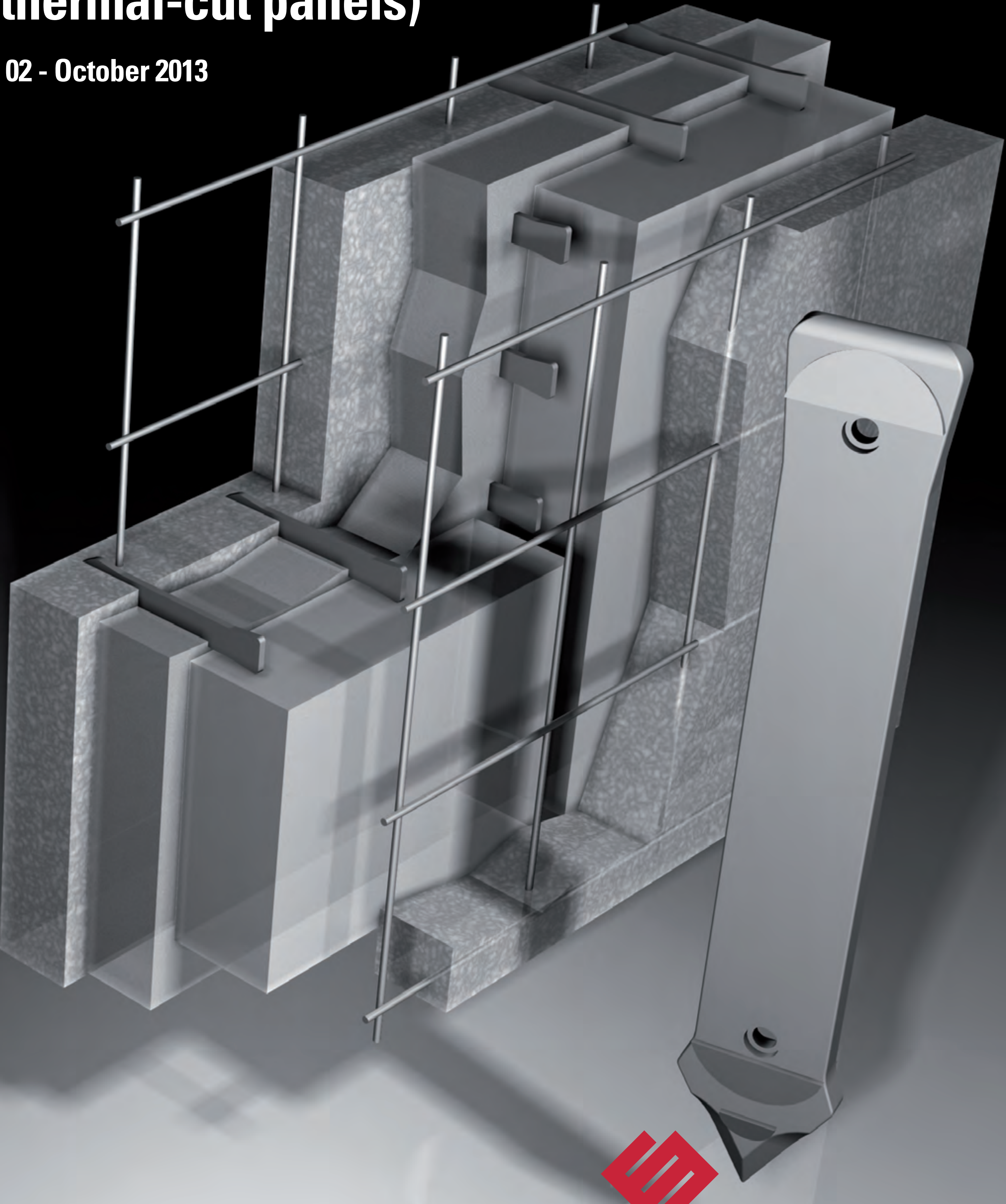
EDILMAC ESP PINS
(for thermal-cut panels)

Edition 02 - October 2013



EDILMATIC

Anchorage, supporting and lifting systems for prefabricated elements.
Accessories, fasters and metallic items.

Index

CONNECTION PINS FOR THERMAL-CUT PANELS

Connection Pins for Thermal-cut Panels

EDILMATIC ESP

GENERAL INFORMATION

The curtain wall panels are the external "coat" of r.c. prefabricated structures and must meet suitable requirements of heat and sound insulation compliance with current regulations on energy saving.

From a typological point of view, panels can be classified according to parameters such as stratigraphy, internal structure, geometrical shape and type of surface finishing. The production currently available on the market substantially proposes 3 panel categories: monolithic, lightweight and multilayer or ventilated "Sandwich".

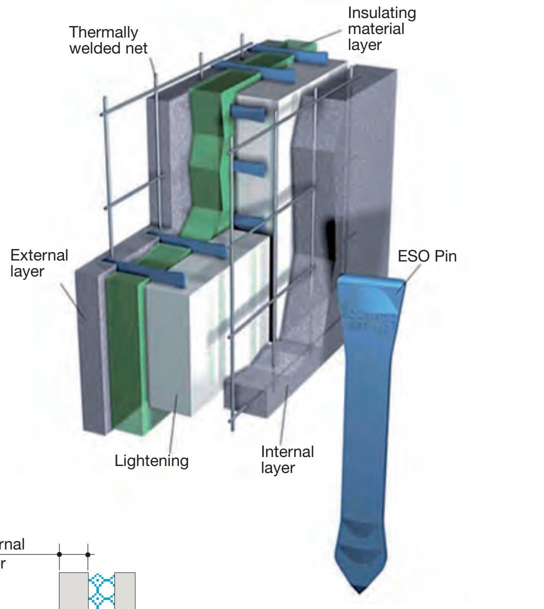
The Edilmatic ESP connector is a connecting system allowing making these types of thermal-insulation panels, preventing from creating thermal bridges.

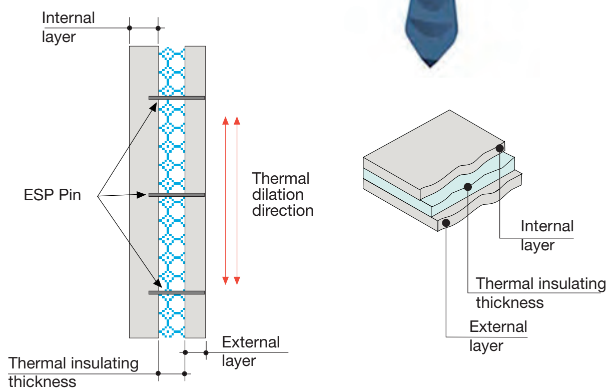
Thermal-insulation panels schematically consist of two concrete layers (the outer wall is supported and the inner one is supporting) between which a thermal-insulation material is inserted. The ESP connector, appropriately prepared, connects the two concrete layers by crossing the thermal-insulation layer and supports the outer panel.

