BPNMMEN0519

baupanel system

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ASSEMBLY MANUAL

baupanel®
system

Assembly Manual

EPS

Concrete
High strength

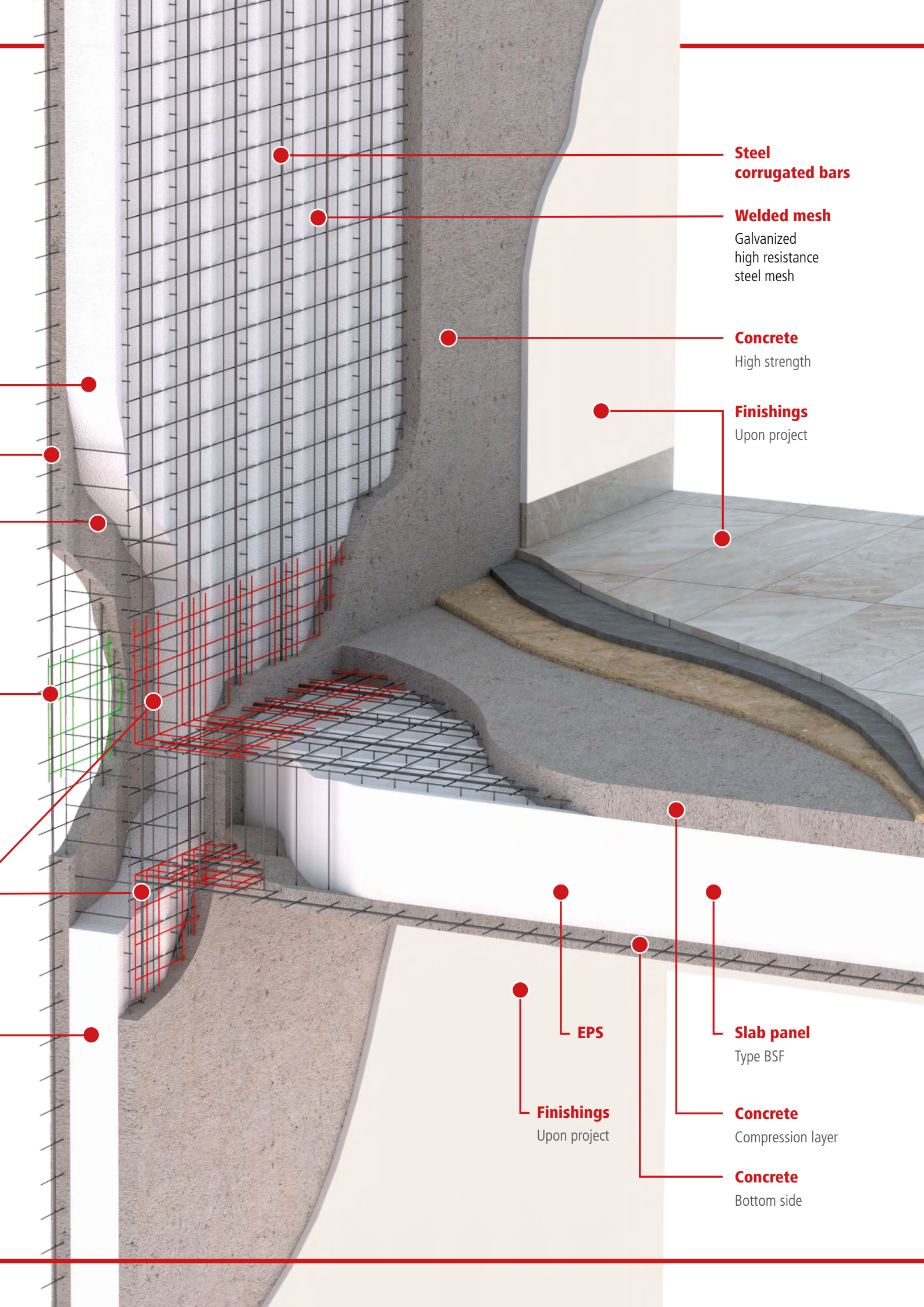
Steel Connectors

Flat reinforcement mesh
Galvanized high resistance steel mesh

Angular reinforcement mesh
Galvanized high resistance steel mesh

Vertical panel
Type BSR

*** The phases with instructions for the projection of concrete are only recommendations of Baupanel® for an optimal result.**


Steel corrugated bars
Welded mesh
Galvanized high resistance steel mesh
Concrete
High strength
Finishings
Upon project
EPS
Slab panel
Type BSF
Finishings
Upon project
Concrete
Compression layer
Concrete
Bottom side

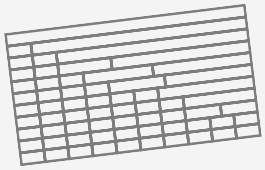
1

Necessary Elements

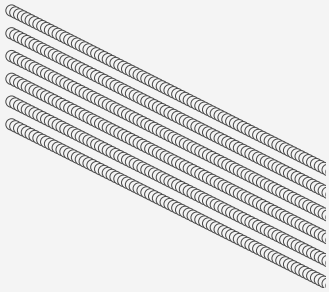
Before starting to build

The construction system Baupanel® allows a very high speed of execution. The labor yield for the integral system can be estimated at an average of 2.20 man-hours per m2 of panel (combination of floors and walls). These returns are indicative and will depend on the typology as well as the complexity of each project.

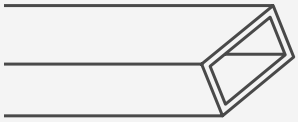
That is why it is necessary to have all the elements listed below, prior to the start of the works, to achieve a continuous work process that allows achieving the indicated performance.



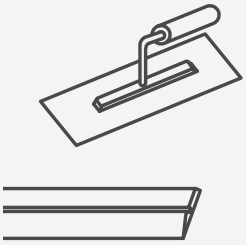
Coordination with installers who must start their tasks on the 3rd day of work



