



Seismic anchorages for **panels**



SEISMIC ACTION

PARALLEL TO THE PANELS SURFACE

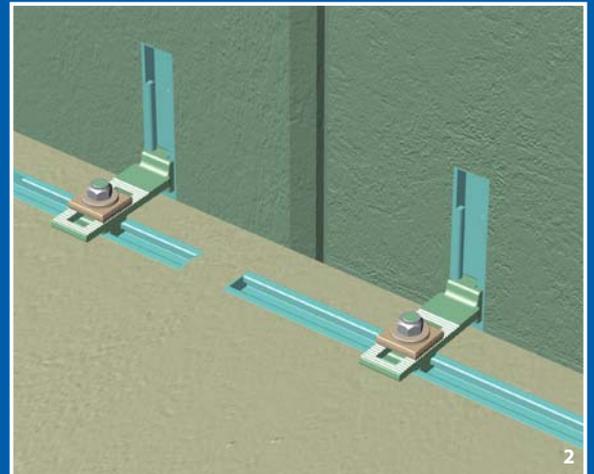
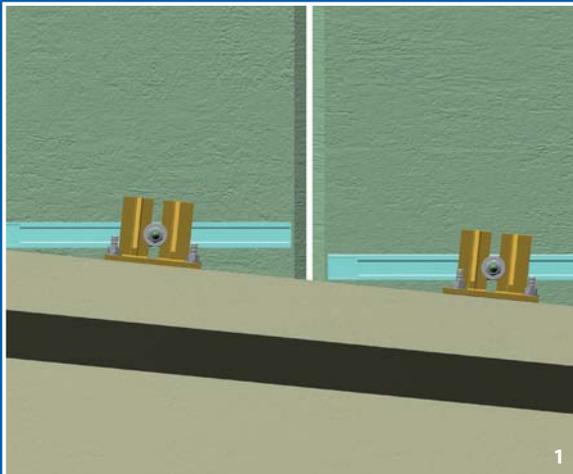
Walls consisting of prefabricated panels that discharge their own weight to the ground feature a significant stiffness degree, so that it becomes indispensable using connections that allow the structure to move independently from the panels, which remain fixed; in other words, the panels mass must not be called into play. Whereas horizontal prefabricated panels, to the contrary, discharge their own weight to pillars, their mass will be called into play; still, it will be necessary not to let them cause additional stiffness to the structure.

SEISMIC ACTION

PERPENDICULAR TO THE PANELS SURFACE

Panels do not feature any stiffness, hence their connection to the structure shall be sized depending on their mass, with restraints that shall be related to the design acceleration.

All anchorages shall feature strength to the seismic action perpendicular to the wall equal to 30 kN at SLU



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Type of connection

LABORATORY TESTS

Depending on the kind of construction, it is necessary to distinguish between the situation where anchorage to the structure takes place on a flat surface, by means of stoppers FV/10 and FV/20 or cast-embedded stoppers FVG/10 and FVG/20 (*refer to Fig. 2*), and the situation where anchorage to the structure takes place on a slant surface (FV/10, FV/20) by means of stoppers or a counter-plate FVCP (*refer to Fig. 1*). The anchorage for vertical panels, named FV/10 FVG/10, allows a reciprocal movement equal to ± 10 cm. The anchorage named FV/20 FVG/20 allows a reciprocal movement equal to ± 20 cm, i.e. double as much as previous one.

If panels are anchored to pillars (e.g. onto Girella or Tirella type corbels), it is necessary to eliminate any stiffness degree using anchorage FO/00 FOG/00, which acts as a hinge thus preventing the relative sliding movement between the upper edge of the horizontal panel and the pillar (*refer to Fig. 3*). The lower edge, to the contrary, shall rest on two carriages in order to have the possibility of sliding by at least ± 4 cm on the lower supporting corbels.

The guide located on the pillar has a mere positioning and vertical adjustment purpose, while the guide to be used in the panel is always the ± 3 cm one with a vertical stop point.

