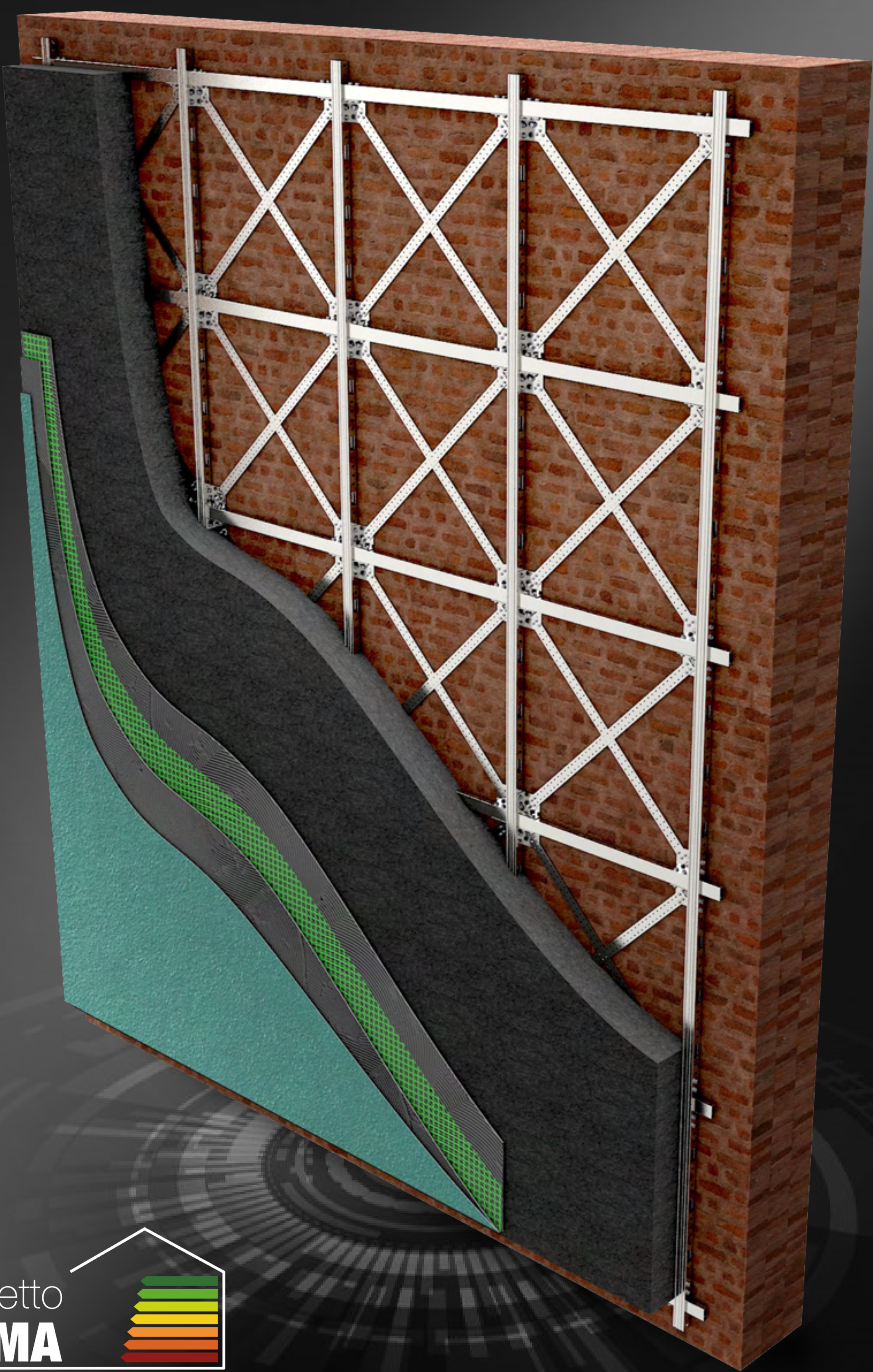
RESISTO 5.9 tube

il cappotto antisismico



Progetto
SISMA

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ABOUT US

PROGETTO SISMA SRL

Progetto Sisma is **pure innovation and expertise**, concentrated in a **team of experts** in **seismic retrofit and energy efficiency**.

Progetto Sisma relies on **young resources** who fully share the company philosophy, contributing to the **evolution of the company** which is constantly projected towards **innovation.**

Today we have about **30 people between employees and collaborators** who are part of what we consider a **family**.

Our "home" is located in the **heart of Emilian industry**, more precisely in **Fiorano Modenese**: it is an **area of 2000 m^2**, divided between an **office-building** spread over 3 floors and 1000 m^2 of **warehouse**. There is also an area dedicated to **Research and Development** which is the beating heart of the company, and a spacious conference room.

OUR MISSION

Italy is a country at **high seismic risk** due to its particular geographical position which places it in the convergence zone between the African plate and the Eurasian plate. In 2,500 years we have suffered **30,000 earthquakes of medium and strong intensity**, the most recent and devastating ones in L'Aquila in 2009, in Emilia Romagna in 2012, in Central Italy in 2016 and on Etna in 2018.

Therefore, it is essential to make a **seismic improvement of existing buildings** to make them safer, in case of a seismic event.

Progetto Sisma was born with the intention of designing a **single product capable of improving existing buildings both seismically and energetically** and aims to become the **market leader in its segment**.

Our mission is to respond to the demand for **safety and thermal efficiency** of buildings in a country that increasingly focuses on the issue of **prevention**.

RESISTO 5.9 TUBE

ANTI-SEISMIC COAT

The **RESISTO 5.9 TUBE SYSTEM** is an **innovative technological solution** that aims to guarantee an **improvement in seismic performance combined with an energy efficiency of existing buildings**, according to current regulations. The system is designed on the basis of a laser scanner survey and according to the structural project developed by the technician in charge, allowing a series of advantages, including the **reduction of work on site**, with a consequent **reduction in intervention times** and total **elimination of waste processing**, which translates into **cost savings** and **attention to the environment**.

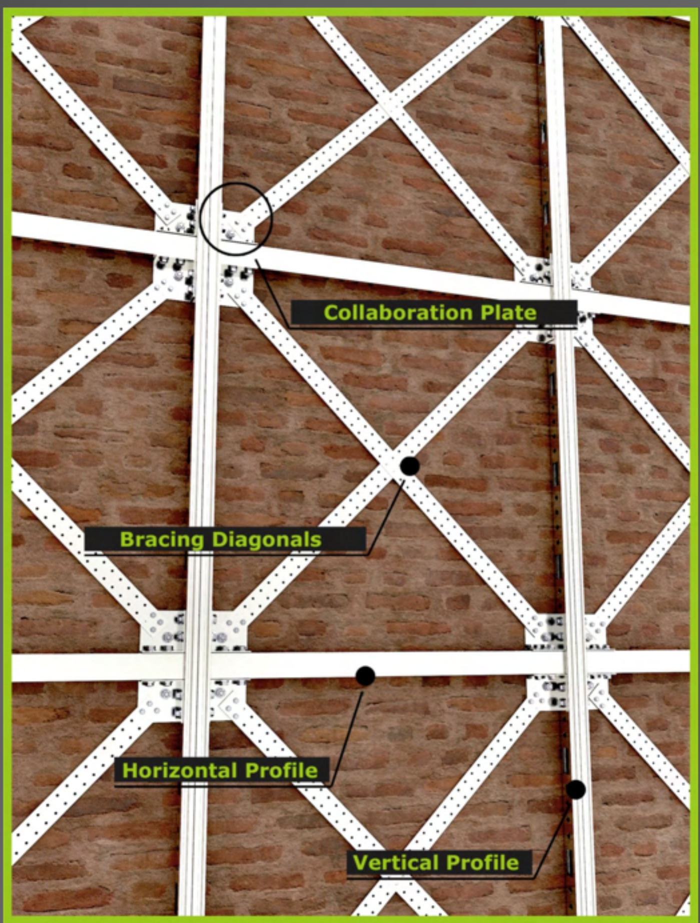
The **RESISTO 5.9 TUBE SYSTEM** can be applied to:

- **masonry buildings**
- **reinforced concrete frame buildings**

The intervention is aimed at the **seismic improvement/adaptation of masonry buildings** pursuant to § 8.4.2 and 8.4.3 of the NTC2018, generally falling within the scope of **global interventions**, with the aim of **improving the entire structure**.