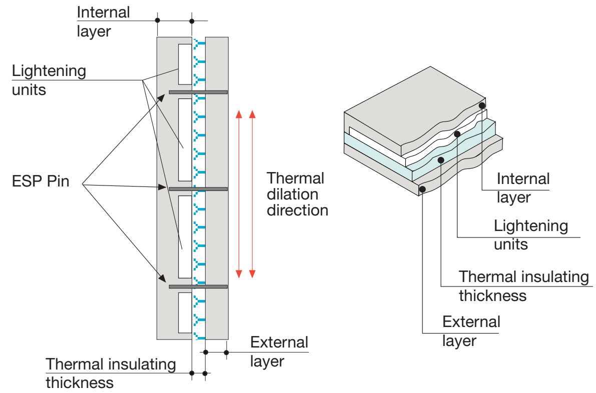
The range of Edilmatic ESP connectors comprises 2 connection pins types, **ESP 140** and **ESP 260**, to be used according to the thickness of the insulating layer.

Connecting pins are realized by means of injection molding of thermoplastic material reinforced with fiber-glass, characterized by a very low heat conductivity which allows for a correct distribution of temperatures inside the panel by inhibiting the creation of thermal bridges.

Both **ESP 260** and **ESP 140** models are characterized by excellent mechanical properties in terms of tensile, flexural and shear strength and by a very high ductility thanks to its internal steel core. The specific structure makes it very easy to insert it in any kind of heat insulating material.







TECHNICAL PROPERTIES OF THE POLYMER

The outer coating of the **ESP connection pins** is made of thermoplastic material: it is a heat stabilized polymer composite with very high wear resistance and good mechanical strength and high toughness specifications. From a chemical point of view, the used composite is resistant to the aliphatic and aromatic hydrocarbons, gasoline, oils, ketones, ethers and alkaline solutions.

Thermal properties of the polyamide layer	
Density (ISO 1183)	1,33 - 1,57 g/cm³
Fusion temperature (DSC ISO 11357)	260 °C
Flammability (UL 94)	HB class
Thermal conductivity	0,3 W/m°K

Table 1. *Properties of the thermoplastic material*

Connection Pins for Thermal-cut Panels

EDILMATIC ESP

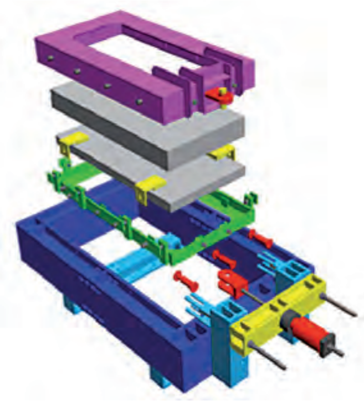
SHEAR STRENGTH OF CONNECTIONS

For defining Edilmatic ESP connection pins an experimental campaign has been carried out in order to establish the mechanical and physical properties of the connectors in different conditions of use. All the technical reports of carried out experimental trials are available at Edilmatic. In order to evaluate the shear strength of ESP connectors, some panel parts have been tested by imposing an increasing relative sliding between supported and supporting outer layers). Trial samples were representative of a portion of a curtain wall and thermal-cut panel constituted by two concrete outer layers, one supported and the other one supporting, connected between them through symmetrically positioned ESP connection pins.

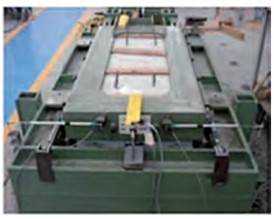
The **Table 2** shows the results of cut trials carried out on connectors. On the side, there are diagrams of trials with loads and stress and project displacements. There are a **Maximum project Load** (P_{Rd}) and a **Maximum Project Displacement** (δ_{Rd}) which must be considered as the sum of the effects due to the weight of the outer panel portion supported by the connection pin and to the thermal deformations.

	Thermo insulating layer I	Load at break P_u	Displacement at break δ_u	Designed load P_{Rd}	Designed displacement δ_{Rd}
ESP140 Pin	mm	kN	mm	kN	mm
SIDE direction	I ≤ 80	13,5	40,0	0,8	0,5
FLAT direction	I ≤ 80	17,0	25,0	0,8	2,0
ESP260 Pin	mm	kN	mm	kN	mm
SIDE direction	I ≤ 150	7,93	13,88	0,8	0,2
FLAT direction	I ≤ 150	4,30	16,2	0,8	3,5