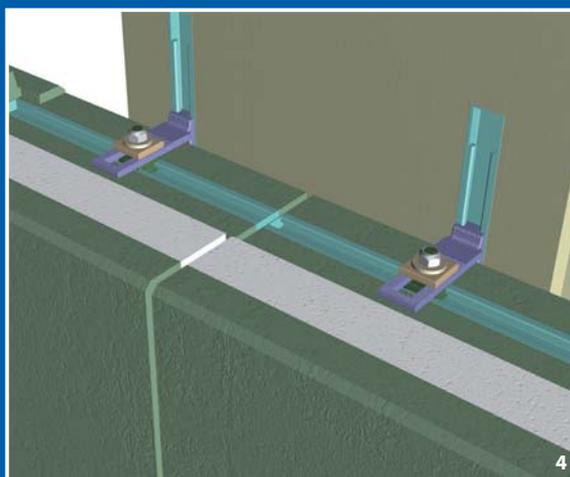
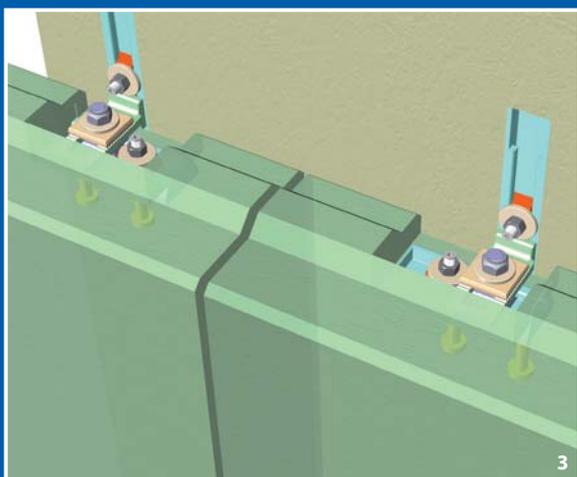
In case of an earthquake along a direction parallel to the panel surface, the threshold of the seismic action on the FO/00 anchorage shall be increased from 30 to 60 kN.

Depending on the design choices, it is possible to provide a visible anchorage with stoppers into the pillars (FO/10, FO/20) or cast-embedded profiles FOG/10 and FOG/20 (*refer to Fig. 4*), or else a hidden anchorage that allows sliding ranges between ± 3 cm and ± 20 cm (*refer to Fig. 3*). The hidden anchorage always requires two cast-embedded guides; it is recommended when fire resistance has to be guaranteed.

Vertical panels resting on the ground

Horizontal panels supported by pillars

Horizontal panels resting on the ground



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Other verifications

VERIFICATIONS OF THE CONNECTION

The standards require verifying the movements induced by the seismic action at the restraint point (since a connection is being considered, such movements are not the damage verification ones, but rather the ultimate stress ones). Depending on such movements, it is necessary to verify whether a guide allowing ± 10 cm is enough, or else a double movement is necessary (± 20 cm).

The calculation of the horizontal restraint force F_a shall be carried out in accordance with NTC (D.M. 14/01/2008) or EC8, and may be verified by means of the equation below, where F_a is the horizontal seismic thrust (kN/m^2):

$$F_a = 3,72 \alpha \cdot p$$

Where:

3,72 = coefficient obtained assuming that:

$q_a = 2$ (for walls)

$S = \text{soil factor} = 1,35$

$z/h = 1$

$T_a/T = 1$

$\alpha = a/g = \text{design acceleration}$

$p = \text{panel weight (kN/m}^2\text{)}$

As it may be remarked, when verifying connections the horizontal seismic action at the SLU in zone 1 ($\alpha = 0,35$) exceeds the weight, i.e. $F_a = 1,3 p$.

It is important to point out that the sliding guide features a reduced thickness, which prevents interrupting the reinforcements of the element where the very guide is embedded..

In low seismicity connections (third and fourth seismic zone) it is necessary to verify that the wind action is not stronger than the very earthquake.



FIG. 5



Vertical panels

Connection type FV/10/20

- The mass does not take part in the seismic action along X direction
 - The mass takes part in the seismic action along Y direction
- Maximum pull $F_a = 30 \text{ kN}$

FV/10

Relative movements $< \pm 10 \text{ cm}$

FV/20

Relative movements $< \pm 20 \text{ cm}$

FIG. 6



Connection type FVG/10/20

- The mass does not take part in the seismic action along X direction
 - The mass takes part in the seismic action along Y direction
- Maximum pull $F_a = 30 \text{ kN}$