The system can also be adopted only as a **local intervention** pursuant to § 8.4.1 of the NTC2018 and can concern **interventions on single portions or single masonry elements**, in order to contribute to the **reduction of the vulnerability of the structure with respect to local mechanisms/kinematics**.

The high degree of design-freedom of the RESISTO 5.9 TUBE SYSTEM **guarantees intervention on almost all types of buildings** also through **integration with other structural reinforcement solutions**.



SEISMIC REINFORCEMENT

EXTERNAL MODULAR CLADDING

The reinforcement of the masonry elements is performed by means of integrative collaborating steel structural elements on the surface. The system is made up of **steel elements suitably connected to each other and connected to the masonry.**

The elements are positioned in adhesion on the external surface of the wall, placed side by side and connected to the masonry by means of non-through anchors with regular pitch.

The anchoring must be of the chemical type, achieved by injection of a specific resin into holes of suitable diameter and depth and subsequent insertion of class 8.8 threaded steel rods. The presence of **anchors** in a minimum number of 4/m^2 distributed over the entire surface of the masonry wall **allows collaboration between the existing wall and the reinforcement**.

Each profile will be connected to the adjacent one/s in order to ensure **continuity of the reinforcing elements** along vertical, horizontal and diagonal directions: shaped **pre-galvanized steel plates** allow the profiles and diagonals to be joined together, through galvanized **steel bolts** of class 8.8.

STEEL PROFILES

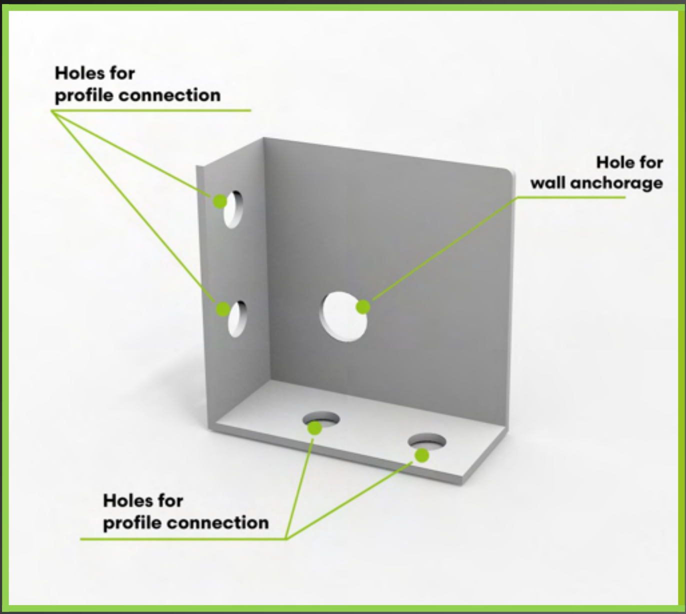
ELEMENTS WITH TUBULAR SECTION

The **metal profiles** are obtained through a **cold shearing and profiling process** of **2 mm thick pre-galvanized S250GD+Z steel plates**, with a rectangular section with dimensions of 60 mm x 45 mm and 60 mm x 25 mm respectively in the vertical and horizontal directions.

Special ribs along the entire lenght of the elements, thanks to the particular production process, give the profiles **greater srenght**. This specific section shape makes it possible to **reduce the use of steel with the same performance**.

The presence of **holes and notches** allows for modularity of the system with a **pitch of 250 mm**, guaranteeing the **continuity of the vertical and horizontal elements**, thus adapting the intervention to any configuration of the wall to be reinforced.

CONNECTING ELEMENTS



COLLABORATION PLATE

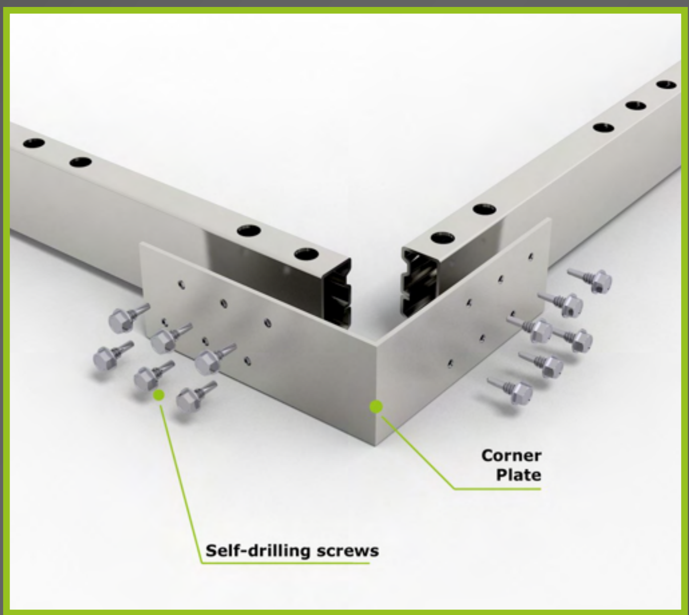
Steel plate obtained by laser cutting and cold bending of thin sheets, **3 mm thick**, in pre-galvanized S250GD+Z steel.

The plate allows **all the elements to be connected to each other**. It allows also the **anchoring to the masonry** and the laying of the **diagonal braces**.

CONNECTION PROFILES

Metal profiles obtained by laser cutting thin sheet metal with a thickness of 2/3 mm in galvanized S250GD+Z steel, with a **tubular section**.

The profile allows the vertical and horizontal elements to be **connected along their lenght**.



CORNER PLATE

Steel plate obtained by laser cutting and cold bending of thin 3 mm thick sheets in galvanized S250GD+Z steel. The plate **allows the horizontal elements to be connected to each other at the corners or edges**. It is also used to **anchor the system near roofs or balcony slabs**, as well as to overcome any obstacle such as gas pipes.

DESIGN, PRODUCTION AND INSTALLATION

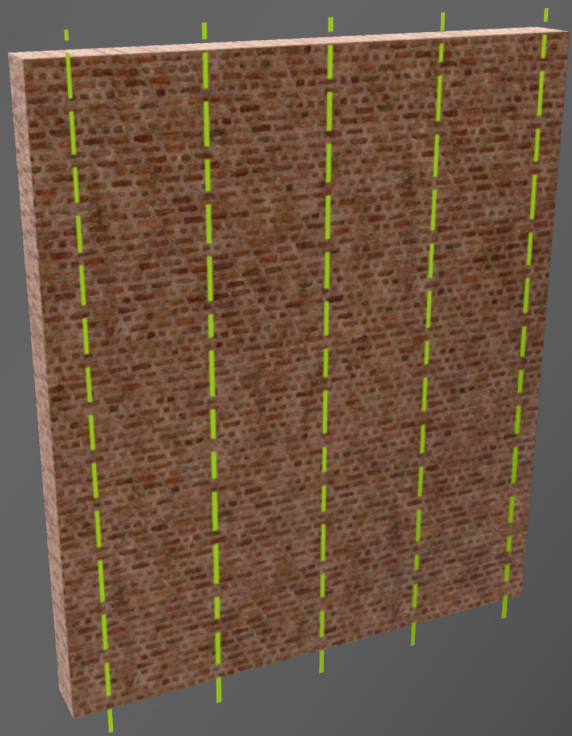
FROM DESIGN TO THE START-UP ON-SITE

Following a **precision geometric survey** carried out with the aid of a **laser scanner**, the **three-dimensional model** of the Resisto 5.9 TUBE system is produced in synergy with the structural works designer. All the geometric information necessary and useful for installation is translated into **the assembly drawing that will be supplied with the system**. The design perfectly follows the dimensions and all the openings of the building subject to intervention. Based on the specifications provided by the designer, the tubular section profiles, the collaboration plates and the bracing diagonals are made in pre-galvanized structural steel.