Table 2. *Summary of cut test results*



Equipment Detail



Trial detail

Part detail

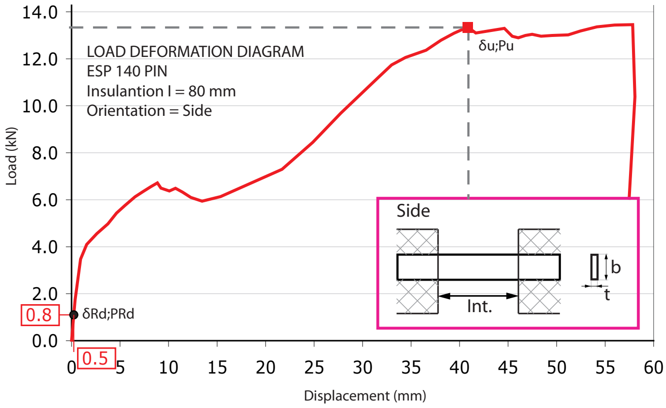


Chart 1. *Load-deformation ESP 140 Side*

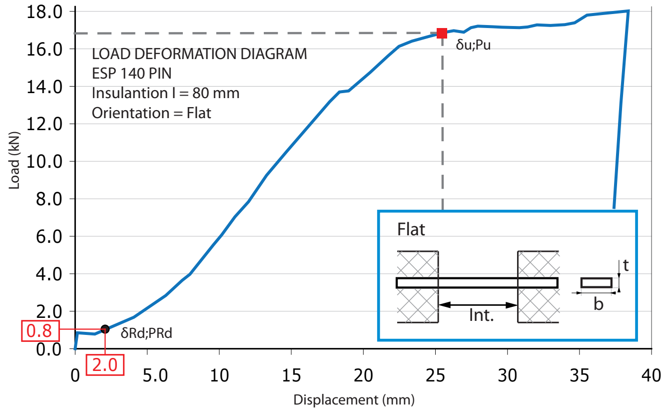


Chart 2. *Load-deformation ESP 140 Flat*

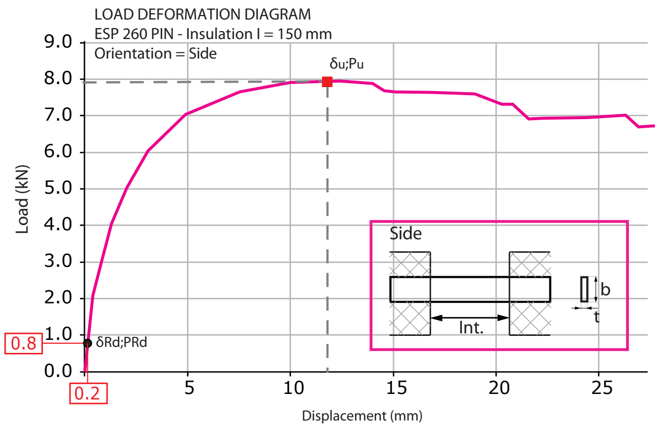


Chart 3. *Load-deformation ESP 260 Side*

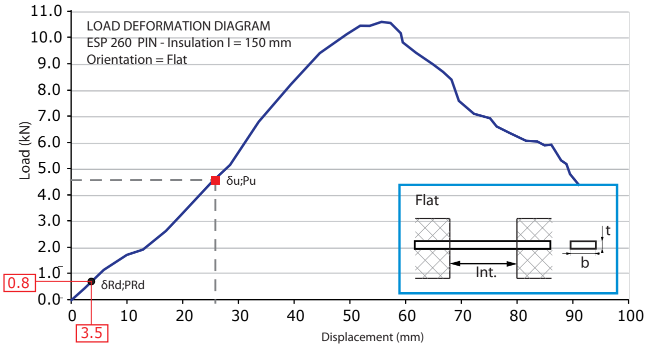


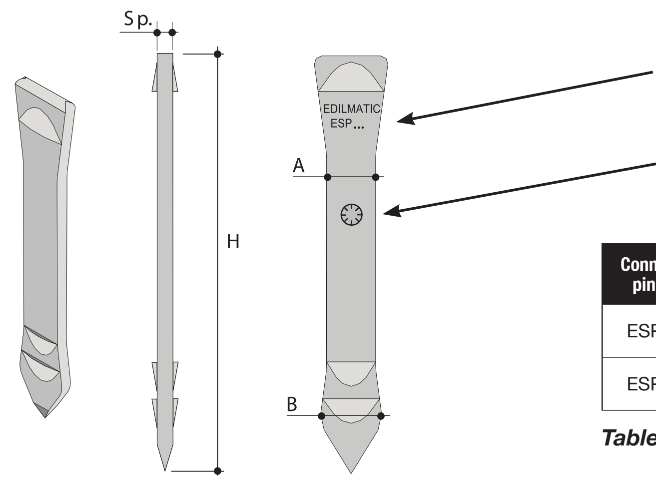
Chart 4. *Load-deformation ESP 260 Flat*

Connection Pins for Thermal-cut Panels

EDILMATIC ESP

TYPES AND DIMENSIONS

The range of ESP connectors comprises 2 connection pins types, **ESP 140** and **ESP 260**. Upon each connector is highlighted the Edilmatic indication with the identification of the connector type and in the central area of the connection pin there is a symbol with the indication of the batch code (month and year of production).

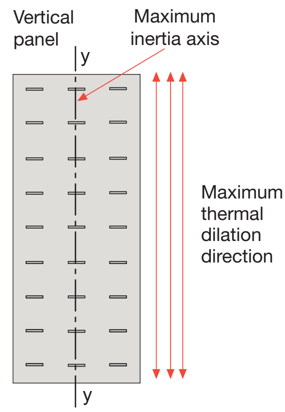


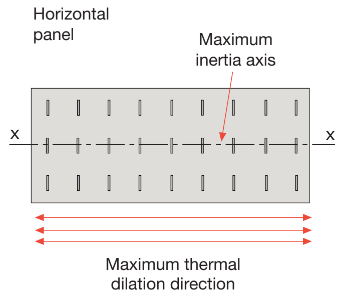
Connection pin type	A	B	Sp	H
ESP 140	28	34	7	200
ESP 260	41	47	10	260

Table 3. *Dimensions (mm) of connectors*

CONNECTION PIN ARRANGEMENT

During the positioning, connection pins must be oriented so that the "plain part" is stressed according to the maximum inertia axis in the direction of the highest thermal expansion of elements. In the right figures there are two types of panels, horizontal and vertical ones, with the schematization of the arrangement of the ESP connection pins with respect to the orientation of the panel, to the direction of the maximum thermal expansion and to the inertia axes.





PROJECT DETAILS - PROJECT LOADS

According to project purposes for the determination of the number of connection pins, a Usage Load (**C_u**) is defined, according to which, due to the thickness of the outer layer, the minimum number of connection pins to be positioned both in standard panels and in lightweight panels is defined. In **Table 4** there are the values of Usage Load **C_u** for each type of connection pin according to the structure of the insulating material "I" and the positioning distances recommended. However, it is available, upon request, the software dedicated to the ESP connection pins management which automatically indicates the type of suitable connection pin according to the geometrical features of the product.

Type of pins ESP	Insulating layer thckness I	Use load C_u	Minimun axle (suggested) $d_{i,max}$	Minimun distance from border (suggested) $d_{b,min}$
	mm	kN	mm	mm
ESP 140	40 ≤ I ≤ 80	0,8±5%	600	100
ESP 260	80 < I ≤ 150	0,8±5%	600	150

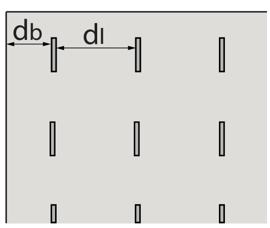


Table 4. *Usage loads, distances and positioning spacings of connection pin positioning*

Connection Pins for Thermal-cut Panels

EDILMATIC ESP

PROJECT DETAILS - EXAMPLE 1

The project approach for the positioning of ESP connection pins in the lightweight thermal-cut panels is necessarily different with respect to the multiplayer panels. There are no reference distances and the positioning of connection pins, complying with the applicable project loads and related displacements, must take place in the peripheral areas (edges) and in the gaps between the lightening elements (pilasters).

Panel length:	L_u =10000 mm
Panel width:	L_a =2500 mm
Outer layer thickness:	S_p =60 mm
Thickness of the heat-insulating elements:	I =60 mm

Weight calculation of outer layer:
γ_{cls} x L_u x L_a x Sp = 2500 x 10 x 2,5 x 0,06 = **3750 kg**

According to **Table 4**, **ESP 140** (40 ≤ I ≤ 80 mm) connection pins should be used.

As a function of **C_u = 80 kg**, the total amount of connection pins is equal to:
total n° of connection pins = 3750/80 = 47 connection pins

Therefore, a minimum of **47 connection pins** is needed in the peripheral areas and in edges among the lightening elements. The designer can choose the spacings in which the connectors are positioned.
In this case, assuming the presence of four lightening elements, 4**7 connection pins on 5 vertical rows and 2 horizontal rows** must be prepared.