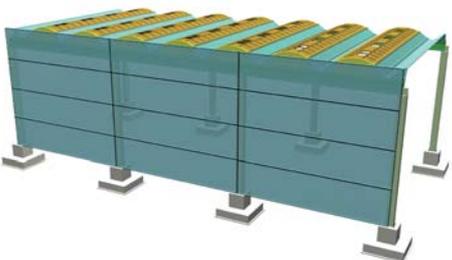
FVG/10

Relative movements $< \pm 10 \text{ cm}$

FVG/20

Relative movements $< \pm 20 \text{ cm}$

FIG. 7

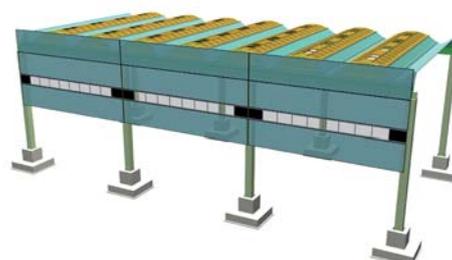


Horizontal panels

Connection type FO-FOG/3/10/20

- The mass does not take part in the seismic action along X direction (the weight is discharged to the foundations) Relative movements $< \pm 20 \text{ cm}$
 - The mass takes part in the seismic action along Y direction
- Maximum pull $F_a = 30 \text{ kN}$

FIG. 8



Connection type FOG/00

- The mass takes part in the seismic action along X direction
 - The mass takes part in the seismic action along Y direction
- Maximum pull $F_a = 60 \text{ kN}$
- The mass takes part in the seismic action along Y direction
 - Maximum pull $F_a = 30 \text{ kN}$
 - Movements between the panel lower edge and the corbel $\leq 4 \text{ cm}$

Using a Girella/Tirella corbel, it is possible to rely on a lower restraint, due to the 20° slant of the corbel resting plane, provided that, naming R the reaction of the panel onto the corbel, it may be verified that: $F_{ay} \leq \text{tg } 20^\circ R = 0,36 R$. If the value of F_{ay} exceeds $0,36 R$, it is necessary to prevent the panel from lifting, using an apposite "vertical blockage".

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Sizing of anchorages

CONNECTION FVG 10/20

EXAMPLE NO. 1:

Vertical panel, size 12 x 2,5 m
(3,8 kN/m² located in a zone with design acceleration $a = 0,25$ g).
Two blockages are required at the top:

The seismic action on the blockage equals:

$$F_{ay} = \frac{3,72 \cdot 0,25 \cdot 3,8 \cdot 12 \cdot 2,5}{2 \cdot 2} = 26,50 \text{ kN}$$

In this case no. 2 FVG 10/20 are used, depending on the structure movement at the restraint point.

EXAMPLE NO. 2:

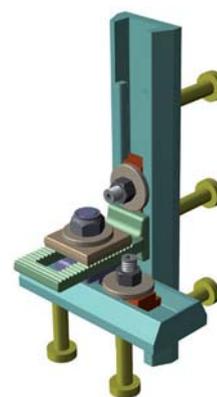
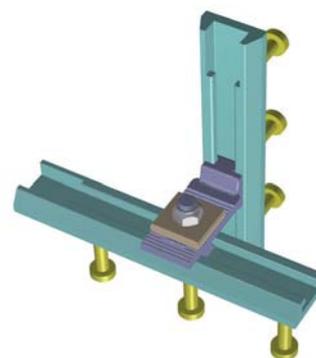
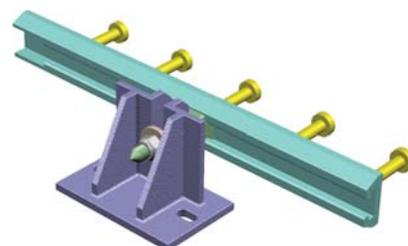
Horizontal panel supported onto the lower one, resting on the ground or suspended on corbels, size 10 x 2,5 m (3,80 kN/m²) sand located in a zone with design acceleration $a = 0,15$ g. The use of two blockages will be considered if panels are provided with a male-female joint.

Two blockages are provided at the top:

The seismic action on the blockage equals:

$$F_{ay} = \frac{3,72 \cdot 0,15 \cdot 3,8 \cdot 10 \cdot 2,5}{2} = 26,50 \text{ kN}$$

In this case no. 2 FVG 10/20 are used, depending on the structure movement at the restraint point.



CONNECTION FVG 10/00

Horizontal panel supported by two corbels, size 10 x 3 m in a zone with design acceleration $a = 0,25$ g.

Two blockages are required at the top (hinges) and two lower restraints (carriages) in the corbels Girella/Tirella type.