STEP 1 - TRACKING OF VERTICAL PROFILES

The **tracing of the position of vertical profiles on the masonry** takes place **starting from a corner of the building**. This phase is essential to have a correct positioning of the Resisto 5.9 Tube System.

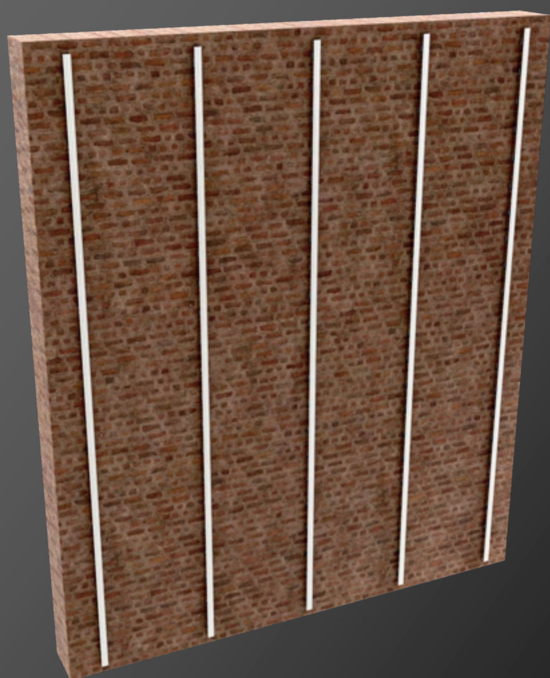
In correspondence with corners and edges, it is necessary to maintain a distance between the vertical profile and the corner/edge not exceeding 150/200 mm.



STEP 2 - INSTALLATION OF VERTICAL PROFILES

The **positioning of the vertical profiles** is achieved in adhesion to the masonry, only on the **external side**, starting from a corner of the building.

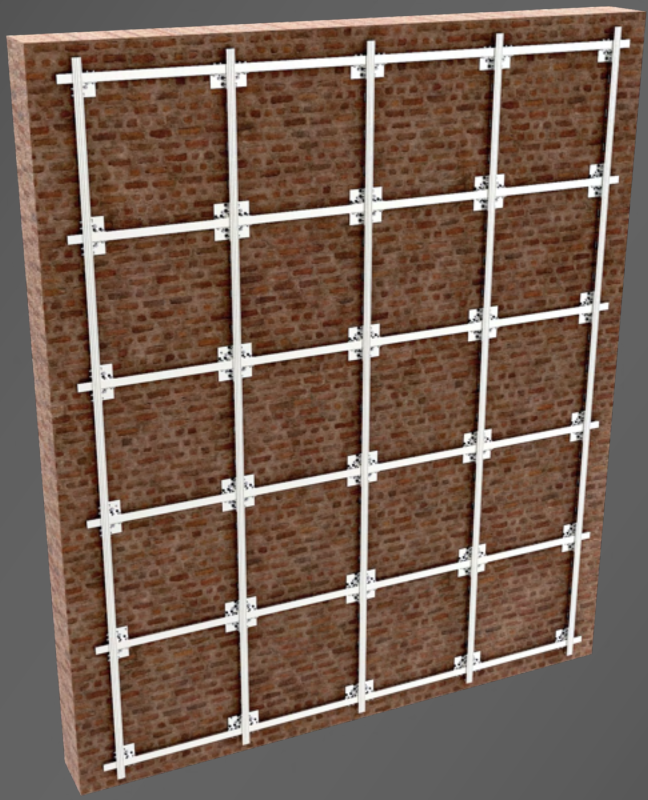
To fix the vertical profiles to the masonry it is necessary to use **temporary fixing plugs**, placing one at each end of the rod.



STEP 3 - INSERTION OF HORIZONTAL PROFILES

The installation of the horizontal profiles is carried out by inserting the profiles inside the notches of the vertical profiles.

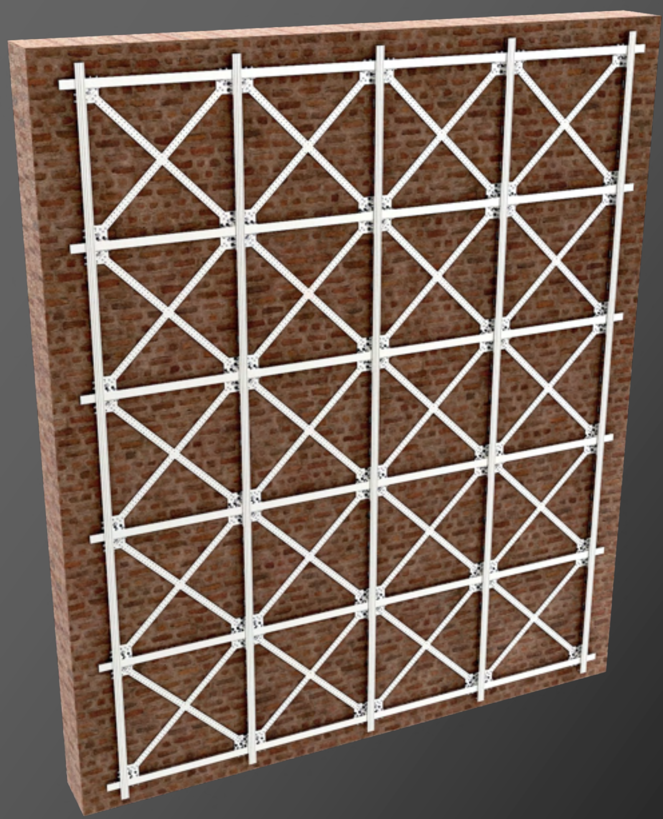
The connection is achieved, by means of bolted unions, at the intersection nodes, between vertical and horizontal profiles, thanks to the collaboration plates.



STEP 4 - ANCHORING AND INSTALLATION OF THE DIAGONAL BRACES

The **connections to the masonry** are made via the collaboration plates. They consist of non-**passing chemical anchors with a regular pitch**.

The assembly phase of the anti-seismic structure ends with the **installation of the bracing diagonals, in correspondence with the collaboration plates, using self-drilling screws**.



CONNECTION PHASES

FOCUS ON CONNECTIONS AND ANCHORS


FIG. 1


FIG. 2


FIG. 3

CONNECTION BETWEEN ELEMENTS - PROFILES

The **connection between the tubular profiles** and the collaboration plate is made by means of bolted unions, with M12 elements in class 8.8 galvanized steel (fig.1)

The **metal profiles with a length of 3000 mm and 4000 mm** respectively in the horizontal and vertical directions are joined by **special connecting-elements** inserted internally at the ends of the profiles and fixed by means of **bolted unions**.

WALL CONNECTION - ANCHORS

The **connections to the masonry** are made through **non-passing chemical anchors** with a regular pitch.

After making holes of suitable diameter/depth and blowing/brushing the cavity to eliminate residues, **certified epoxy resin is injected** starting from the bottom of the hole; the anchoring is completed by the subsequent **insertion of an M12/M14 threaded rod in class 8.8** and tightening on the collaboration plate with nut and washer (fig. 2)

COMPLETION - DIAGONAL BRACES

The metal structure is completed by positioning the **diagonal braces**: **3 mm thick**, **55 mm wide**, pre-galvanized S250GD+Z steel plates. They are provided with **modular pitch holes**, which allow fixing them on the collaboration-plates using **self-drilling screws** in galvanized steel certified for fixing (fig.3)

ANGULAR CONNECTION

FOCUS ON CORNERS OF THE BUILDING

ANGULAR CONNECTION

In **load-bearing masonry buildings**, the system will be completed by **angular elements** composed by metal plates for connecting the metal profiles placed on all the sides of the building and obtaining a **continuous and global encirclement of the structure**.

