

Anti-Seismic and Structural Strengthening Systems for Schools

PRODUCTS FOR STRUCTURAL STRENGTHENING





1 | Anti-collapse system for ceilings using the **MapeWrap EQ System**
"Mother Teresa of Calcutta" Comprehensive School - Toro (Campobasso)



2 | Anti-collapse system for dividing walls using the **MapeWrap EQ System**
Dante Alighieri Secondary School - Gorizia

MapeWrap EQ System

Patented, certified system developed to make buildings safer, such as by preventing dividing and buffer walls collapsing and preventing ceilings from collapsing. The system is made up of **MapeWrap EQ Net** glass fibre reinforcement that forms a perfect bond with rendered substrates by applying **MapeWrap**

EQ Adhesive, a polyurethane adhesive in water dispersion. When applied on buffer and dividing walls it prevents them tipping over and when applied on ceilings it prevents them collapsing.

Planitop HPC (High Performance micro-Concrete) Tecnology

An exclusive strengthening system made up of micro-concrete with very high compressive strength, high ductility and the capacity to absorb high fracture loads. This product is a type of fibre-reinforced concrete that contains a high percentage of steel fibres which, by exploiting their residual tensile strength, increase the overall load-bearing capacity and ductility of structures (two properties which are fundamental in areas at risk of seismic activity). This technology consists of a special formula,

Planitop HPC, developed to strengthen load-bearing structures (beams, pillars, joints) with a layer of compact cladding (1.5-3 cm thick) and is used alongside **Planitop HPC Floor**, which was developed to strengthen the outer face of concrete, brick/cement and wooden floors by applying a strengthened, compact added layer (1.5-2.5 cm thick) without any further reinforcement.

Mapei FRG System

Strengthening system developed for brick, stone, tuff and mixed masonry consisting of the application of glass or basalt fibre mesh and an inorganic, cementitious or lime-based matrix that ensures excellent chemical-physical and elastic-mechanical compatibility with the substrate. The strengthening system is applied to a structure to increase the shear strength of bay walls by overcoming the lack of tensile strength in the walls, making

them more ductile without altering their mass and stiffness. The strengthening system offers several important advantages when used on buildings of historical or artistic interest. Rather than replace the existing structure, the system works in parallel without modifying the structure and without altering the way its mass and stiffness are distributed.

Mapei FRP System

Structural strengthening system comprising high strength and very high strength fibres and epoxy matrixes specially formulated for the repair and static and seismic upgrading of structures made from normal, pre-stressed and reinforced concrete, steel, masonry or wood. There are various types of

fibres that characterise this type of structural composite: carbon, glass, steel and basalt. This system increases the performance characteristics of structures by increasing their strength and ductility.



1 | Anti-seismic protection by applying **MapeWrap EQ System** applied on dividing walls - *San Vincenzo (Livorno)*



2 | Anti-seismic protection by applying **MapeWrap EQ System** applied on dividing walls - *Teresio Olivelli Comprehensive School - Darfo Boario Terme (BS)*



3 | Strengthening the outer face of a floor with a pour of **Planitop HPC Floor** *Mons. Giovanni Bacile School - Bisacchino (Palermo)*



4 | Shear strengthening of bay walls with **Mapegrid G220** and **Planitop HDM Maxi** *Sant'Agostino Primary School - Ascoli Piceno*



5 | Strengthening a beam-column hinge point with **MapeWrap C** fabric *"Schools Project" - L'Aquila*



6 | Shear strengthening of pillars with **MapeWrap C** fabric *Mirto District Elementary School - Crosia (Cosenza)*

Anti-seismic protection for school buildings

The need to **improve and upgrade the anti-seismic protection** for our school building stock is becoming more and more urgent every day as a result of our improved understanding of the “demand” that seismic activity has on such structures. This understanding, unfortunately, has increased because of our experience of the powerful, sometimes violent, earthquakes that have struck Italy in the last few years.

