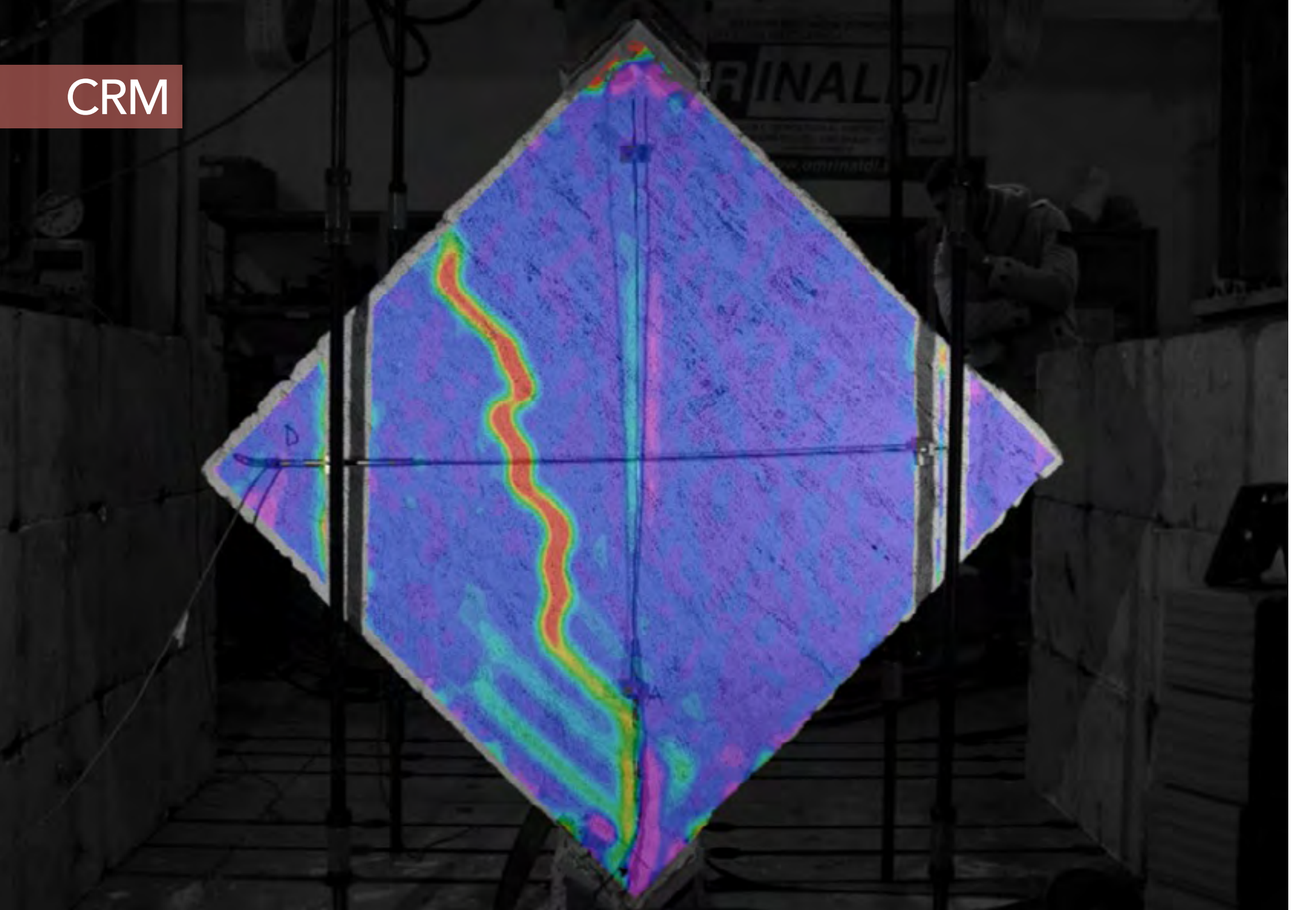
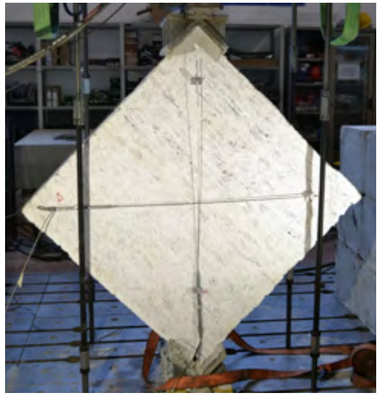
CRM





DIC (DIGITAL IMAGE CORRELATION)

Optical method, without any form of contact, to analyse displacements, deformations and vibrations on objects or materials subject to an applied force.

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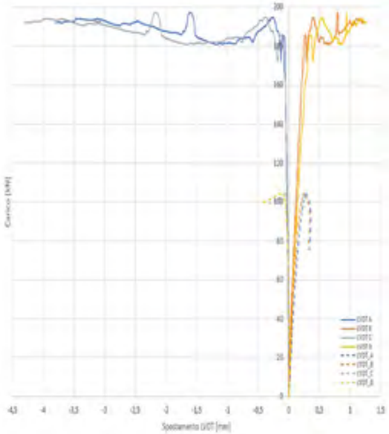
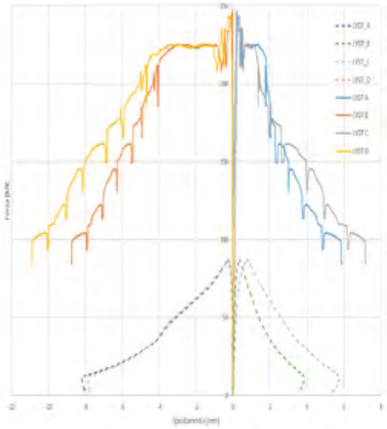
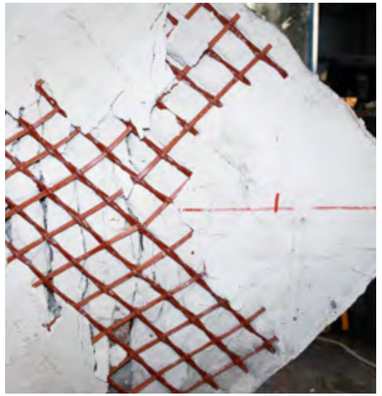


EXPERIMENTAL RESULTS

Strengthening with FRP (Fibre Reinforced Polymer) meshes and hydraulic lime, without any connections. High increment of rupture load with release of the reinforcement system.





EXPERIMENTAL RESULTS

Strengthening with FRP (Fibre Reinforced Polymer) meshes and hydraulic lime, with helicoidal stainless steel connections. High increment of rupture load without release of the reinforcement system.

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