Seismic action perpendicular to the panel surface

$$F_{ay} = \frac{3,72 \cdot 0,25 \cdot 3,8 \cdot 10 \cdot 3}{2} = 26,50 \text{ kN}$$

every blockage shall provide a restraint higher than F_{ay}

Seismic action parallel to the panel surface

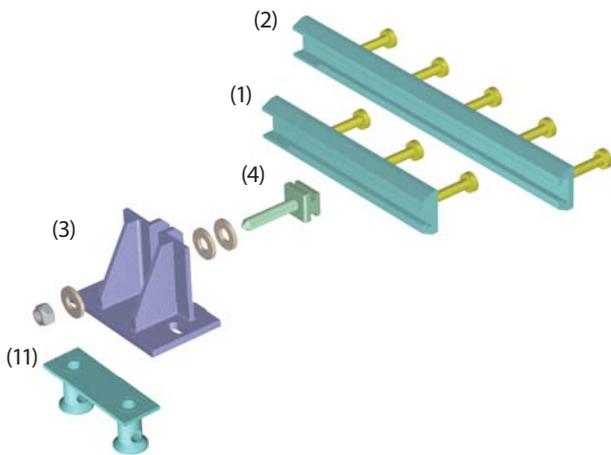
$$F_{ax} = \frac{3,72 \cdot 0,25 \cdot 3,8 \cdot 10 \cdot 3}{2} = 53,01 \text{ kN}$$

Therefore no. 2 FOG/00 are provided, since the blockage strength along direction X is double as much (60 kN).

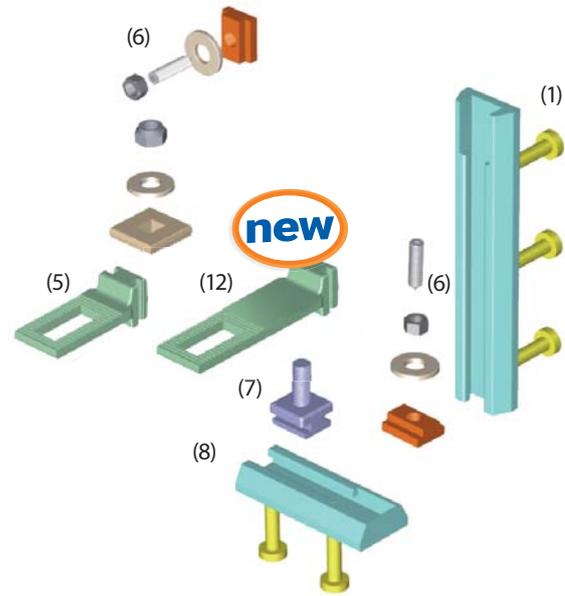
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Description of items