The earthquakes in San Giuliano in Apulia in 2002, Aquila in 2009 and Emilia in 2012 have highlighted the **problem of safety in our schools in the event of seismic activity**.

Why school buildings are vulnerable and at risk during seismic activity

There are numerous reasons why many of our school buildings are vulnerable during earthquakes.

The most common are the following:

- the **classification of earthquakes** and relative norms and standards up until 2003 are **inadequate**;
- their **architectural configuration**;
- the design of certain features and the **building materials** used are often **of poor quality**;
- **insufficient maintenance**;
- structural modifications carried out after their construction.

Much of the building stock was designed according to standards applied prior to those adopted since 1974 (Law 64) and the buildings are often in areas in which the risk of seismic activity has been reclassified. With regard to this problem, therefore, studying the behaviour of buildings during seismic activity, assessing their vulnerability as a result and designing appropriate interventions to improve or upgrade buildings to provide protection in the event of seismic activity are some of the most topical research themes in the field of structural engineering.

Most existing structures, and in particular, but not only, multi-storey reinforced concrete buildings, have structural irregularities in both the horizontal and vertical planes.

The poor attention paid to construction features, such as joint areas which are particularly loaded and stressed during seismic activity, means they cannot be relied upon to provide sufficient strength, deformation and energy dissipation capacity in the post-elastic area, that is, their ductility.

Another important cause of the vulnerability of school buildings

during seismic activity is their architectural and structural configuration. Schools carry out various activities within the same building, which is why different types of room have to be built (classrooms, laboratories, gymnasiums, theatres, assembly rooms, etc.). Since there are different functions within the same building this means the rooms will have irregular and/or particularly articulated shapes, in both the vertical and horizontal planes. This irregularity in shape leads to structural irregularities, an unfavourable characteristic in terms of performance during seismic activity, which provokes a concentration of damage in certain areas or on individual floors, leading in certain cases to their collapse.

Amongst the technologically innovative strengthening systems adopted, are the strengthening systems by Mapei based on the use of composite materials.

Thanks to their 20 years of experience in the field of improvements and upgrades to provide extra protection during seismic activity, Mapei has various exclusive solutions available for the field of structural engineering, from the classic Mapei polymer matrix and fibre-based **FRP System** to the more modern concept of strengthening based on the use of Mapei inorganic matrixes and fibres, the **FRG System**, right up to the latest generation of strengthening solutions for non load-bearing structures, the **MapeWrap EQ System**, together with ultra high performance cementitious composites represented by **Planitop HPC** (*High Performance micro-Concrete*) technology.

The advantages with adopting these systems are:

- **simple, quick** application;
- **highly durable**;
- no increase in the masses involved in the intervention so **no modification to the stiffness of the structure**;
- their validity and effectiveness are **supported by tests** carried out by the DiSt (Department of Structural Engineering and Architecture) of the “Federico II” University of Naples.

Strengthening systems for schools constructed in reinforced concrete



* *Guidelines for repairing and strengthening structural elements, buffer walls and partition walls.*

** *Instructions for the design, application and control of static consolidation interventions using fibre-reinforced composites.*

*** *Instructions for the design, construction and control of structures in fibre-reinforced concrete.*



Localised strengthening of beam-pillar joints using carbon fibre fabrics from the **FRP System** line (ReLuis)

(Ref. "ReLuis Guidelines"^{**} par. 3.1.3;
Ref. CNR DT 200 R1/2013^{**})



External connections between buffer walls and the reinforced concrete structure (anti-tilting system) using mesh and mortar from the **FRG System** line

(Ref. "ReLuis Guidelines"^{**} par. 4.1)



Strengthening a floor with an added layer to form a rigid plane using **Planitop HPC Floor**