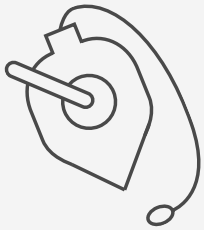
Corrugated steel bars ø 6 mm



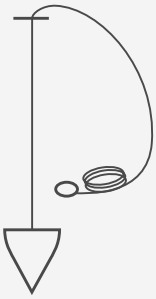
Rules



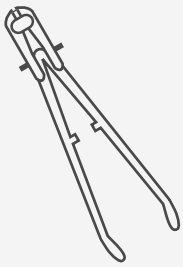
Trowels



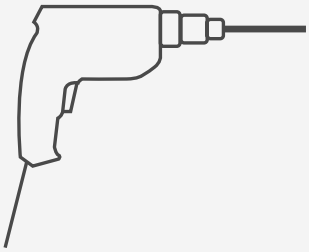
Line tracer



Sinkers

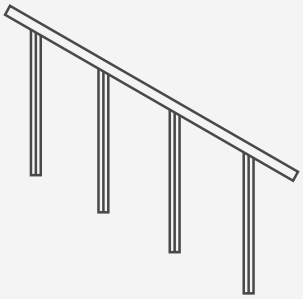


Cutter

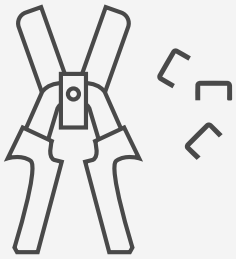


Drill

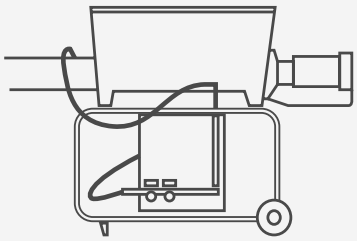
Concrete separators



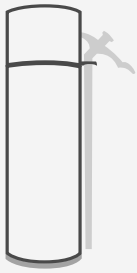
Girders and struts



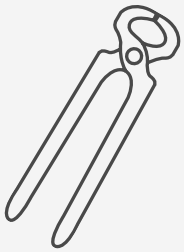
Staplers and staples



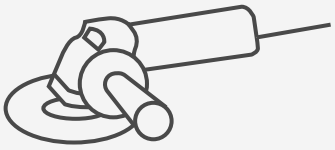
Projecting machine



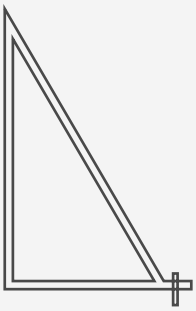
Polyurethane foam



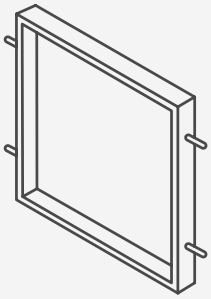
Tongs



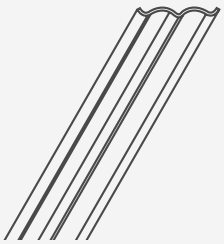
Radial slicer



Fixed squares and subjection



Doors and window frames



Screed Lines

Foundation

The **Baupanel® System** is compatible with any type of foundation whether continuous surface or linear.

The type of foundation chosen will depend firstly on the bearing capacity of the land and, secondly, on the distribution of the building.

We must have the advantage that the **Baupanel® System** is lighter than a traditional building, which allows the volume of the foundation to be much smaller.

In addition, due to the great contribution of stiffness of the Baupanel® walls, a reduction of the steel sections necessary in the foundation is achieved, all of which represents an important economic saving.

2

Layout and placement of assembly bars

First, the walls will be staked out, drawing for each of them, two lines whose distance should always be equal to the nominal thickness of the panel of that wall + 27 mm.

On these lines will be allocated the centers of the assembly bars that will always be corrugated bars of 6 mm in diameter and 40 cm in length.

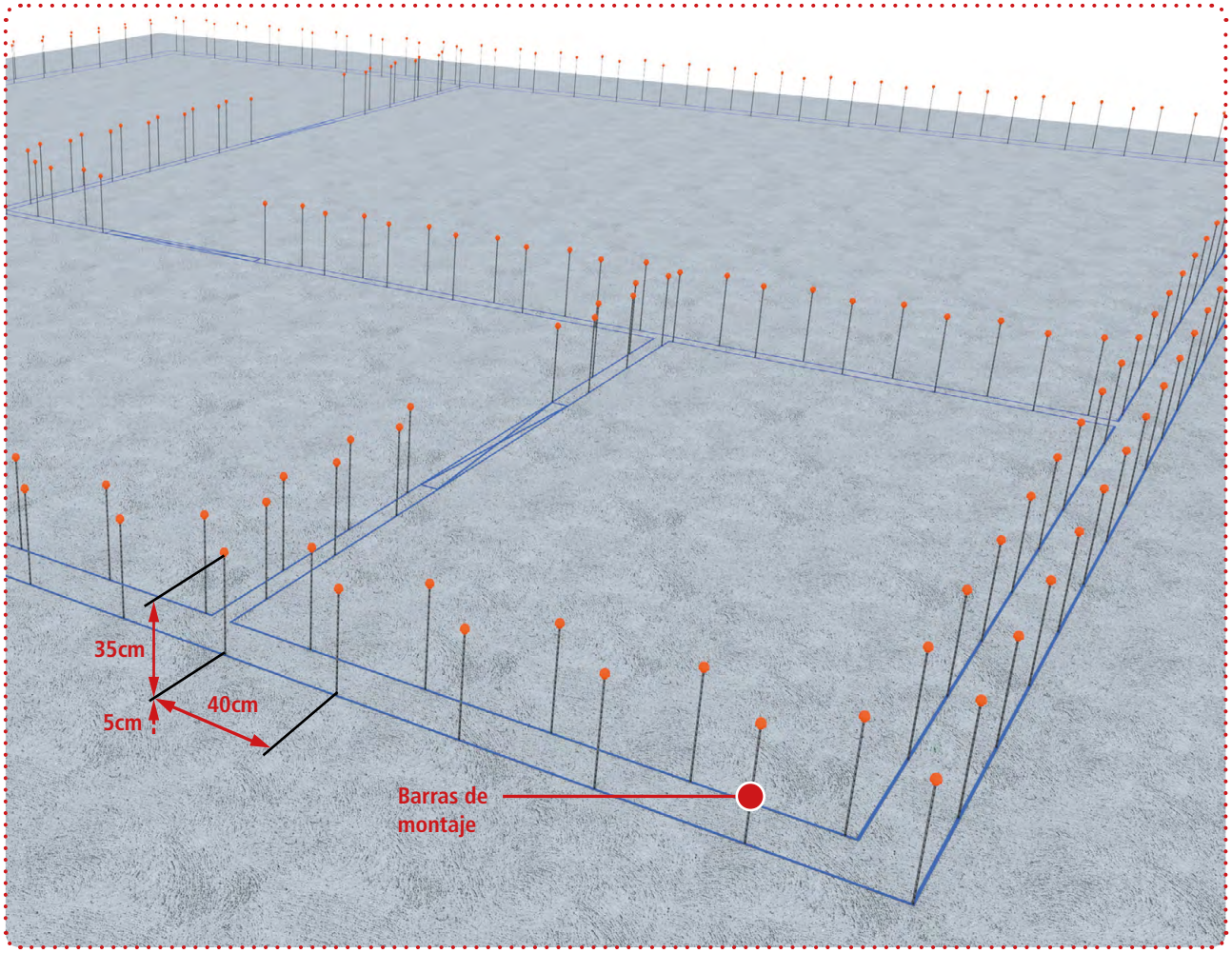
Diameters greater than 6 mm should not be used, in order to avoid coating problems of these bars.

Holes will be drilled in the foundation with a 6 mm drill bit and a minimum depth of 50 mm, to subsequently nail the assembly rods to the hammer.

As a general rule, chemical anchoring is not required since the efforts to which they are subject are to shear.

In the case of earth retaining walls, the separation of the assembly bars, which may be smaller than usual, must be checked in the work plans.