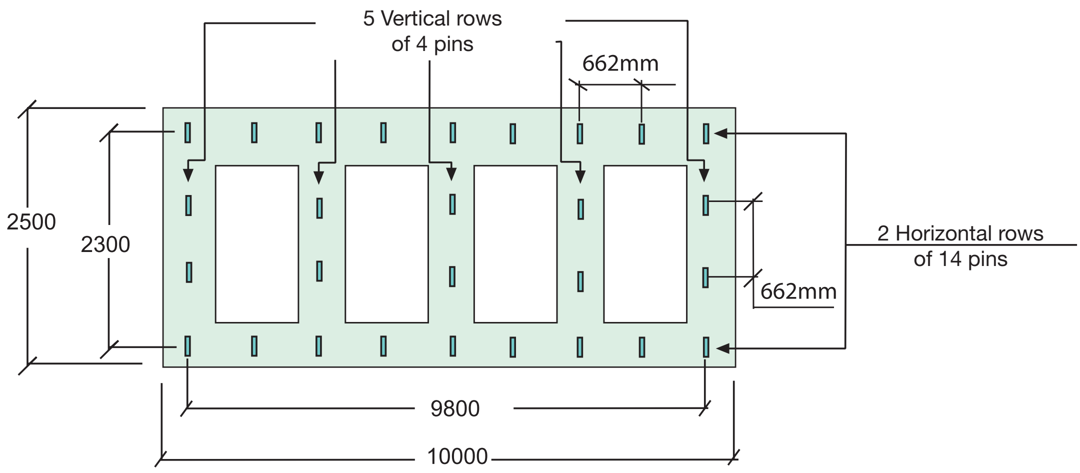
It is possible to determine an indicative spacing for the positioning of the connection pins, considering the total perimeter development of the horizontal and vertical edges and taking into account the minimum distances from the edge.

We obtain:
9800 x 2 + 2300 x 5 = **31100 mm** representing the development of the useful surfaces for the positioning of connection pins.

The indicative spacing for the positioning of the connectors is: **31100 mm / 47 = 662 mm**

For the horizontal rows we have: 9800 mm / 662 mm = **14 connection pins each Horizontal row**

For the vertical rows we have: 2300 mm / 662 mm = **4 connection pins each Vertical row**



** Total used **ESP 140** connection pins = **48**

Connection Pins for Thermal-cut Panels

EDILMATIC ESP

PROJECT DETAILS - EXAMPLE 2

Panel length:	L_u =8000 mm
Panel width:	L_a =2000 mm
Outer layer thickness:	S_p =60 mm
Thickness of the heat-insulating elements:	I =90 mm

Calculation of the Outer Coating weight:
$\gamma_{cls} \times L_u \times L_a \times Sp$ = 2500 x 8,0 x 2,0 x 0,06 = **2400 kg**

According to **Table 4**, **ESP 260** (80 < I ≤ 150 mm) connection pins should be used.

As a function of **C_u=80kg**, the total amount of connection pins is equal to:
total n° of connection pins = 2400/80 = 30 connection pins

Therefore, a minimum of 30 connection pins is needed in the peripheral areas and in edges among the lightening elements. The designer can choose the spacings in which the connectors are positioned.
In this case, assuming the presence of four lightening elements, **30 connection pins on 4 vertical rows and 2 horizontal rows** must be prepared.

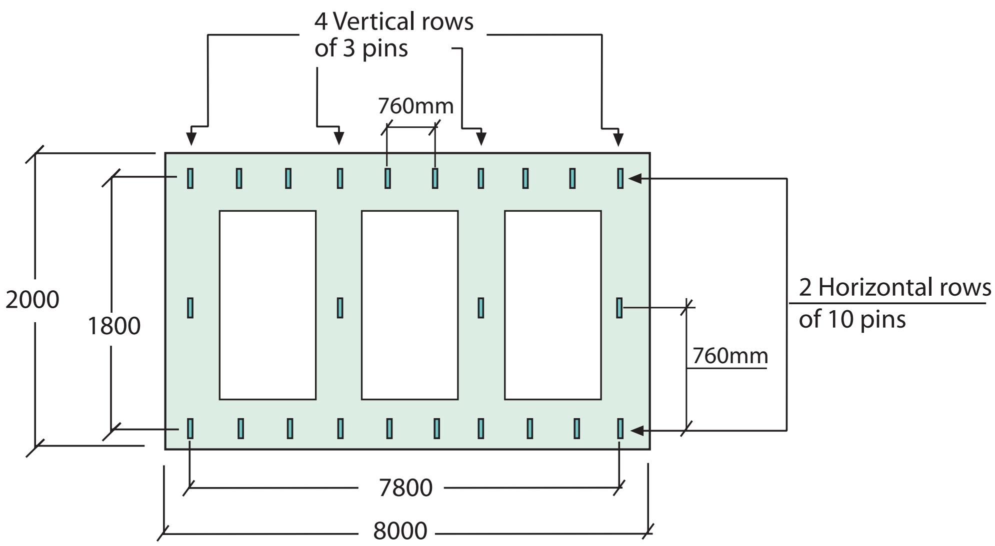
It is possible to determine an indicative spacing for the positioning of the connection pins, considering the total perimeter development of the horizontal and vertical edges and taking into account the minimum distances from the edge.

We obtain:
7800 x 2 + 1800 x 4 = **22800 mm** representing the development of the useful surfaces for the positioning of connection pins.

The indicative spacing for the positioning of the connectors is: **22800 mm / 30 = 760 mm**

For the horizontal rows we have: 7800 mm / 760 mm = **10 connection pins each Horizontal row**

For the vertical rows we have: 1800 mm / 760 mm = **3 connection pins each Vertical row**



** Total used **ESP 260** connection pins = **32**

Connection Pins for Thermal-cut Panels

EDILMATIC ESP

PROJECT REQUIREMENTS

In order to obtain a structurally safe product, during the project step of the panel the deformations induced by the thermal expansion of concrete should be assessed. This assessment is important both for evaluating the correct positioning distances, in case of adjacent panels, and for a first assessment of the stresses to which ESP connection pins can be subject.

The thermal expansion increases as a function of distance from the center of the element and in the project of a thermal-cut panel, it is to be considered that the connectors that will suffer the most distorting effect are those located at the ends of the element. It is then appropriate to verify that these connectors are always solicited within the limits of the project indicated.

For example, we can suppose to make a thermal-cut panel of length equal to L = 10 mt and that the effect of the thermal-expansion is uniformly distributed on the two sides of the element.