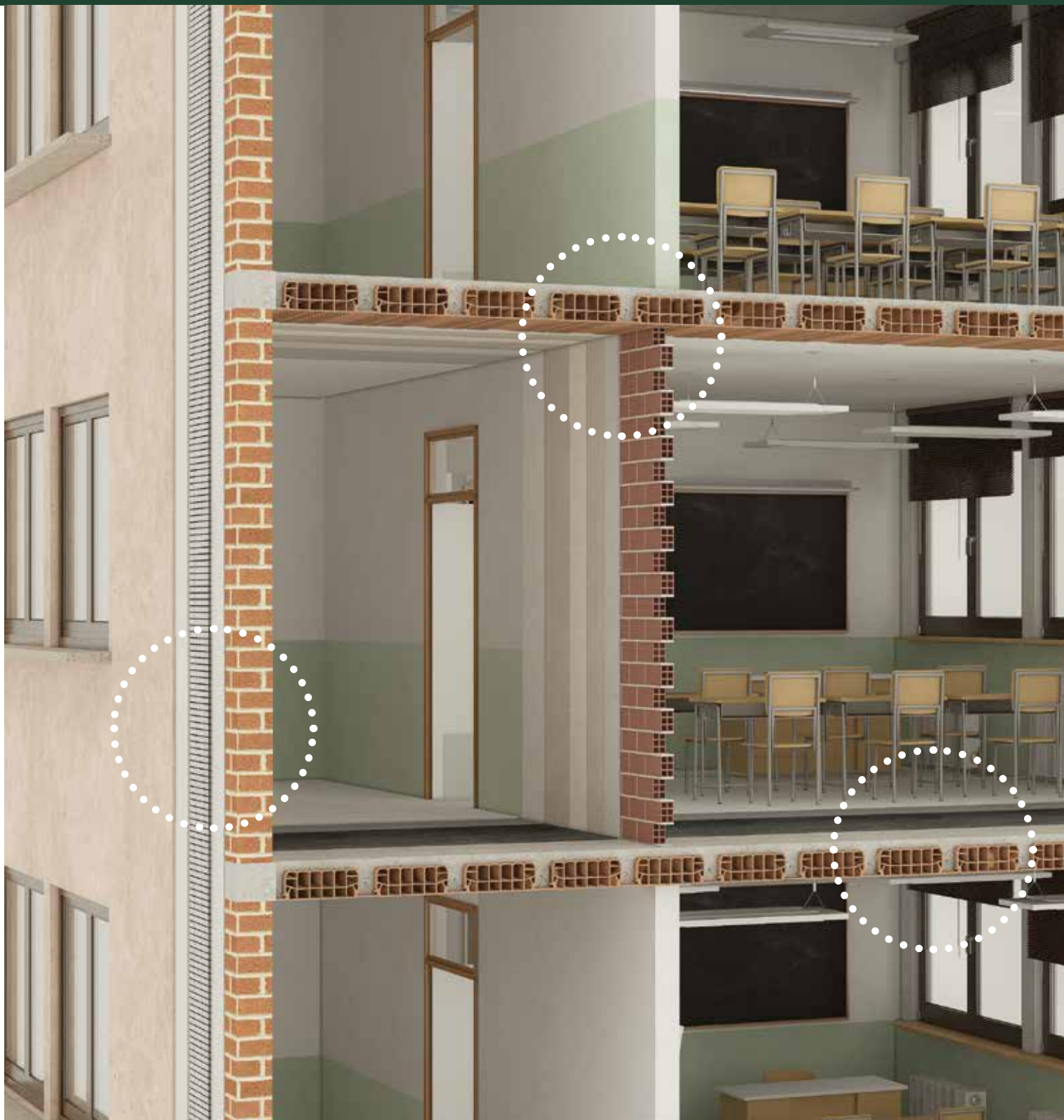
(Ref. CNR 204/2006^{***})



System to protect buffer walls and prevent the collapse of ceilings in classrooms during seismic activity using the **MapeWrap EQ System**