CONNECTIONS ON R.C. STRUCTURES

GUIDELINES AND TIPS FOR R.C. FRAME STRUCTURES AND INFILL PANELS

In **reinforced concrete frame buildings**, the metal profiles are connected to the reinforced concrete columns **and beams** in order to make the reinforcing metal elements **collaborate with the existing reinforced concrete frame and with the infill walls.**

CONNECTION TO COLUMNS

Near **each single column**, it is necessary to **place a vertical row** of collaboration-plates and carry out the **anchoring directly on the reinforced concrete** (fig. 4)

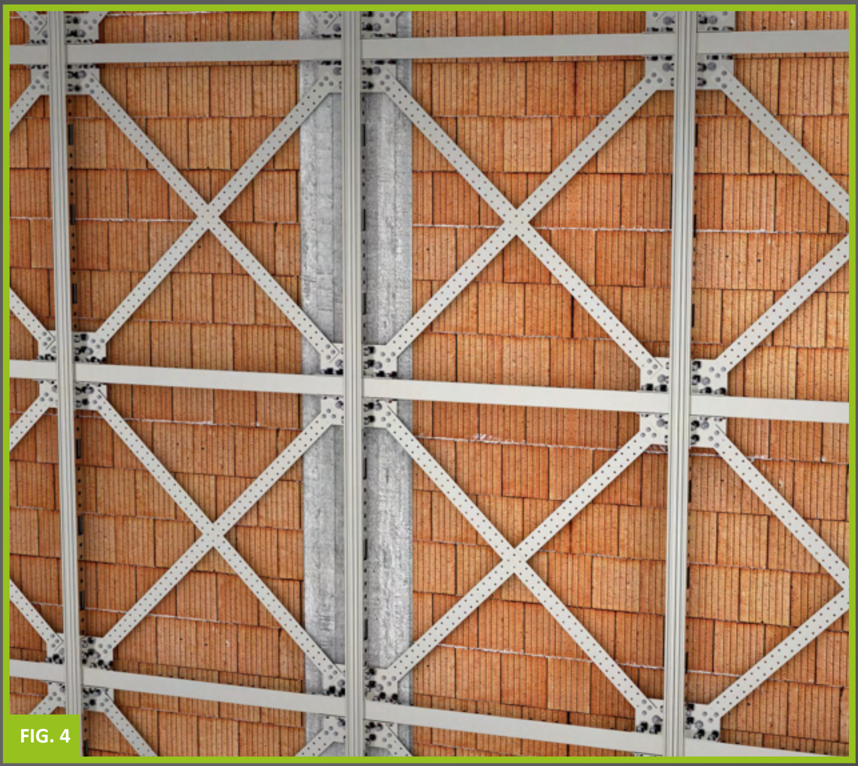


FIG. 4

CONNECTION TO BEAMS

At the height of **each beam**, it is important to **lay a horizontal row of collaboration-plates** and to **anchor the system to the reinforced concrete** (fig. 5)

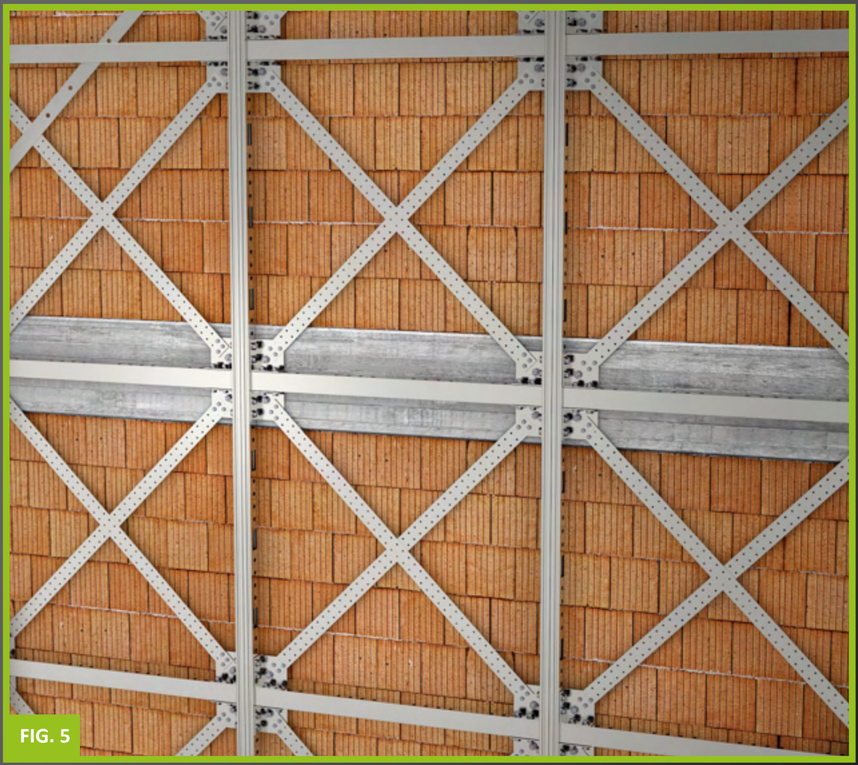


FIG. 5

THERMAL INSULATION

INSULATING MATERIALS

Once the installation of the metal structure has been completed **and after having checked the tightening of all the bolted unions**, **the walls of the building are ready to be insulated**, in order to improve their thermal performance.

SINTERED EXPANDED POLYSTYRENE

The **insulating panels** measure **1000x500 mm** (fig. 6)

The presence of perimeter rabbets on the four sides allows **interlocking installation of the insulating panels**, **improving the finished flatness of the insulation** (fig. 7)

The **special grooves** created in the rear part of the insulating panel, with constant distance and therefore **perfectly modular**, allow **precise and rapid installation** along the entire mesh of the metal frame. This allows the **thickness of the finished package** to be **reduced** as the empty areas left by the metal profiles are filled (fig. 8)