Assuming a thermal excursion of 30°C the maximum deformation of the panel ($\delta_{x,T}$) and then of the connector, is calculable with the formula:

$\delta_{x,T} = \lambda \bullet \Delta T \bullet d_x$ … where

λ = coefficient of thermal expansion of the concrete (10^{-5} °C^{-1})
ΔT = thermal differential expected
dx = distance of the connector from the center of gravity of the panel

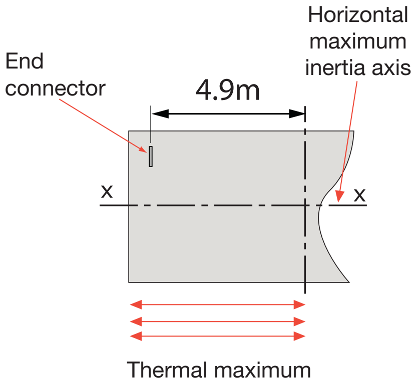
… we obtain

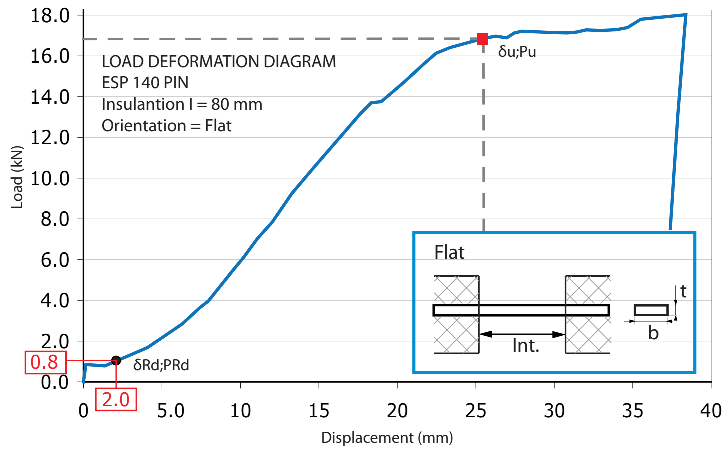
$\delta_{x,T} = \lambda \bullet \Delta T \bullet d_x = 10^{-5}$ °C^{-1} . 30°C . 4.9mt = 1,47mm maximum deformation of the end connector

Assuming the use of a Edilmatic ESP 140 connector, (see below) with Load-Deformation curve for cut subjected Connection pins plain oriented, should be noted that for deformation equal to 1.5 mm the connection pin is solicited with about **0.3 kN** and then below the project load recommended (0.8 kN).

This preliminary analysis should always be performed in order to evaluate the proper use of the connection pin, preparing the appropriate distances between adjacent panels and avoiding hard spots that could affect the structural stability of the panel and create excessive stresses in the connectors.

It is important to emphasize that with the **K-term** software for the management of the connectors that Edilmatic makes available, the value of maximum deformation of the panel is automatically calculated as a function of the expected thermal differential.



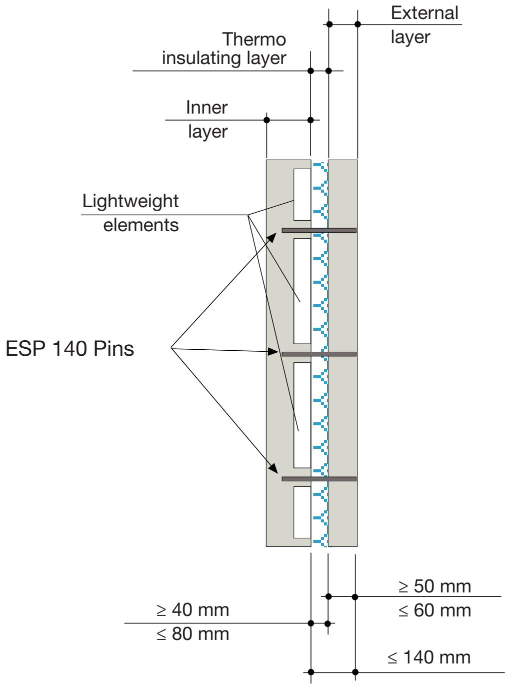


Connection Pins for Thermal-cut Panels

EDILMATIC ESP

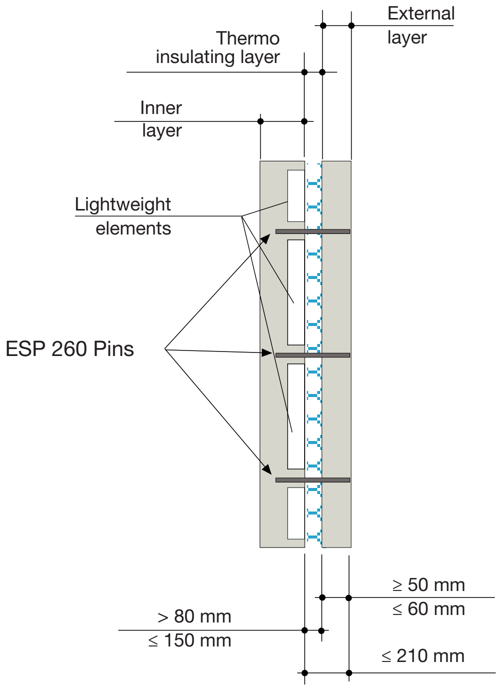
PROJECT REQUIREMENTS

In the use of Edilmatic ESP connection pins some size limitations are placed for various layers constituting the same panel in order to optimize the performance of connection pins and not to create tensile overloads in the material.
The limitations are also present in the software and are precautionary in order to avoid misuse of the connectors.
Within certain limits it is possible to increase the number of connection pins per m² especially in cases in which the thickness of the outer layer exceeds the limits laid. In these cases, however, it is always recommended to consult the technical department of Edilmatic for a preliminary evaluation of the stratigraphy of the panel and for the procedural indications.



For ESP 140 pins

Thickness external crust + Insulating layer thickness	**≤ 140mm**
Maximum thickness of insulating layer	**≤ 80mm**
Minimum thickness of insulating layer	**≥ 40mm**
Minimum thickness of external concrete	**≥ 50mm**
Maximum thickness of external concrete (*)	**≤ 60mm**



For ESP 260 pins

Thickness external crust + Insulating layer thickness	**≤ 210mm**
Maximum thickness of insulating layer	**≤ 150mm**
Minimum thickness of insulating layer	**> 80mm**
Minimum thickness of external concrete	**≥ 50mm**
Maximum thickness of external concrete (*)	**≤ 60mm**

(*) Higher outer concrete thicknesses are allowed if an appropriate number of connection pins per m² is used. The correct number of connection pins must be determined with appropriate calculations and the subsequent positioning must be carried out with an appropriate gauge.