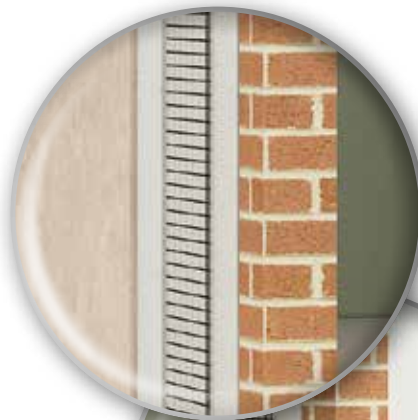
(Ref. "ReLuis Guidelines"^{**} par. 4.1)

Strengthening systems for schools with masonry walls



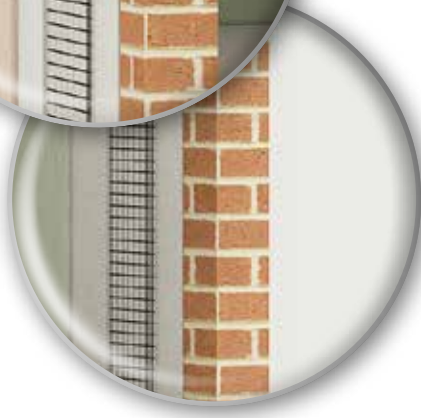
**** Instructions for the application of the "New Technical Construction Norms", Ministerial Decree 14.01.08.

**** Guide to the design and application of an externally bonded fabric-reinforced cementitious matrix (FRCM) system for the repair and strengthening of concrete and masonry structures.



Shear strengthening of load-bearing bay walls using mesh and mortar from the **FRG System** line

(Ref. circular No. 617 - 02.02.09, par. C8.1****; ACI 549****; "ReLUIS Guidelines" par. 3.2.4.2)



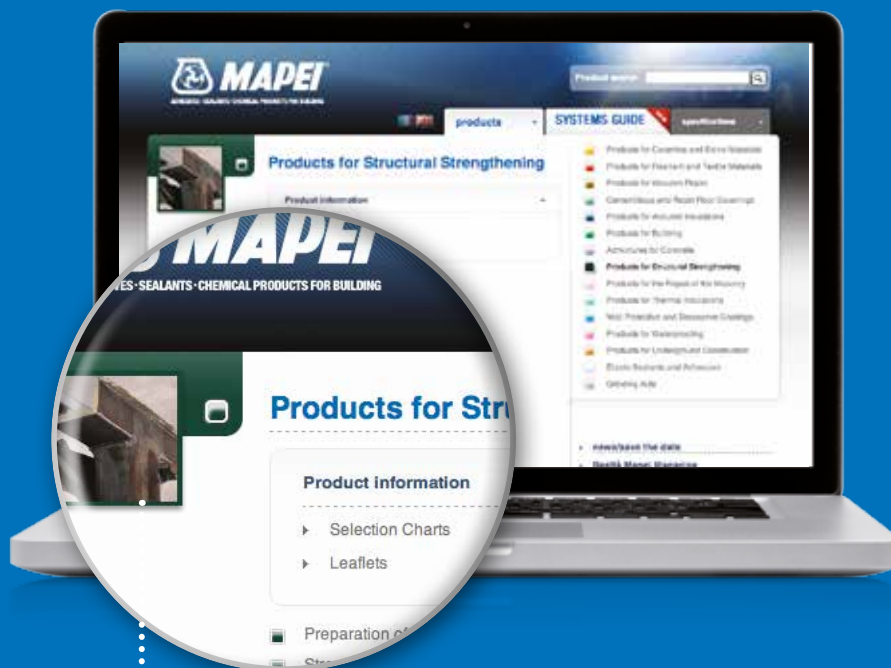
System to protect buffer walls and prevent the collapse of ceilings in classrooms during seismic activity using the **MapeWrap EQ System**

(Ref. "ReLUIS Guidelines" par. 4.1)



Strengthening a floor with an added layer to form a rigid plane using **Planitop HPC Floor**

(Ref. CNR DT204/2006****)



● **Technical documentation**

From the technical area menu you can view the technical documentation divided per product lines and type of document.

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