The assembly bars will be in staggered formation with a longitudinal separation of 40 cm.



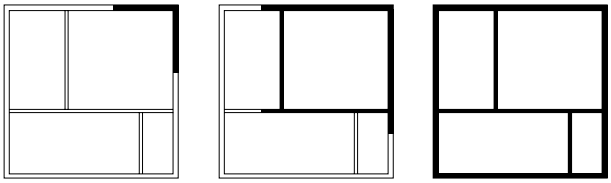
2

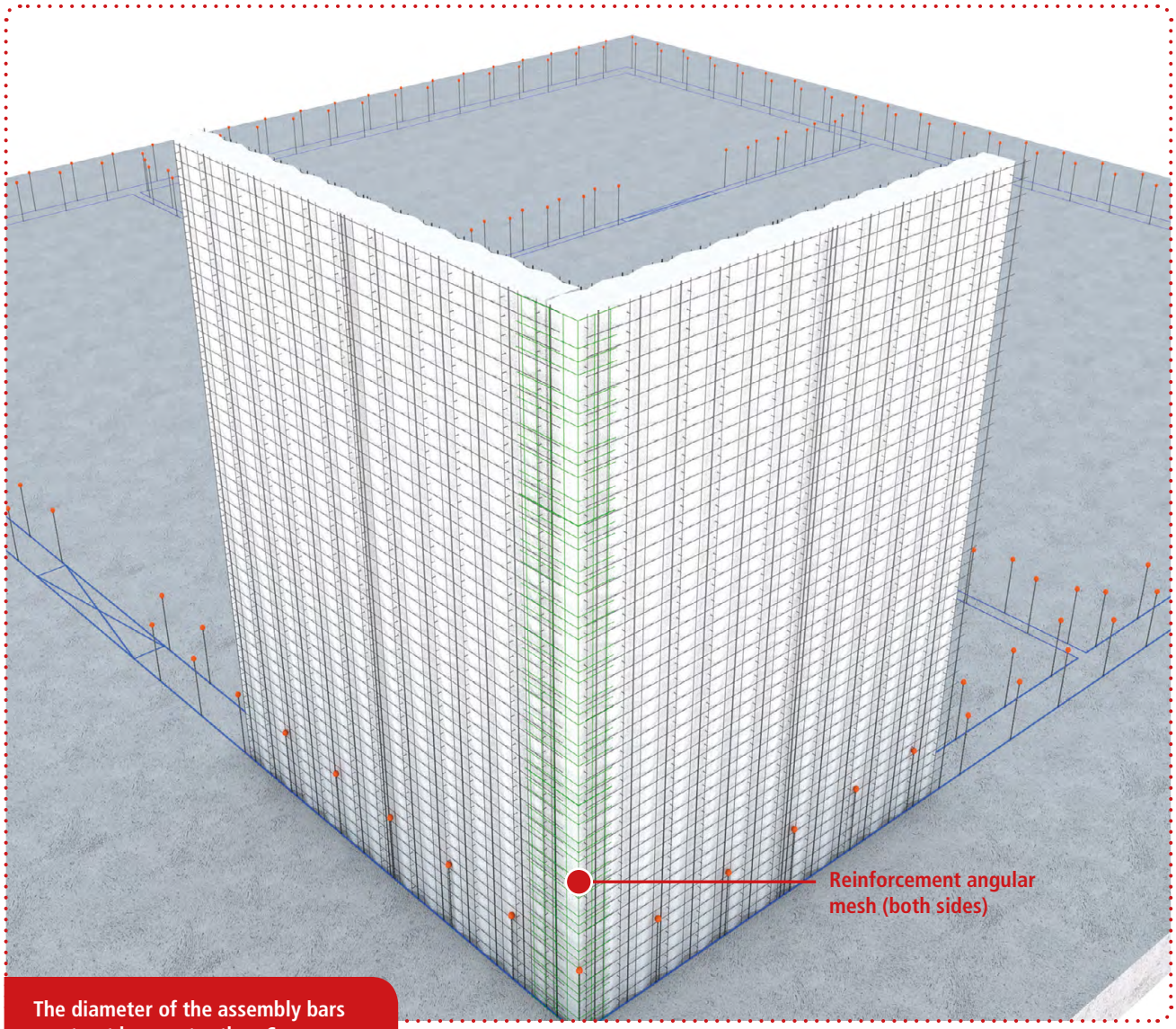
3

Panel Placement

Baupanel®

Once the assembly bars are installed, we are ready to start placing the panels. The assembly of the panels should always start at one corner of the building, so that two panels placed in square support each other. **(3a)**.





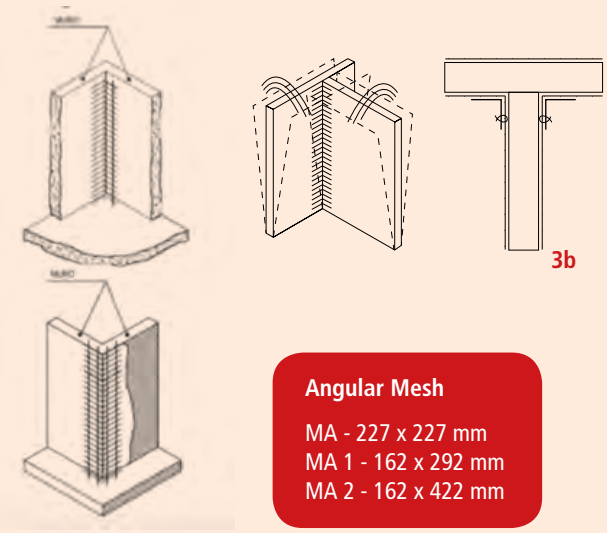
The diameter of the assembly bars must not be greater than 6 mm

3a

Placement of angular meshes

This corner joint is tied by means of the angular reinforcement meshes that are placed from floor to ceiling without overlaps or interruptions **(3b)**.

The angle meshes will be tied only to one of the two panels that are, to allow the movement and the correct panel plumb, with a maximum tolerance of 8 mm per height of plant **(3b)**.



Angular Mesh

MA - 227 x 227 mm
MA 1 - 162 x 292 mm
MA 2 - 162 x 422 mm

All corner junctions have to be reinforced by angular meshes, both on the inside and on the outside, to achieve the continuity of the meshes and a monolithic construction.

The interior joints will always be made with an MA type mesh.