Connection Pins for Thermal-cut Panels

EDILMATIC ESP

USAGE PRESCRIPTION

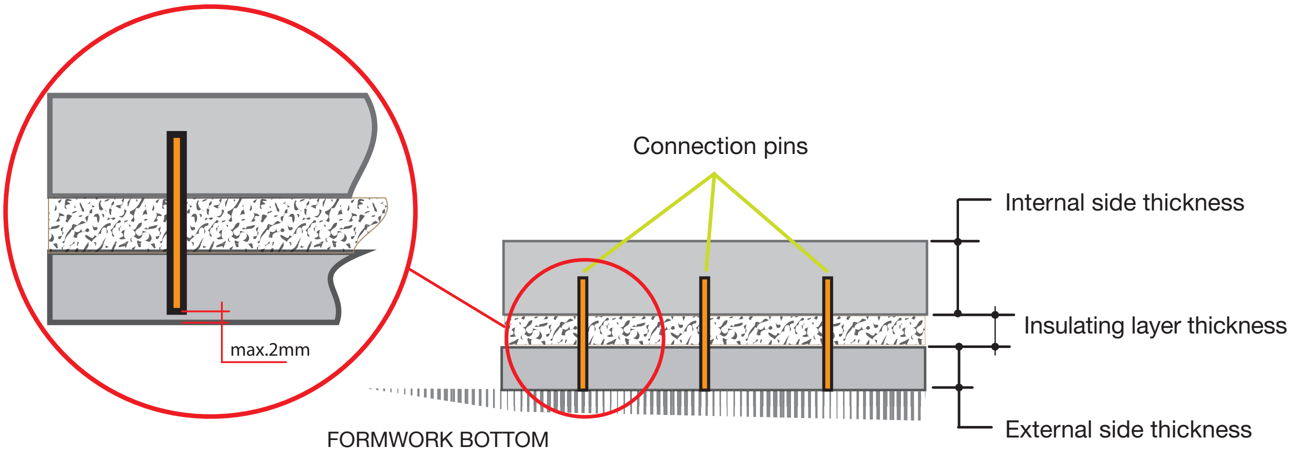
For a correct and practical use of the Edilmatic connectors, some procedures for the realization of the panels should be respected, otherwise the technical performances of the connection pin and consequently, the static stability of the elements in which they are used may be jeopardized.

- The fluidity of the concrete used should be adequate to the room temperature existing during the production. During summertime the concrete must be absolutely more fluid compared to winter time;

- The connection pins must be inserted in the outer concrete layer immediately after casting and laying of the insulating material. It is recommended not to wait for too much time before carrying out the work.
  An excessive hardening of the outer concrete layer may prevent from a correct clamping of the connection pins and compromise their capacity;

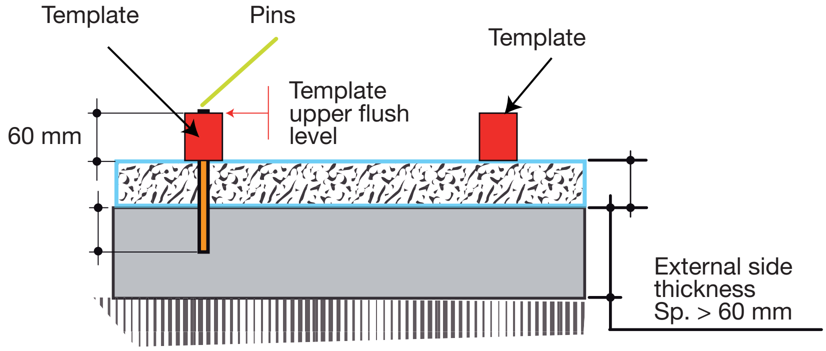
- During the insertion of the connectors, make sure that the thickness of the outer concrete layer reaches the bottom of the formwork, lift up the connector after the contact with the caisson bottom just of a few mm in order to avoid that the connection pin may be visible from the outside, especially in case of an evident shrinkage of the concrete in panels with special exterior finishes (grit, bricks, etc…);

- In the production of the panels it is recommended to use vibrating formwork. This will improve the quality of the panels obtained with these equipments and will optimize the clamping of the connection pins in the outer concrete layers.



It is allowed lifting the connector after the contact with the caisson bottom just of a few mm in order to avoid that the connector may show through in case of an evident shrinkage of the concrete.

For thicknesses of the outer concrete layer higher than 60 mm, it is recommended to use a “positioning gauge” “ so that the connection pins are inserted to the correct depth. The gauge is positioned on the insulation material and the connection pin is inserted until the upper level of the gauge itself. In this way, regardless of the thickness of the outer layer, it is certain that the front part of the connection Pin (in the supported layer) and the rear part (in the supporting layer) are enough anchored to the concrete.



Connection Pins for Thermal-cut Panels

EDILMATIC ESP

USAGE PRESCRIPTION

In addition to the general requirements already listed in order to get a technically valid product, certain operational requirements both during storage and transport steps and during the assembly of the panels produced must be fulfilled.

In particular, during the storage it is recommended to:

- Arrange the panels perfectly upright to prevent plastic deformation in the first days of aging;
- Avoid the positioning of panels on the supported outer layer: connection pins should be loaded with a weight of 2/3 times higher than the operating one, and then undergo unplanned stresses;
- Provide (if possible) for an indoor storage which is not directly exposed to the weather (especially to the sun), at least for the first 7/8 days;
- Keep wet the outer surface of the layer brought.

All these interventions help to reduce the effect of differential shrinkage between the outer layers and to obtain a sufficiently straight panel.

During transport and installation steps it is recommended to:

- Avoid abnormal shocks to the product;
- Make sure the supported outer layer is properly supported (use support wedges) to prevent increases in stress from dynamic load;
- Avoid violent supports to the panel during the installation step;
- Provide for appropriate positioning distances between adjacent panels installation taking into account the thermal expansions.

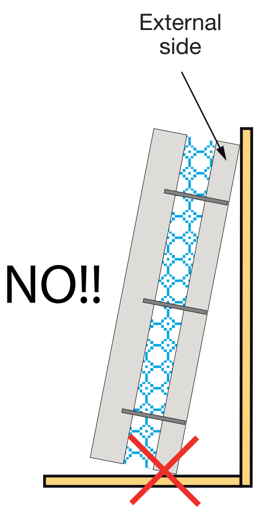


Figure 1
During the storage step, avoid the support of panels on the outer layer.

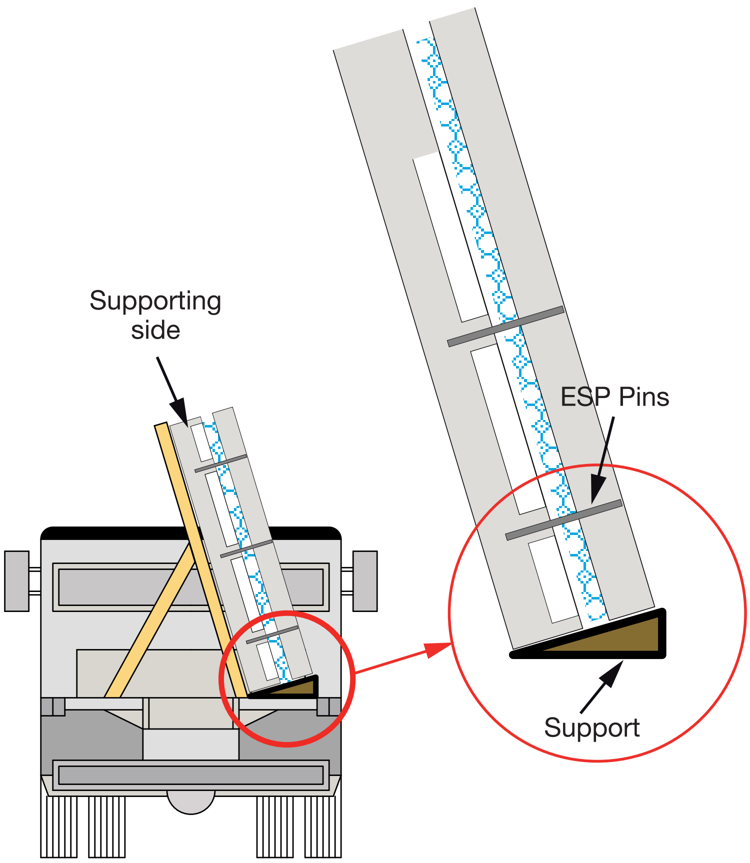


Figure 2
During the transport step, be sure that the outer layer is well supported.