FIG. 6

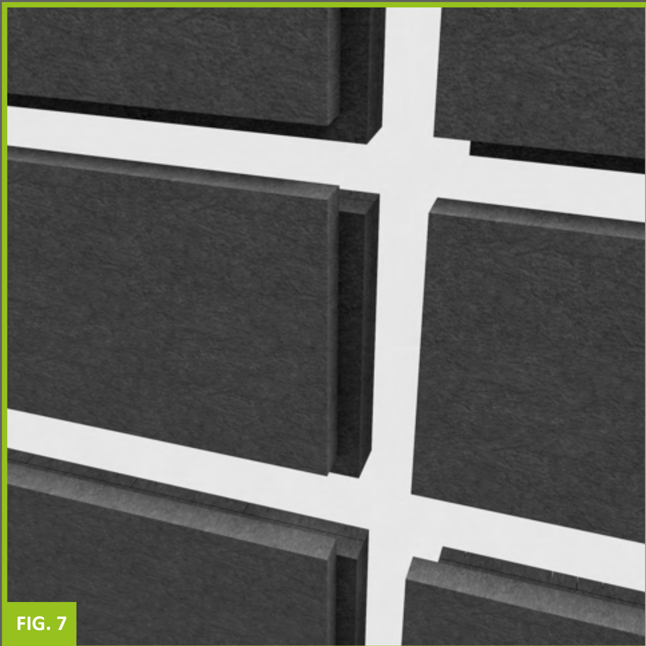


FIG. 7

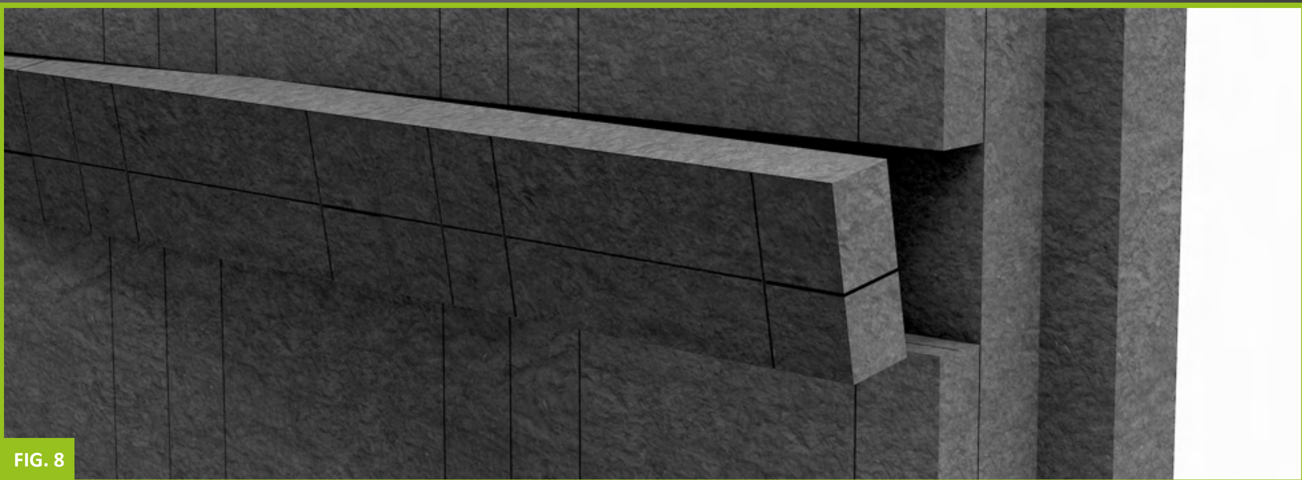


FIG. 8

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The fixing of the insulating panels to the masonry takes place through the use of a particular **high-density polyurethane adhesive foam**, which allows you to regularize the panel in a simple and precise way, **correcting irregularities in the wall** up to 30 mm (fig. 9)

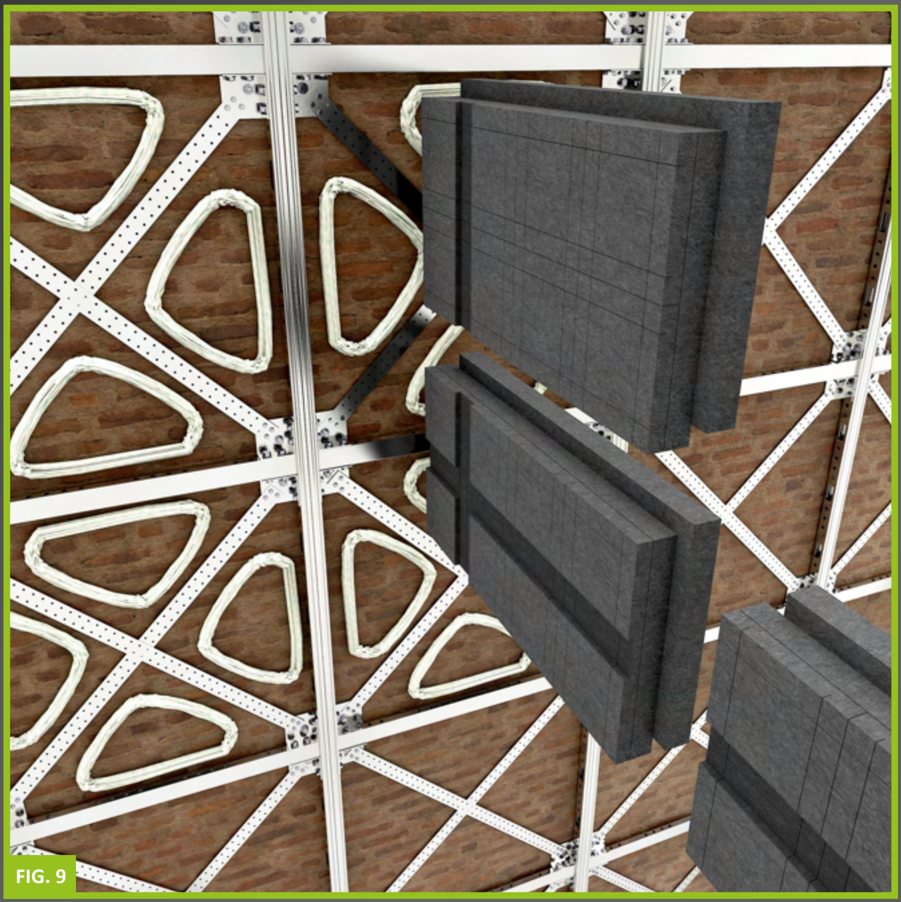


FIG. 9

The **permanent fixing of the panels to the masonry** is carried out using traditional insulation **plugs**, to be arranged at a constant pitch according to the plugging patterns required by law.

In general, **at least 6 anchors/m^2 must be applied**. For edge areas, depending on the case of use, the number increases up to a maximum of 12 anchors/m^2 (fig. 10)

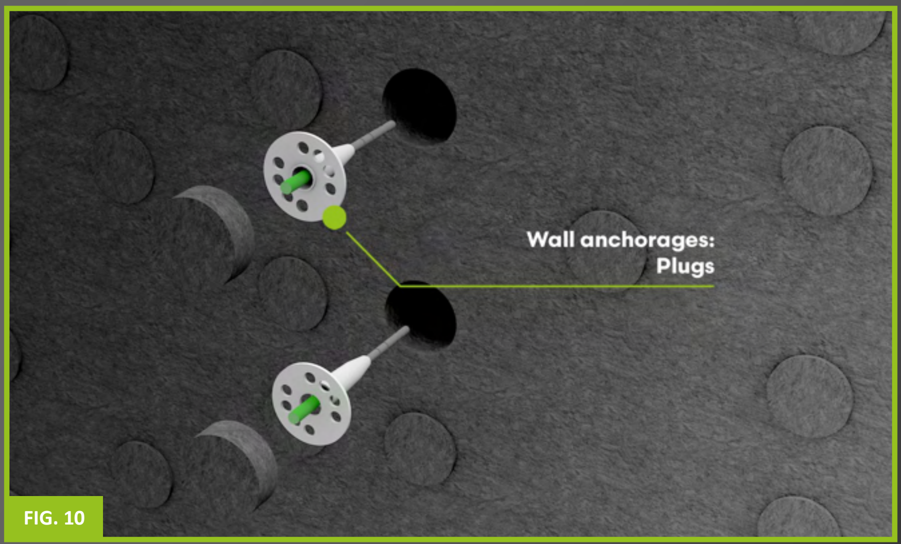


FIG. 10

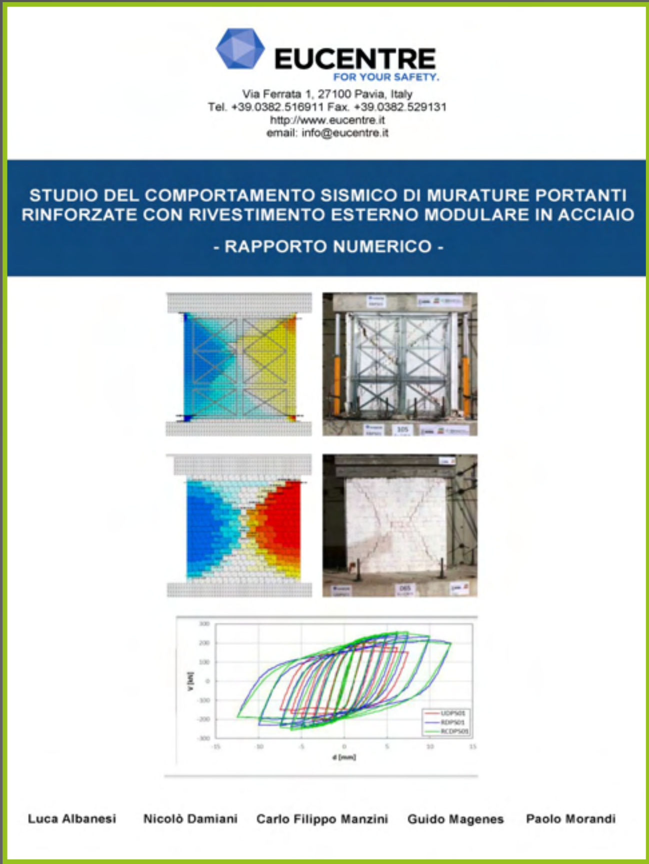
DESIGN GUIDELINES

RESEARCH AND DEVELOPMENT

At the **EUCENTRE Foundation of Pavia** and at the **Department of Structures for Engineering and Architecture DIST of the University of Naples Federico II**, **two distinct innovative researches of a numerical/experimental type were conducted simultaneously**, aimed at evaluating the seismic behavior of load-bearing masonry buildings and reinforced concrete frame buldings (with infill walls), both reinforced with **RESISTO 5.9 Tube** System of Progetto Sisma.