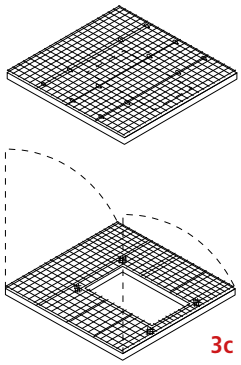
In the outer corners, according to the thickness of the EPS core, the following types of angular meshes will be arranged:

MA: EPS thickness less than or equal to 120 mm

MA1: EPS thickness between 125 - 160 mm

MA2: EPS thickness greater or equal to 165 mm

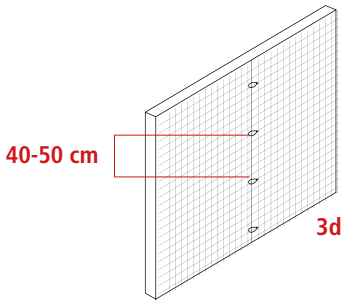
The placement of the panels is done one by one. If the typology of the work allowes it, they can be previously mounted on the ground in groups of 3, 4 or 5 units, then lift the assembled group and place it in **(3c)**. This procedure should not be performed on days with bursts of winds greater than 8 km / h.



In general, the assembly of panels will only respect the holes corresponding to the doors, while the windows will be cut later, in the position indicated in the project. The lintels of the doors can be made by mounting the panel in horizontal position.

The mesh panels protrude on opposite sides on their longitudinal sides; When placing a panel next to each other, the juxtaposition of the meshes in a width of 66 mm is produced, which allows the structural continuity in the transmission of the efforts.

The panels are tied together with staples or with wire ties. A fastening every 50 cm will be sufficient (7 modules of the transverse reinforcement of the panel) **(3d)**.



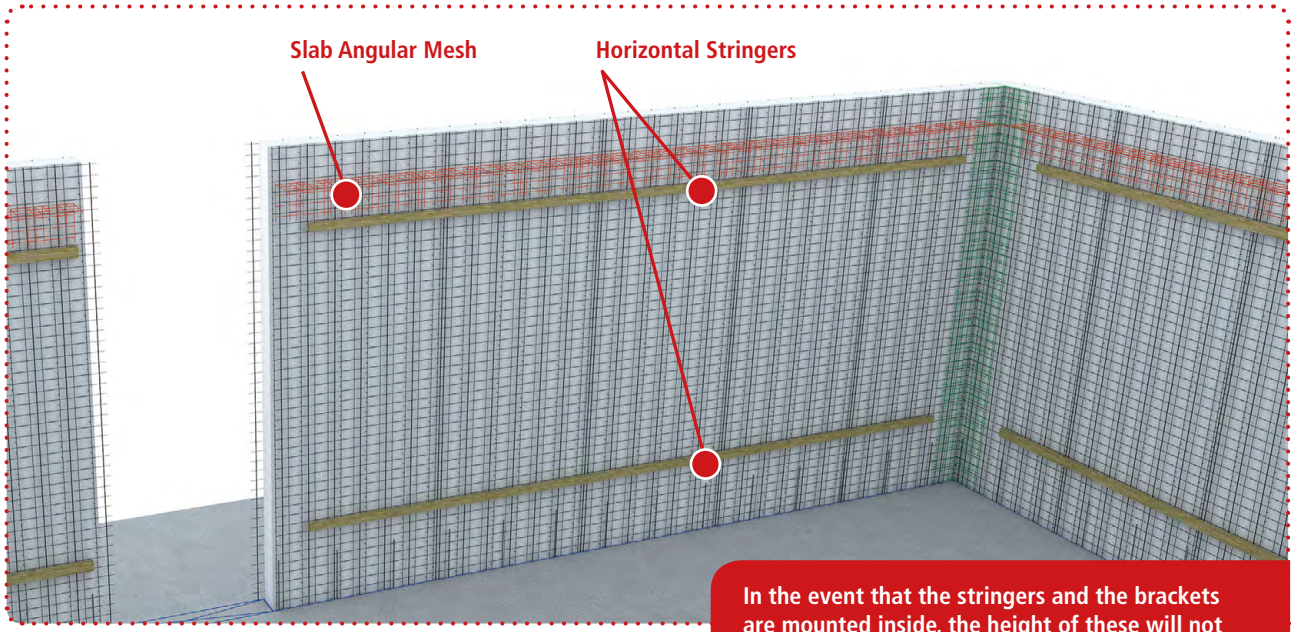
The assembly bars should also be tied to any of the vertical bars of the panel mesh.

The wire of the ties should never protrude more than 10 mm, so that it is always within the thickness of the concrete layer that will later be applied, in order to avoid corrosion over the wire edges.

4

Alignment of panels

Horizontal stringers (rulers) will be placed above the lines of window lintels and doors to align the walls. Therefore it should be taken into account the height of placement of angular meshes for the slabs. Steel square tubes or straight wooden braces can be used, which will be tied from the opposite side of the panel. The alignment and subsequent plumb should always be arranged on only one side of the panel, leaving the opposite side clear.



In the event that the stringers and the brackets are mounted inside, the height of these will not overlap with the angular support grid of the floor.

4

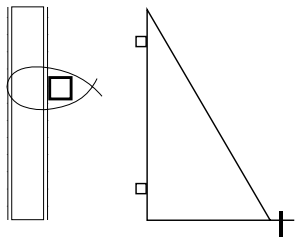
5

Panel plumbing

To fasten the panel alignment rules, inclined struts or articulated brackets will be used that will be fixed to the screed. These squads will provide the perfect plumb.

Separation between brackets: every 2 or 3 panels.

The binding of the rules must be done from the opposite side of the panel **(5a)**.



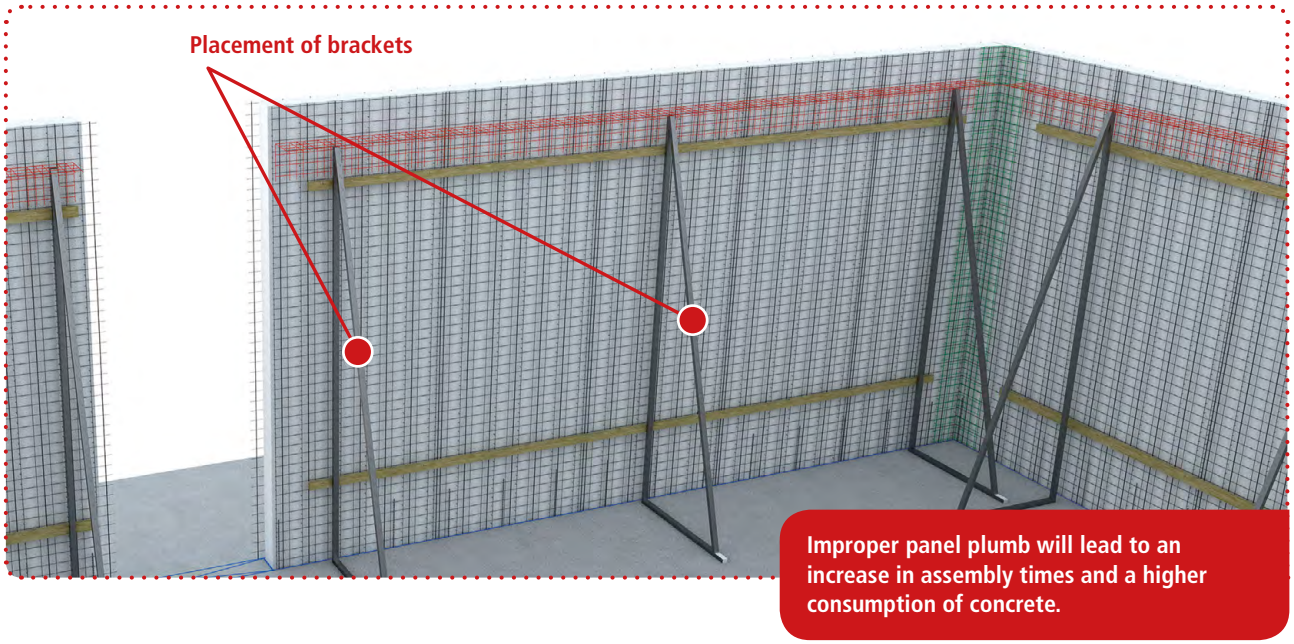
5a

Both the struts and the brackets must be perfectly fixed to the sill to temporarily withstand the wind forces.