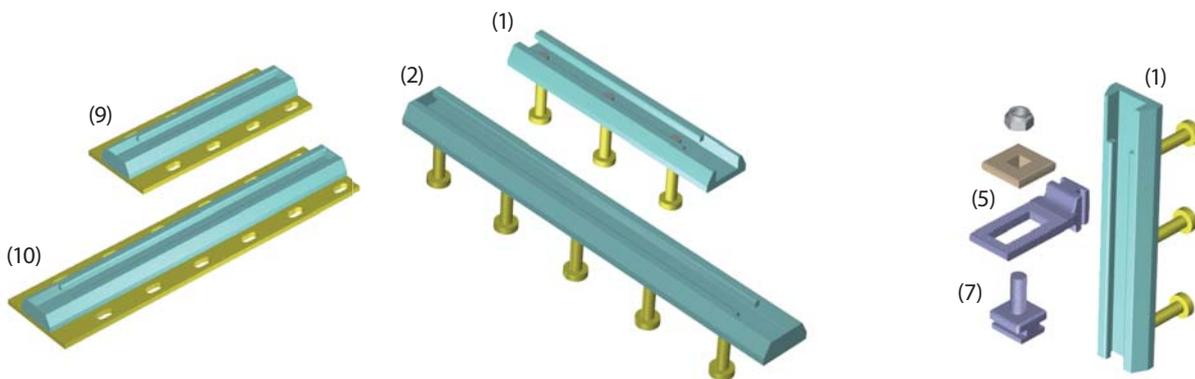
CONNECTION FV/10/20



CONNECTION FOG/00



CONNECTION FOG/10/20



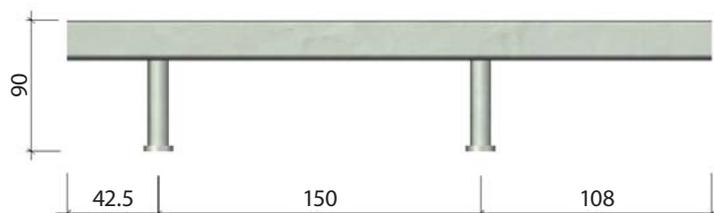
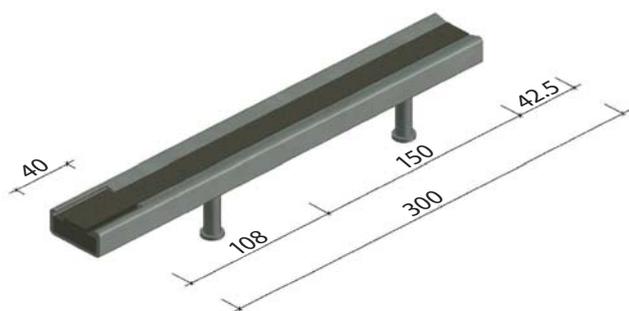
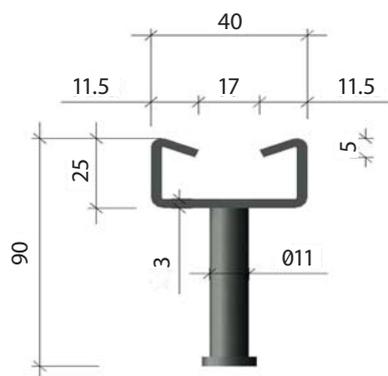
Code	Item	Material	Pieces/package	
(1)	0302101002	Sliding guide ± 10 cm	S355 (Polyurethane spongy filler)	20 pz
(2)	0302101003	Sliding guide ± 20 cm	S355 (Polyurethane spongy filler)	12 pz
(3)	0302104001	Anchorage for vertical panels	S355	Sfuso
(4)	0302107001	Coupling for vertical panels	S355	24 pz
(5)	0302108002	Coupling for horizontal panels L = 170	S355	40 pz
(6)	0302105101	Vertical blockage	S355	80 pz
(7)	0302110001	Short threaded coupling, Teflon-coated M16	S355	40 pz
(8)	0302101001	Sliding guide ± 3	S355	40 pz
(9)	0302106001	Emergency guide L = ± 10 cm	S355	Sfuso
(10)	0302106002	Emergency guide L = ± 20 cm	S355	Sfuso
(11)	0302013001	Counter-plate FVCP	S355	24 pz
(12)	0302108003	Coupling for horizontal panels L=300	S355	6 pz

Zinc coating (galvanised) $\geq 7\mu\text{m}$ - Note: as for design and use, refer also to drawings FIS F3-01 ÷ F3-21

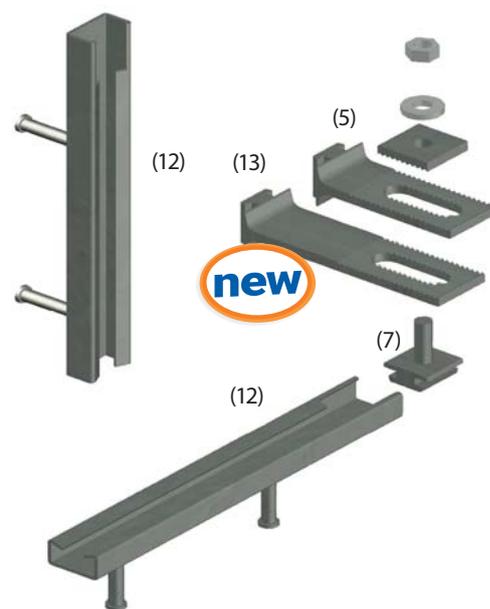
FISIS[®] 15

Description of items

Innovative anchorages for seismic-resistant restraints in prefabricated (precast) panels. All anchorages feature strength capability against a seismic action perpendicular to the wall surface equal to 15kN at SLU. **Fisis 15** responds to requirements set for anchorages in a seismic zone, in compliance with NTC 2008 and the new European standards EC8.