The **experimental campaign** was supported by an **extensive numerical study** , developing advanced models and the executing parametric analyses.

Thanks to these activities, which we have been engaged in for some years now, **it has been possible to define system design guidelines**, useful for the structural designer to easily carry out the necessary analyzes and checks of both load-bearing masonry and reinforced concrete frame structures, reinforced with the Resisto 5.9 reinforcement system



Scuola Politecnica e delle Scienze di Base
Università degli Studi di Napoli Federico II

Dipartimento di Strutture per l'Ingegneria e l'Architettura

DIST

Metodologica per il dimensionamento del sistema Resisto 5.9

A. Formisano

Dipartimento di Strutture per l'Ingegneria e l'Architettura – Università degli Studi di Napoli Federico II

Introduzione

L'applicazione di un sistema di rinforzo controventante dipende da una primigenia valutazione della struttura oggetto d'intervento con riferimento ad alcuni aspetti, quali il livello di protezione target, la regolarità in pianta/altezza, il numero e la posizione delle aperture, il comportamento dissipativo del sistema ecc. Tale valutazione può essere efficacemente condotta attraverso l'uso di analisi non-lineari della struttura originale in modo da ottenere informazioni che possano direzionare la tipologia d'intervento. Il metodo che di seguito verrà esposto mira all'individuazione delle caratteristiche meccaniche e geometriche del sistema controventante e la loro distribuzione, lungo lo sviluppo dell'edificio, al fine di migliorare il comportamento sismico globale.

Procedura di design

Step 1 – Fase preliminare all'applicazione della suddetta metodologia è quella dello studio e dell'analisi della struttura oggetto d'intervento. Tale aspetto riguarda tanto considerazioni di tipo geometrico per la distribuzione spaziale del sistema controventante, tanto di tipo capacitivo dal punto di vista del comportamento strutturale. A tal proposito il primo passo da condurre riguarderà l'esecuzione di analisi statiche non-lineari con le combinazioni previste ai sensi delle NTC2018 al fine di ottenere la *curva di capacità* della struttura a più gradi di libertà (sistema MDOF).

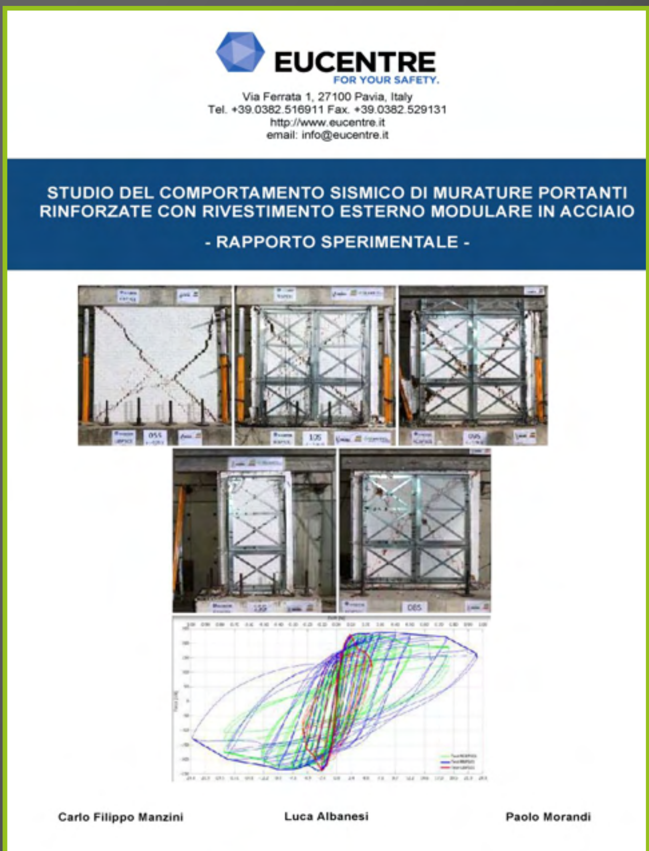
Step 2 – Successivamente alla esecuzione dell'analisi statica non-lineare pushover, si andrà a scegliere, a vantaggio di sicurezza, la curva maggiormente pessimistica del sistema tra quelle derivanti dalle varie combinazioni di carico e distribuzione di forze previste dalla normativa. In questa fase, essendo questa una metodologia per il design capacitivo e, quindi, per la ricerca delle prestazioni di progetto, è di particolare importanza l'individuazione dei meccanismi di danno fragili/duttili nella struttura. Verrà evidenziato sulla curva di capacità il primo evento di danno occorrente, che servirà come target per la fase di progettazione. In questo step verranno individuati i parametri fondamentali per la descrizione del comportamento strutturale del modello MDOF, ovvero *rigidezza k*, *resistenza F* e *spostamento ultimo* d_u.

Step 3 – Ai fini dell'ottenimento di una serie di parametri necessari alle successive considerazioni meccaniche, oltre l'analisi statica non-lineare, bisognerà eseguire un'analisi dinamica lineare (modale).
Da questo tipo di analisi si ricaveranno parametri fondamentali che descrivono il comportamento meccanico del modello MDOF, come modi di vibrare, periodi propri della struttura T, fattori di partecipazione modale Γ, distribuzione delle masse partecipanti m, distribuzione degli spostamenti interpiano Δs_{j}, forze di piano di tagliante sismico $F_{y,j}$, ecc.

Importante sarà il fattore di partecipazione Γ, generalmente espresso come:

$$\Gamma_j = \frac{\sum_{i=1}^{n} m_i \cdot \varphi_{i,j}}{\sum_{i=1}^{n} m_i \cdot \varphi_{i,j}^2}$$

dove $i = \{1 \ldots n\}$ rappresentano i diversi livelli di piano della struttura con $i \geq 2$; $j = \{1 \ldots m\}$ rappresenta il numero del modo di vibrazione a cui si riferisce il fattore di partecipazione modale ; m_i rappresenta la massa del livello i-esimo della struttura ed infine