Connection Pins for Thermal-cut Panels

EDILMATIC ESP

FIRE RESISTANCE OF THE CONNECTION

In order to define the changes in performance of Edilmatic ESP connection pins in walls which require REI certificate, specific tests have been performed for the evaluation of the technical performance of them being subjected to heat as required by law ISO 834. Below are some of the results of the tests carried out at the **POLITECNICO DI MILANO**. Edilmatic makes available the complete test report.

RESULT EXTRACT

In **Figure 1** there are the temperature profiles recorded in some significant steps in the test.
We observe that only the supporting panel, directly exposed to high temperatures, warms up significantly (measuring points T2 and T3), while the panel brought undergoes negligible variations of temperature.

In **Figure 2** in the diagram there is a relative significant displacement between the 2 trial layers which began after about 2 hours from the warming and culminates at about 2h 30'; this displacement is due to the initial bloating of the warm side of the layer in polystyrene. The bloating, being the insulating layer constrained by the supporting equipment of the sample, leads to a rigid rotation of the supported plate with a consequent increase of the relative displacement measurement.
With the beginning of the decomposition of polystyrene, the effect due to the expansion ends and the relative displacement among plates reaches a constant value.

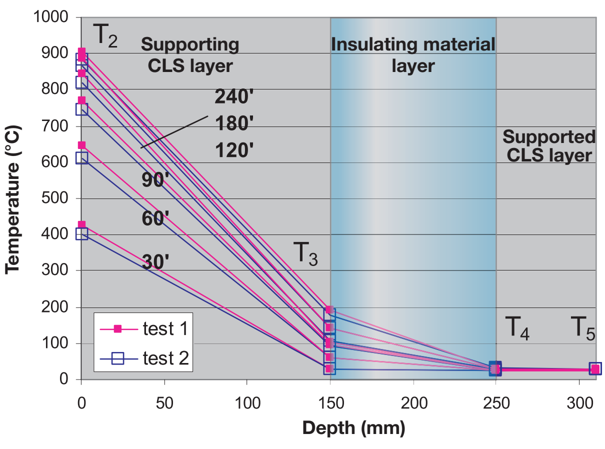


Figure 1
Temperature profiles recorded within the sample in some significant steps.

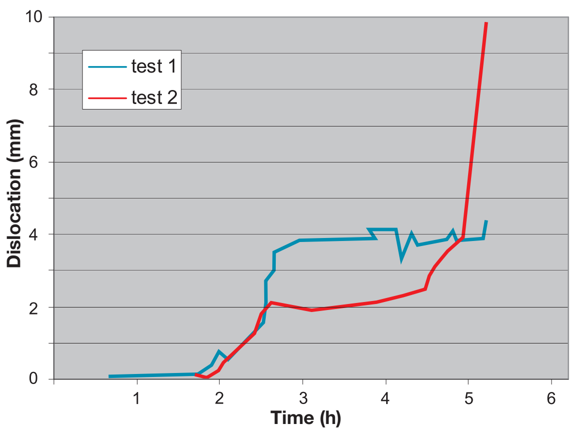


Figure 2
Lowering of the supported panel with respect to the supporting panel.

Connection Pins for Thermal-cut Panels

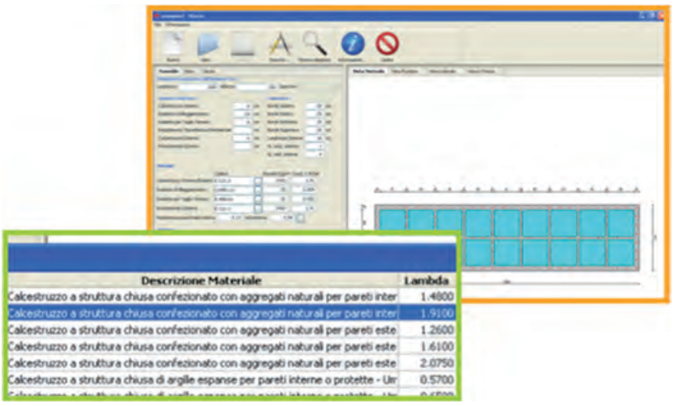
EDILMATIC ESP

CALCULATION SOFTWARE

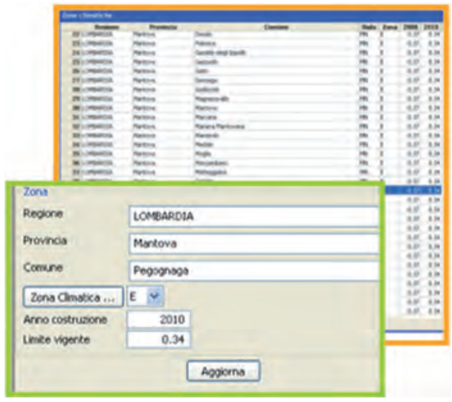
In order to help the designers in using the ESP Edilmatic connection pins, EDILMATIC has realized a calculation software for the production of thermal cut-off panels which according to the input data concerning panel geometry, panel stratification and type of used materials indicates:

- Type of connection pin to be used;
- Number of connection pins to arrange;
- Project DXF with positioning dimensions of the connection pins ;
- Thermal transmittance value of the panel according to UNI EN 6946;
- Limit values of thermal transmittance in the different regions and/or municipalities;
- Calculation report.

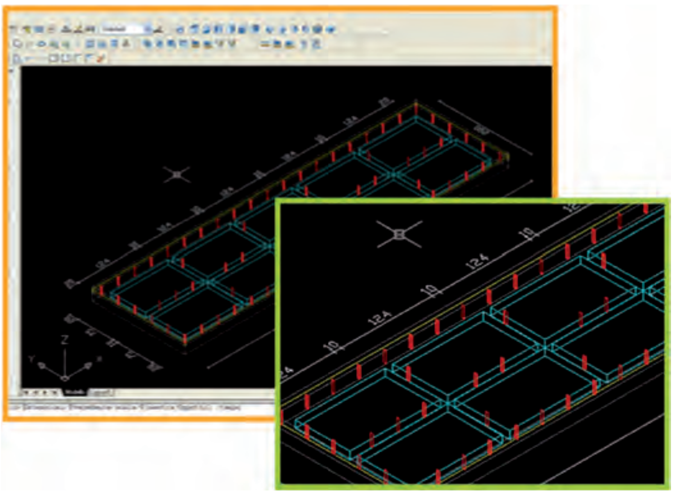
The software is certified and verified as to the calculation portion concerning the transmittance by ICMQ Institute (*Certificate n° 217/13/ISP - Inspection Report n° 150/13/ISP*).