All the elements of alignment, plumb and fastening must be on one side of the panel, leaving the opposite side completely clear, through which the concrete projection step **(5b)** will begin later.

It is very important to pay attention to the correct plumb of the panel, whose maximum tolerance from floor to floor will be ± 8 mm. An incorrect plumb and/or alignment will later require to be corrected with a greater thickness of the concrete layer, which in turn, is very costly in materials and labor.

On the other hand, an excessive thickness of concrete, will leave the rebar with too much coating, favoring the appearance of retraction fissures.



5b

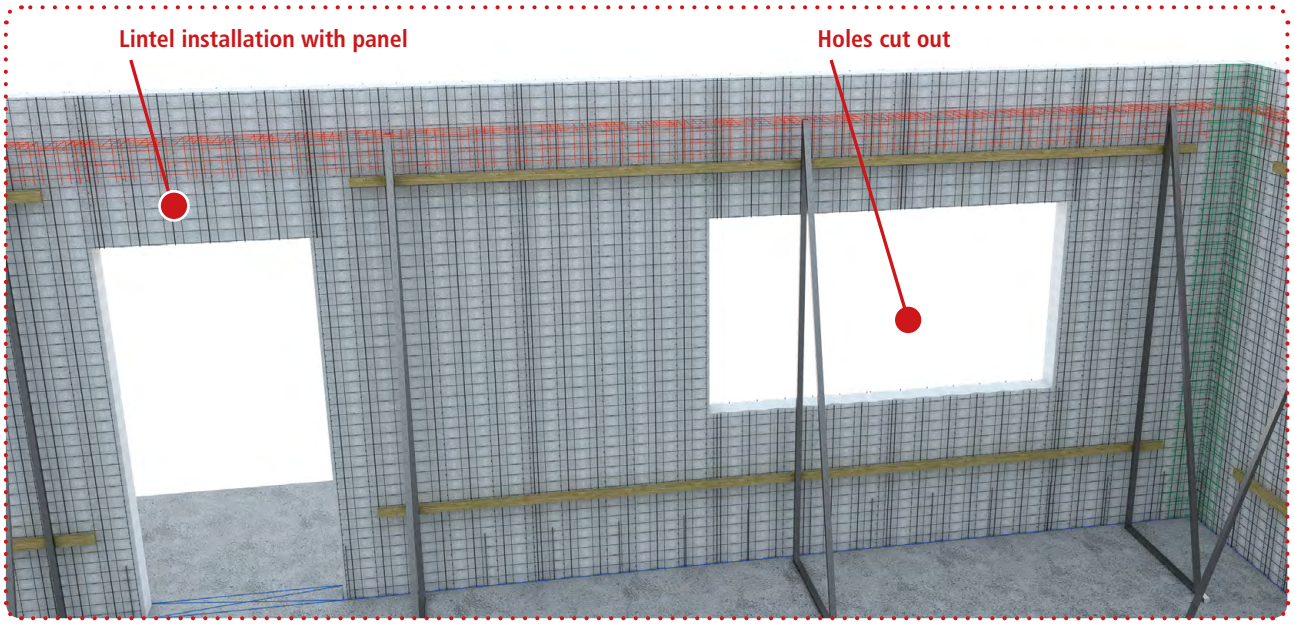
6

Cut out holes

Progress will continue with the placement of panels in all the partitions and walls indicated in the project, respecting the position of the gaps corresponding to the doors. It is convenient to have all the door and window pre-frames at the beginning of the panel assembly.

The trimming of the panels to make the window holes, can be done with a radial cutter or saber saw.

The clearance of the gap will be a maximum of 20mm.