CONNECTION FOG/10 E FVG/10



WORK LOAD AT SLU

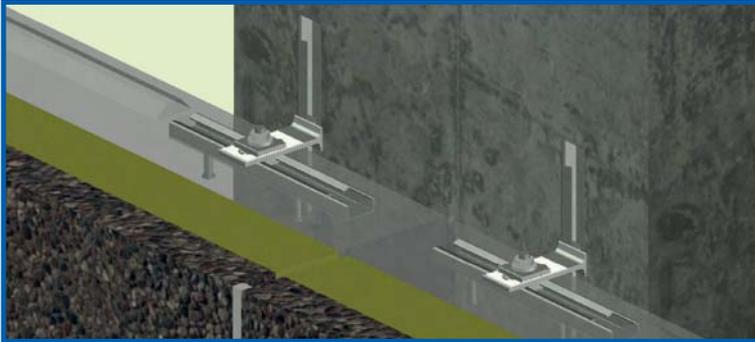
Tensile
15 kN

Shear
15 kN

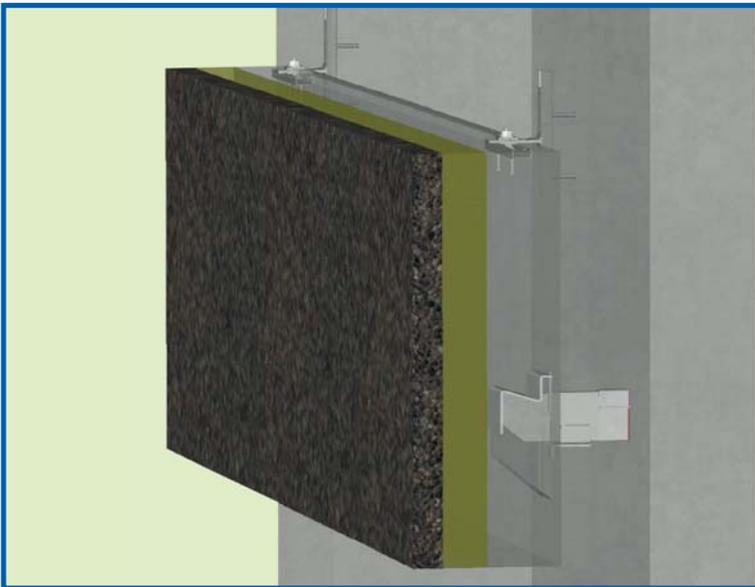
Code	Item	Material	Pieces/package	
(5)	0302108002	Coupling for horizontal panels L = 170 M16	S355	40 pcs
(7)	0302110001	Short threaded coupling, Teflon-coated M16	S355	40 pcs
(12)	0302201001	Fisis15 - Anchorage guide ±10 cm (*)	S235JRG2	30 pcs
(13)	0302108003	Coupling for horizontal panels L = 300	S355	6 pcs

(*) Polyurethane spongy filler

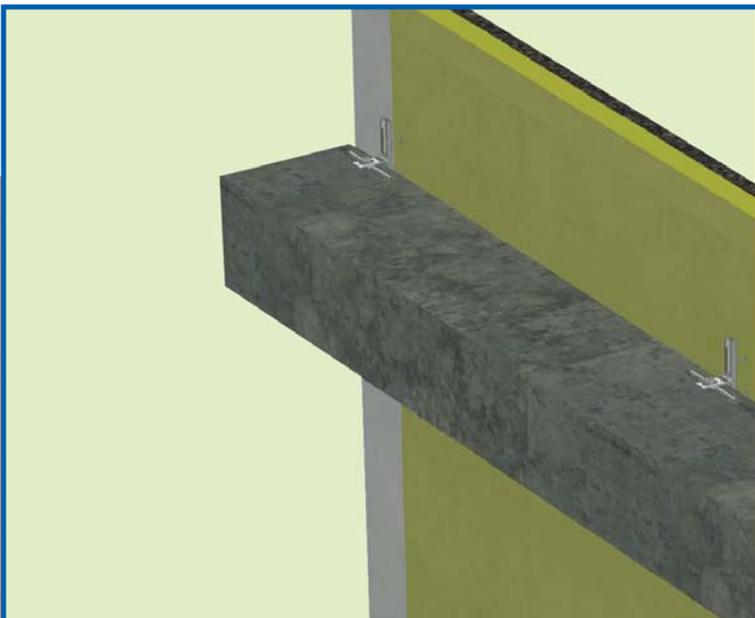
Zinc coating (galvanised) ≥ 7µm



Example of a restraint anchorage between horizontal panels and pillar.



Example of suspended horizontal panels. The restraint is achieved using Fisis 15, the suspension by means of a Tirella "S" corbel.



Example of a restraint anchorage between vertical panels and a flat covering beam.