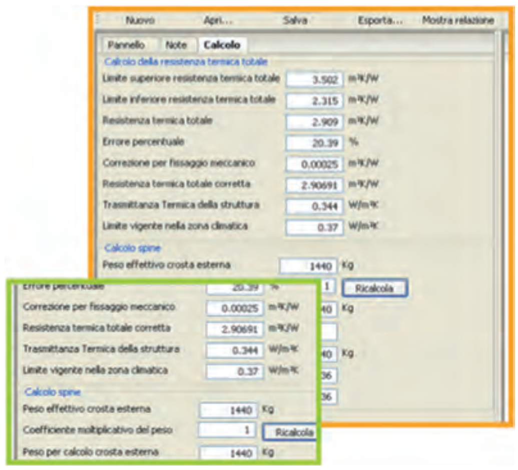
Graphic interface on line and Database of the Materials



Database of the Italian climatic areas



Export of the project in DXF (also in 3D axonometric)



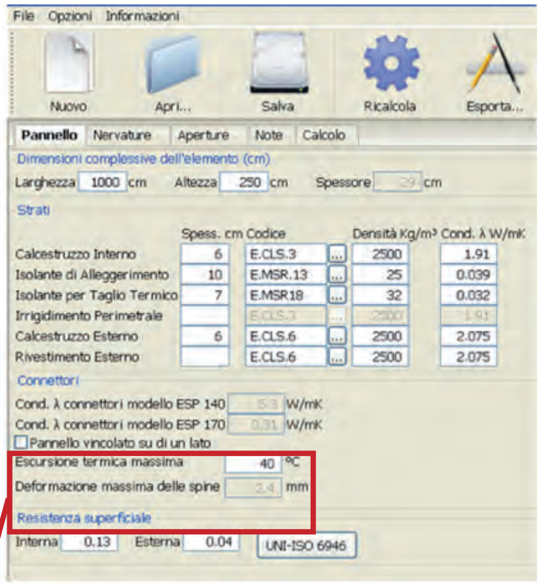
Output with project data and incidence of the connector each m²

Connection Pins for Thermal-cut Panels

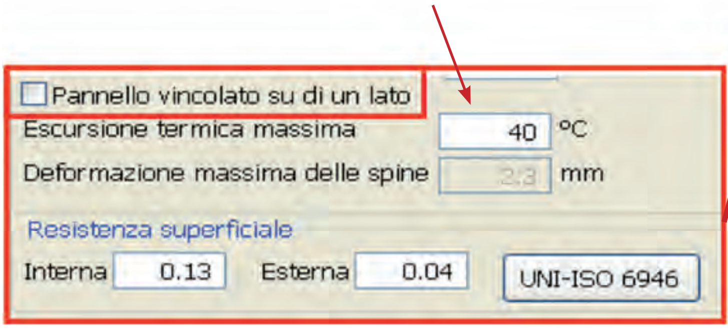
EDILMATIC ESP

CALCULATION SOFTWARE

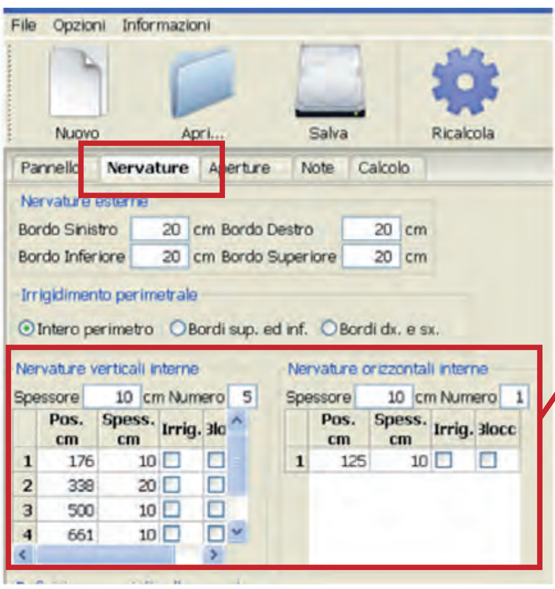
Among the various features introduced in the new release of the Software **kterm 1.6.8**, as already mentioned, it is possible to verify the deformations to which will be subject the ESP connection pins placed at the ends of the panel. By inserting the maximum expected difference in check the maximum deformation of the outer connection pins and evaluate, with the project diagram (Page 3) the stresses induced by it. It is also possible to check the deformations considering the panel constrained to one of the two sides (the more severe case) by activating the appropriate check box.

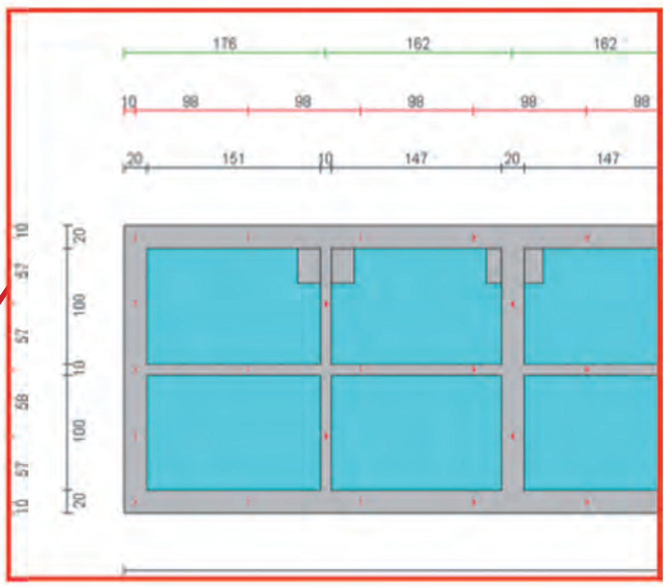


Chek-Box for the constraint of one side of the panel



A new feature available to designers with the **k-term version 1.6.8** is the possibility to manage the positions and the thickness of each backtacking, both vertically and horizontally, with a dedicated menu;
this possibility is not present in previous versions, allowing you to have an instant overview of the distribution of connecting pins and with the export function you will have a “dxf” of the panel that will fully reflect the project Lay-Out.





Notes

Notes

Notes

EDILMATIC

Anchorage, supporting and lifting systems
for prefabricated elements.
Accessories, fasters and metallic items.

EDILMATIC srl
Office and Factory: Via Gonzaga, 11
46020 Pegognaga (MN) Italia
tel. +39-0376-558225 - fax +39-0376-558672
E-mail: info@edilmatic.it - internet: www.edilmatic.it

ICMQ
UNI EN ISO 9001 REGULATION
QUALITY SYSTEM CERTIFICATION
N. 93048 CERTIFICATION

CERTIFIED IQNet QUALITY SYSTEM

ACCREDITATO INSERTI QUALITÀ

Edilmatic QR Code