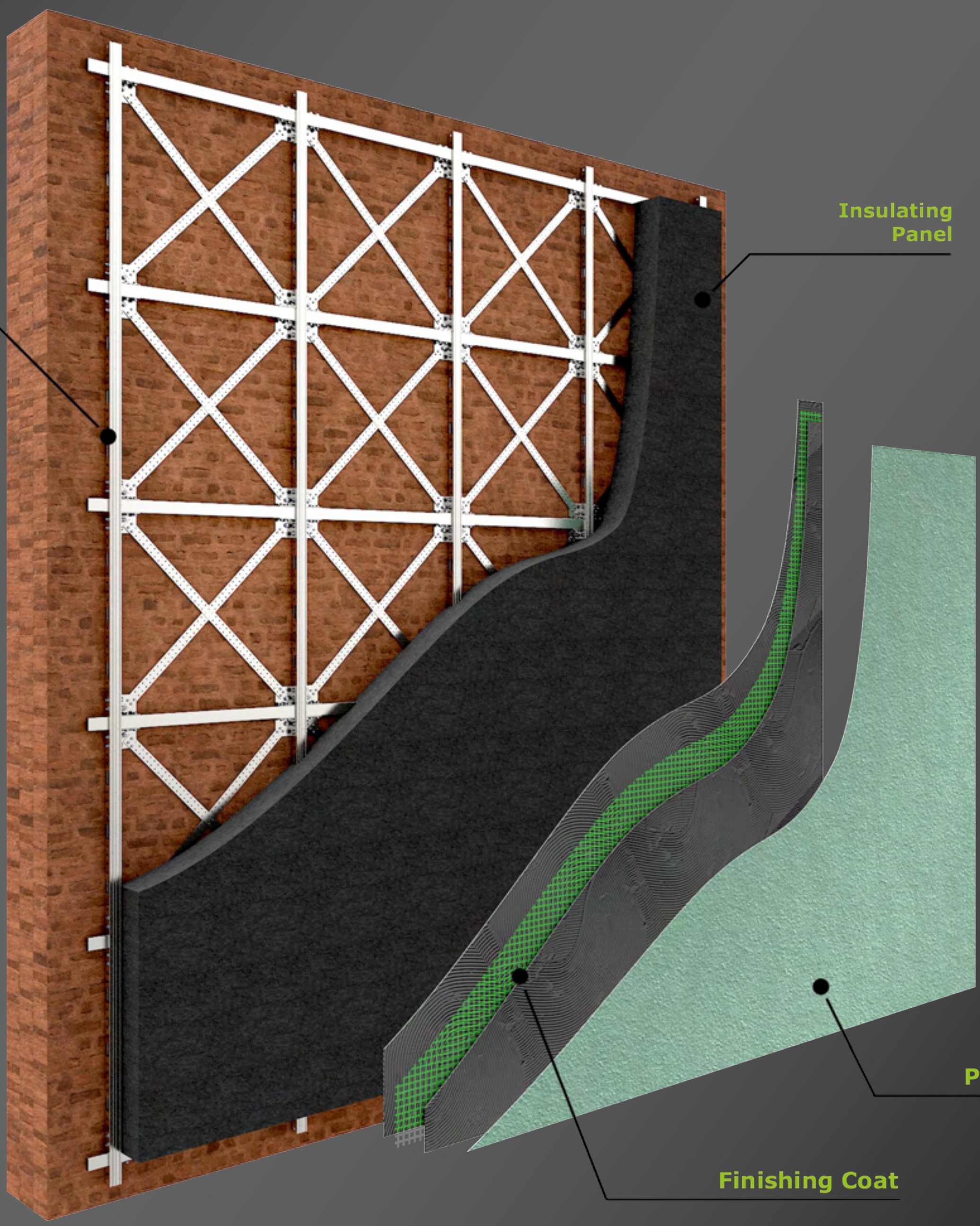
FINISHING LAYERS

THERMAL COAT, COUNTER-WALL AND VENTILATED CURTAINWALL

In addition to seismic reinforcement and energy improvement, the Resisto 5.9 Tube system allows for the creation of a wide range of solutions in terms of external finishing.

TRADITIONAL THERMAL COAT

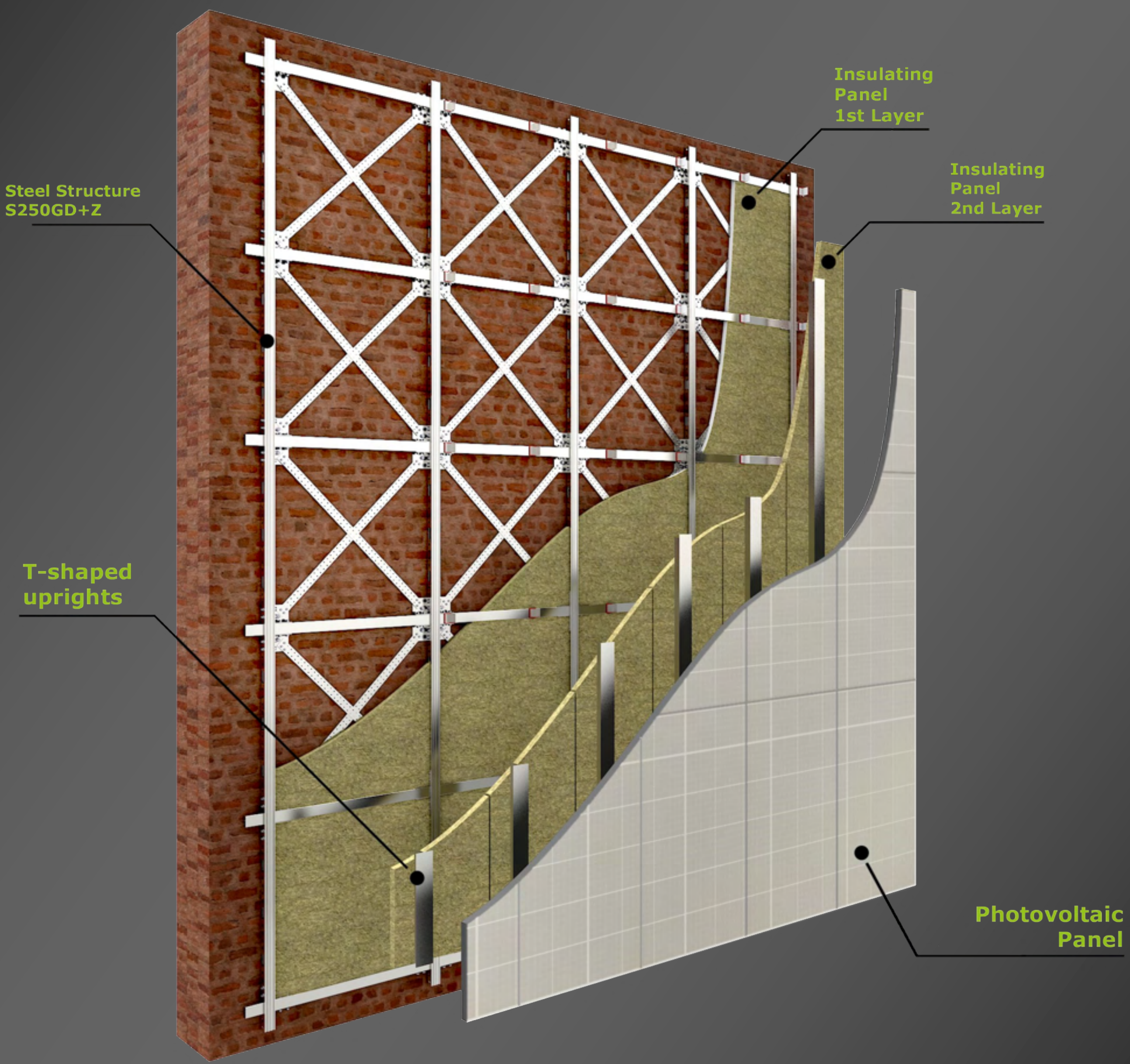
The Resisto 5.9 Tube system involves smoothing the insulating panel directly with high-performance cement mortar and reinforced fiberglass mesh. A traditional finish made up of colored plaster with variable grain size completes the system.



PHOTOVOLTAIC WALL

The **photovoltaic panels** are installed as external cladding of the opaque surfaces of the buildings through **ventilated façade** systems allowing both the use of the building envelope to produce energy and to improve the thermal insulation of the building.