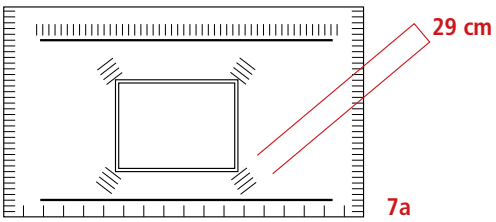


6

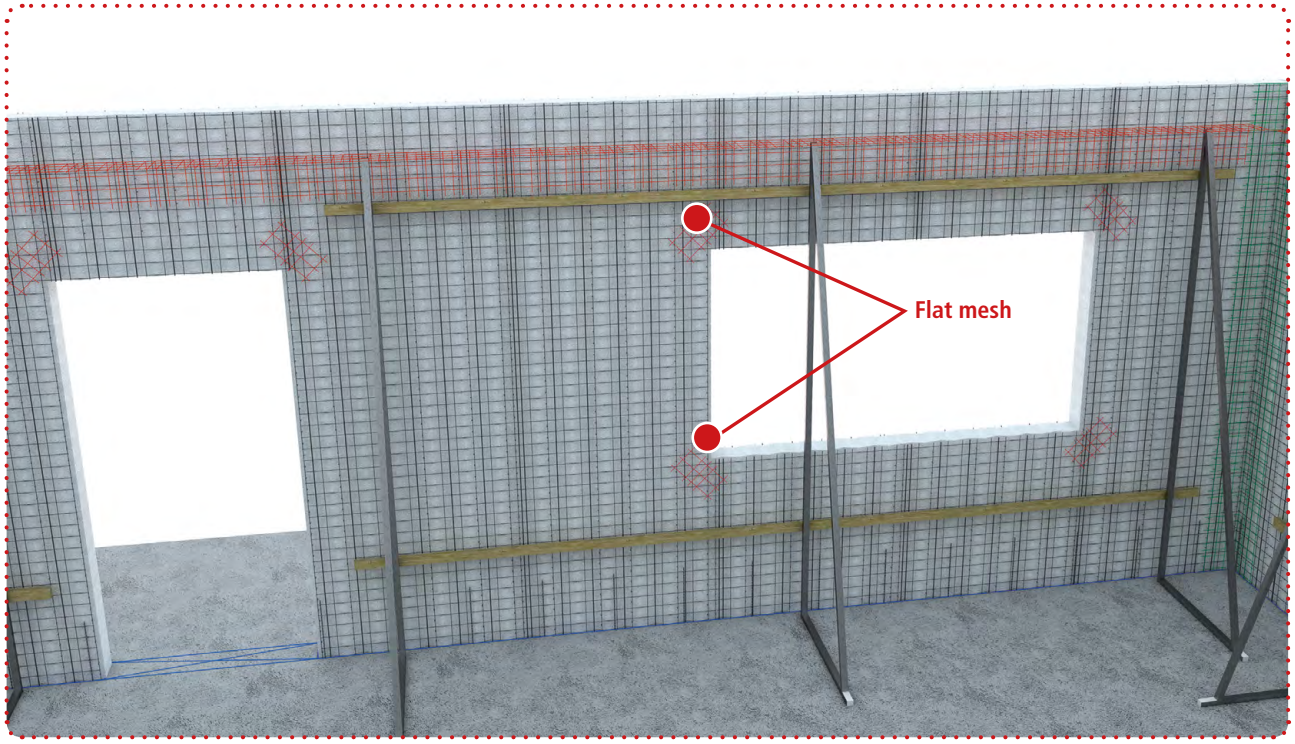
7

Placement of flat meshes

At the vertices of each holes, pieces of steel mesh are placed at 45° of 29 cm in length (1/4 MP flat mesh). These reinforcements will be attached to the panel using staples or wire knots **(7a)**.

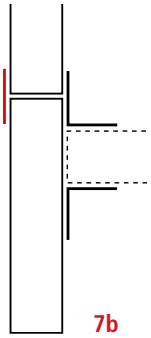


7a



7a

The placement of continuity meshes between vertical panels are normally located between changing façade floors, should be taken into account **(7b)**.



7b

Care must be taken that there is no overlap of more than two meshes over the original panel mesh for an adequate coating of the reinforcements and the concrete layer.

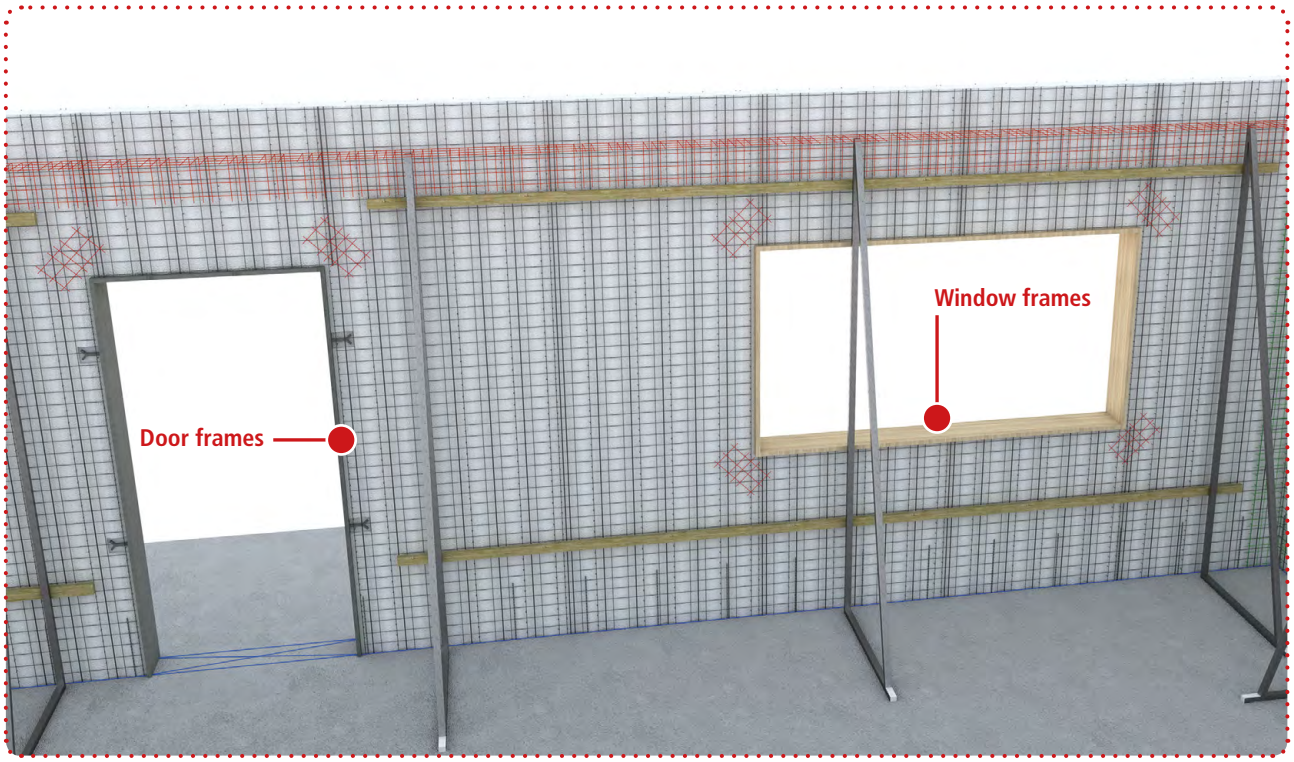
8

Placement of pre-frames

Prior to the placement of the subframes in the window and exterior door openings, a galvanized electrowelded mesh (13 x 13 x 0.9 mm or similar) or triple twisted mesh shall be placed protecting the edges of the panel. The fixing of the mesh will be done by hooks of wire nailed to the EPS on the sides of the panel.

The window frames are placed in order to prepare the holes for the concreting of the walls. It is advisable that they have a depth equal to that of the wall already concreted (EPS + 82/87 mm) so that its edges can be used to master the final layer of concrete.

Once the wall is concreted, these pre-frames are removed leaving the hole perfectly finished, ready to adjust the windows.



8a

The window can be placed directly in the hole and can be fixed preferably with polyurethane foam.

In the case of using metal pre-frames, it is recommended that they have a minimum width and thickness as possible in order to minimize the perimeter of thermal bridge they could cause.

The hollows of interior doors will have wood frames, whose claws will be fixed to the panel and then received in the concreting.

Later the doors can be screwed to it. For the entrance door, a steel pre-frame should be used with the thickness appropriate to the weight of the door and the anchors that will be received when the wall is concreted.

It is convenient that the depth of these inner pre-frames is also thde same as the thickness of the finished concreted panel (eps + 82 mm) so that its edges are used for screeding.

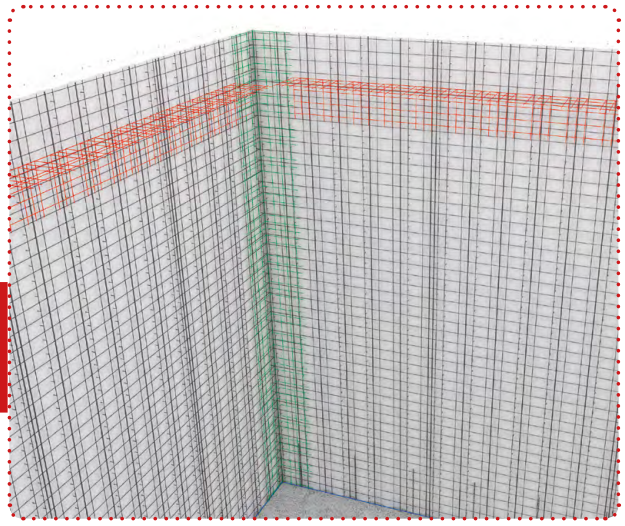
9

Placement of angular meshes for slabs

Once all the gaps in doors and windows have been made, the angular meshes should be placed in order to support the horizontal slab panels. These meshes will be interrupted in the vertical edges to avoid overlapping layers of reinforcement.