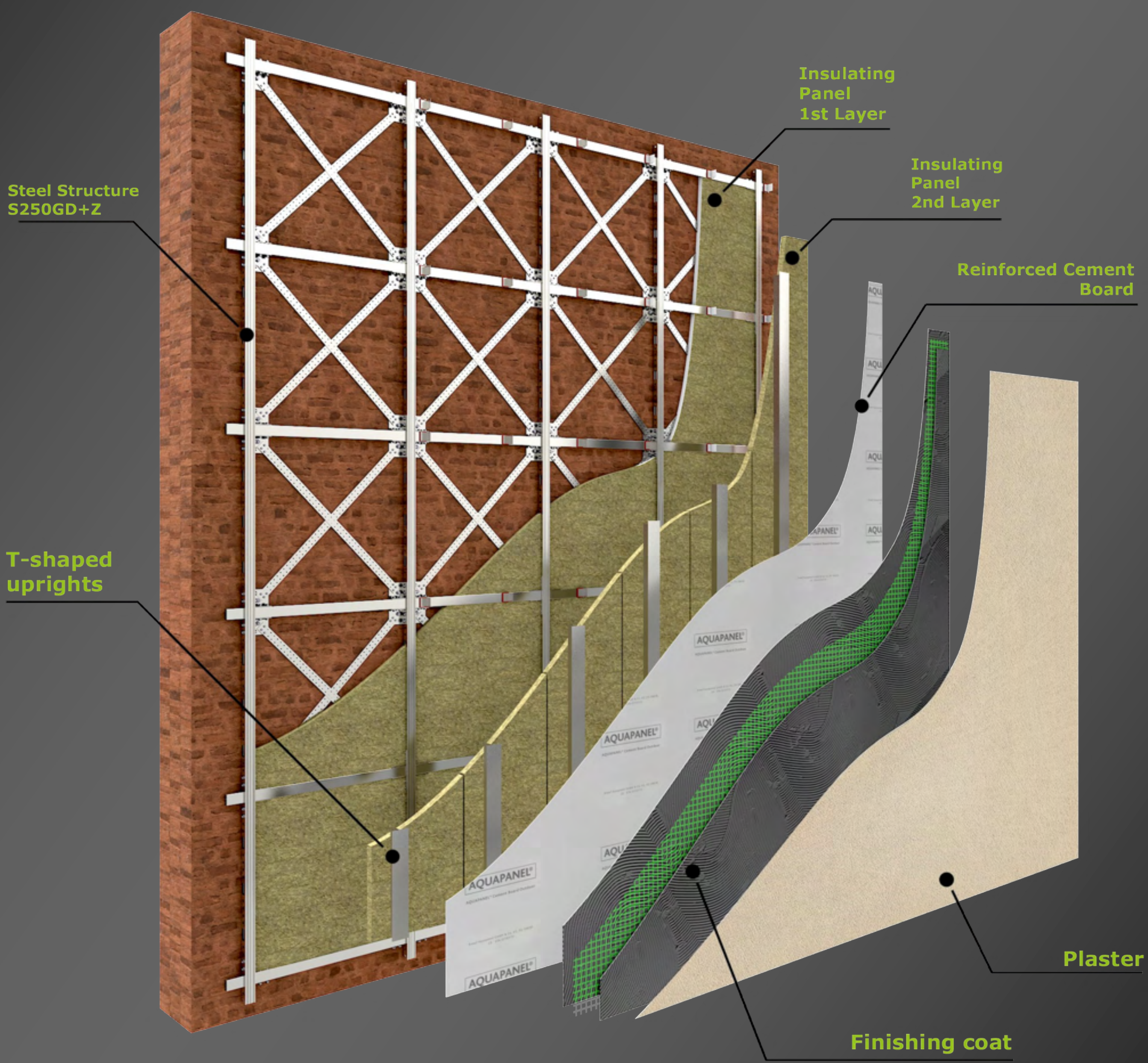
The use of colored glass in the front of the panel, which partially hides the photovoltaic cells, allows for greater aesthetic integration of the building.



COUNTER-WALL

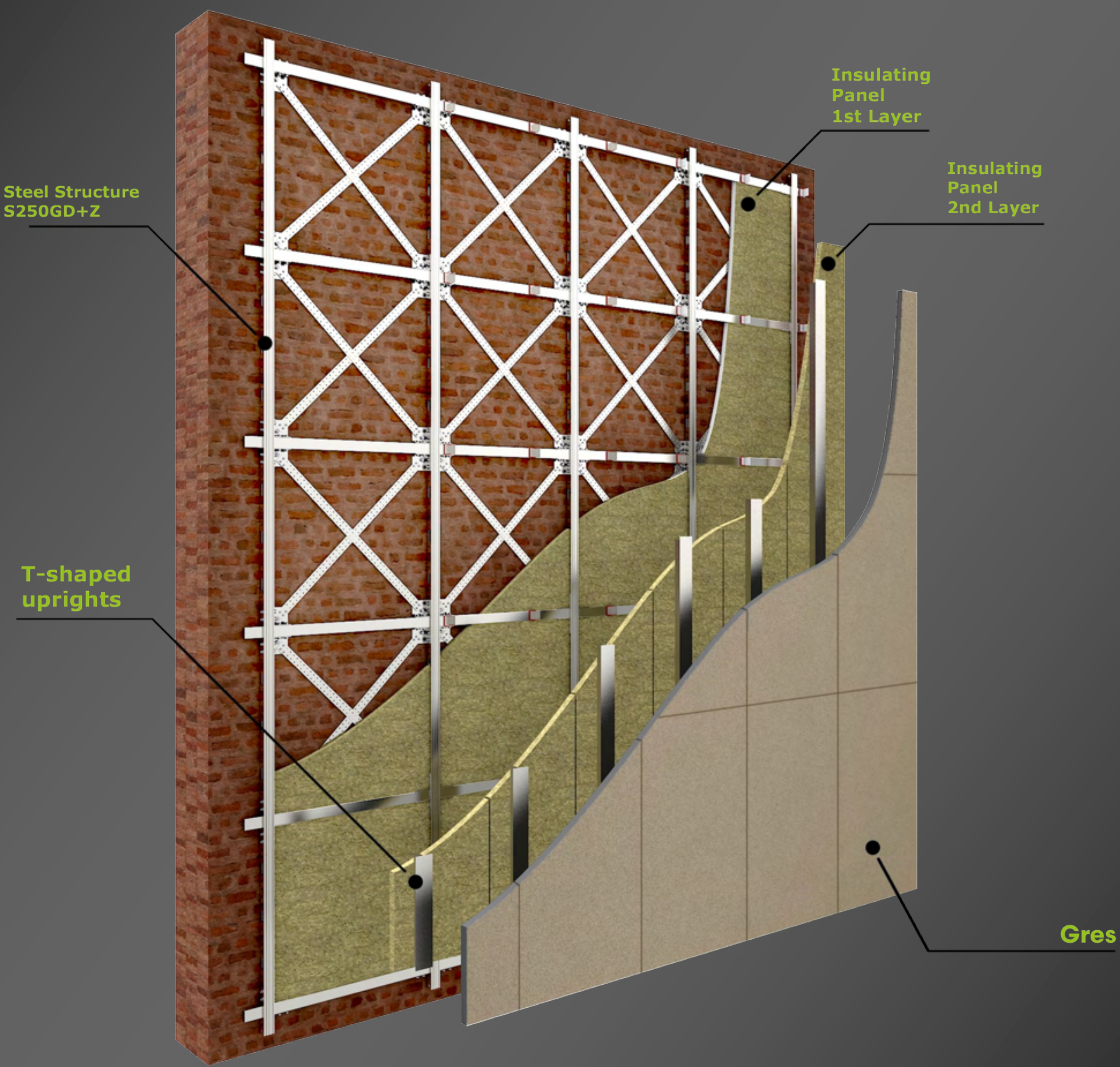
The **counter-wall** system is created in synergy with international partners such as Hilti and Knauf.

It provides for the implementation of shelves and T-shaped uprights, thanks to which it is possible to create false-walls that allow multiple finishes.



VENTILATED CURTAIN WALL

Resisto 5.9 Tube is an adequate support for the installation of any type of ventilated façade, such as porcelain stoneware slabs of any thickness, colored fiber cement slabs, decorative aluminum panels.



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