The angular meshes of the vertical edges are continuous and should not be interrupted.

It is very important that the angular meshes do not overlap; they will be placed one after the other.

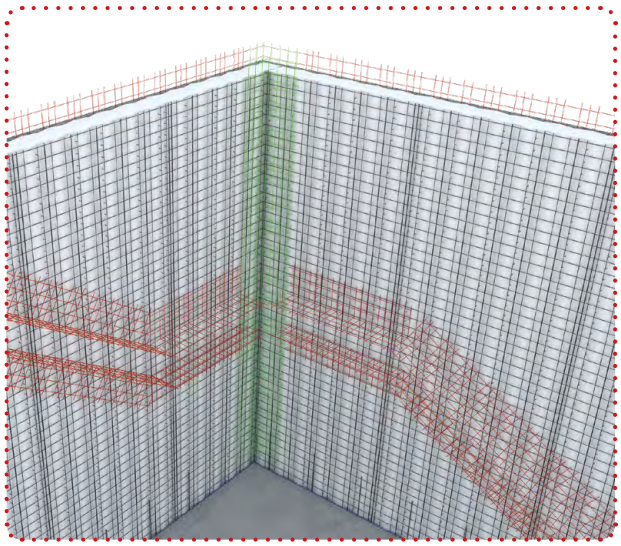


9

10

Placement of angular meshes for staircases

Also in this stage, the stake out of the staircases and landings attached to walls must be carried out; the angular meshes that allow the union of the lower and upper face of these elements to the walls will be placed, which will be explained later in point 21.

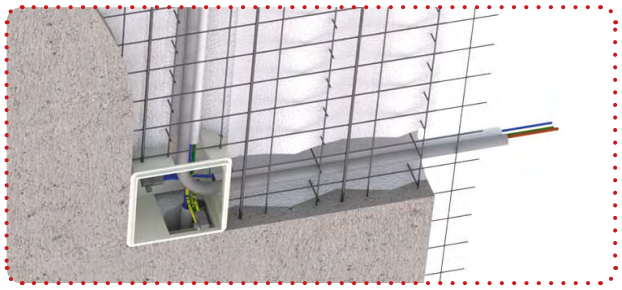


10

11

Pre-installations of electricity and plumbing

The pre-installation of the electricity and plumbing pipes will be carried out by using a hot air gun with which the channel will be made, depressing the polystyrene in the path of each pipe. The flexible pipes will pass behind the steel mesh of the panels. The rigid pipes, as well as the distribution boxes and mechanisms will be placed by cutting the steel mesh; after they are located, the reinforcement will be restored with pieces of flat steel mesh.



11

Concrete Application Phases

Recommendations of Baupanel® System*

12

Screed lines placement for concrete projection

The thickness of the first layer of concrete in walls will be 20 mm on the crest of the polystyrene, guaranteed with wood, PVC or metal screed lines, which can be attached to the crossbars of the steel meshes of the panels. It is essential that these screed lines can be removed simultaneously when applying the second layer of concrete, in such a way that the gap they leave is filled out in the same operation.

12a

You can use floating screed lines nailed to the EPS and separated from the crest of the panel by nails or rounds of 6 mm, welded to the lines every 50 cm **(12a/b)**.

12b

The screed lines will be arranged with a thickness of 25 mm. In the case of the exterior face of façade walls with less proximity to 5 km coastline, 30 mm masters will be available.

The screed lines will lay over the mesh of the panel, avoiding to lay over or overlap any flat or angular meshes attached to the panel mesh.

If it is decided to create screed lines with the same projection material, it is recommended that they are executed after the projection of the first layer. It is important to use an adhesion bridge between the master material and the layer to be applied to avoid micro cracks.

It is convenient to use a 160g fiberglass mesh for an anti-retraction reinforcement effect, in the last applied concrete layer, placed as superficial as possible. In case of application of a thin finishing coating layer on the concrete, you can place the fiberglass mesh in that same layer.

13

Preparation of concrete

Once the operations described have been carried out, concrete is put into operation, for which the EHE and the provisions of UNE-EN 14487-2:2008 or equivalent standard in force will be taken into account.

Concreting may be carried out by pneumatic projection or by pouring using a formwork system.

Concrete made "in situ", from a concrete plant or alternatively bagged products from industrial plants, can be used.

In the case of concrete manufactured "in situ" or from the plant, it is recommended to use pneumatic projection machines with a piston pump system such as Turbosol Mini Avant UNI 30 or Putzmeister P-13. Some pumping machines will only work with bag granules smaller than 4mm.

When using industrial bagging, it will be of great importance to respect the mixing water indicated by the manufacturer. For this, the calibration of the projection machine will be carried out, prior to the start of the projection phase. The calibration consists in calculating the equivalent in water flow, expressed in litres/hour, of the percentage value by weight, indicated by the manufacturer of the industrial bagging. The flowmeters of the projection machines have graduated tubes in liters/hour **(13)**.

All the concretes applied in the **Baupanel® System** must be authorized by the Technical Department prior to their use.

13

14

Concrete application - first layer

On one side

The projection of the concrete will begin on the free and clear faces of the panel, which are the opposite to where the elements of plumb and alignment are located.

The pneumatic projection will always be done in two layers that add from the crest of the wave 30 mm thickness.

In case the work is less than 5 km from the maritime coast, the outer face of the walls will be 35 mm thick from the crest of the panel (5 mm more than the normal case).

Considering that the depth of the wave is 22 mm in the panels of the BSR series, the resulting average thickness of the concrete layer will be 41 mm per wall face **(14a)**.

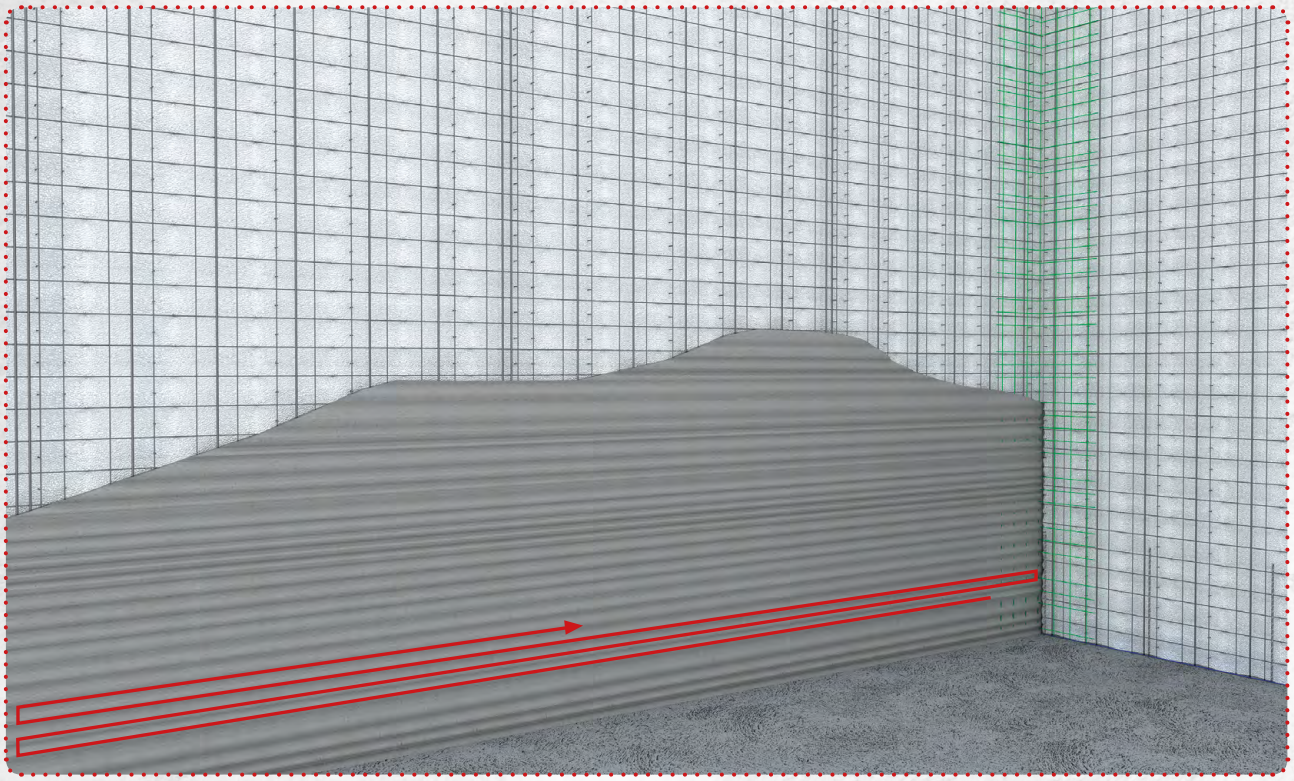
14a

In the case of the outer face of façade walls with less proximity to the 5 km coastline, the average thickness resulting from the outer concrete layer will be 46 mm.

*** The phases with instructions for the projection of concrete are only recommendations of Baupanel® for an optimal result.**

The first layer of projected concrete will have a minimum average thickness of approximately 30 mm and will cover practically all the steel mesh of the panel; Subsequently the second remaining layer will be given until reaching the recommended final thickness. In case of a poor assembly it would be necessary to increase the thickness of the concrete to values higher than 40 mm on the crest of the panel. In this case it would be necessary to have an additional skin armor (galvanized electrowelded mesh).

The first layer will be applied in the form of successive horizontal strings from bottom to top starting from the base of walls. In this way, these cords will be stacked on top of each other, preventing the occurrence of disengagements **(14b)**.



14b

The maximum recommended height to give a first layer of projected concrete will be 5.00 m. With the still moldable material it will be convenient to pass a notched trowel by lightly ironing the given layer of cords, leaving it rough, but with a uniform thickness. The steel mesh of the panel should not be seen after the first layer has been given.

The importance of the reinforcement covering with the first layer of concrete is to reduce the effects of rapid and excessive drying by atmospheric actions, which would deteriorate the mechanical capacity of the material. That is why this first layer should be maintained with a generous watering depending on the prevailing climate.

15

Projecting second layer of concrete on one side

On one face

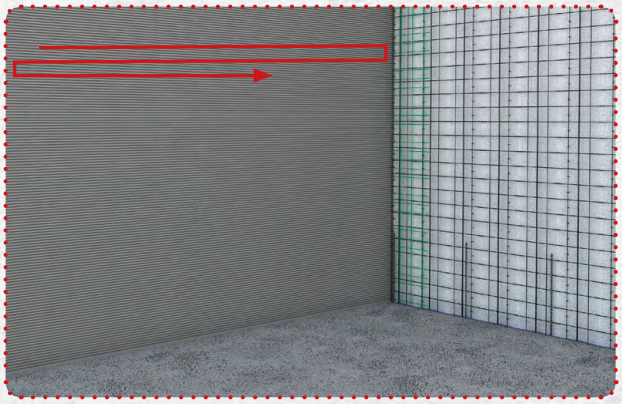
The time to pass between the first and the second layer should be the minimum possible; the second layer can be given preferably the same day or the next day. It will be enough that a couple of hours have elapsed since the first layer was applied and the concrete has partially set. If several days pass without concreting the second layer, an adhesion bridge should be used; An acrylic resin in aqueous dispersion can be used, which will be applied following the manufacturer's instructions.

Prior to the application of the second layer, the first previously projected layer must be watered.

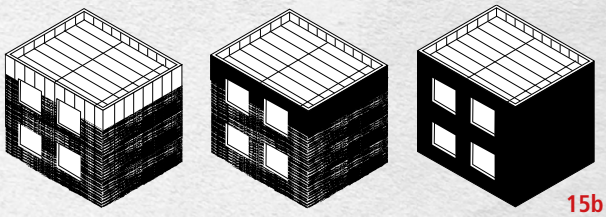
The second layer, usually 5 to 10 mm thick, will be given from top to bottom **(15a)**.

It will be convenient to reinforce the second finishing layer, with alkali resistant fiberglass mesh (Mallatex or similar of 160 g/m2). This secondary reinforcement will be mandatory to use when the total thickness measured from the crest of the wave is greater than 35 mm.

If the construction has more than one floor, the second façade layer can be left to be made once at the end of all other panel installation works **(15b)**.



15a



15b

16

Concrete aplication on opposite side

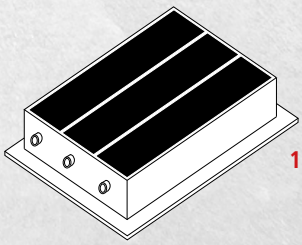
Once the concrete projection of one side has been completed, the aligned and plumbed elements placed on the opposite side can be removed and begin with the projection concrete sequence on it. The time to remove the rules and squares depends on the ambient temperature, but as a general rule, the passage of 24 to 48 hours will enough.

Once the concrete projection is completed, the watering of the walls will be assured 48 hours later and will be extended according to the climatic conditions.

17

Concrete quality control

To check the strength of the bagged concrete or carried out "in situ" prismatic samples of 40 x 40 x 160 mm must be taken, according to UNE EN 1015-11 (Method of tests for mortars). These samples will undergo bending and compression testing according to the prepared control plan.



17

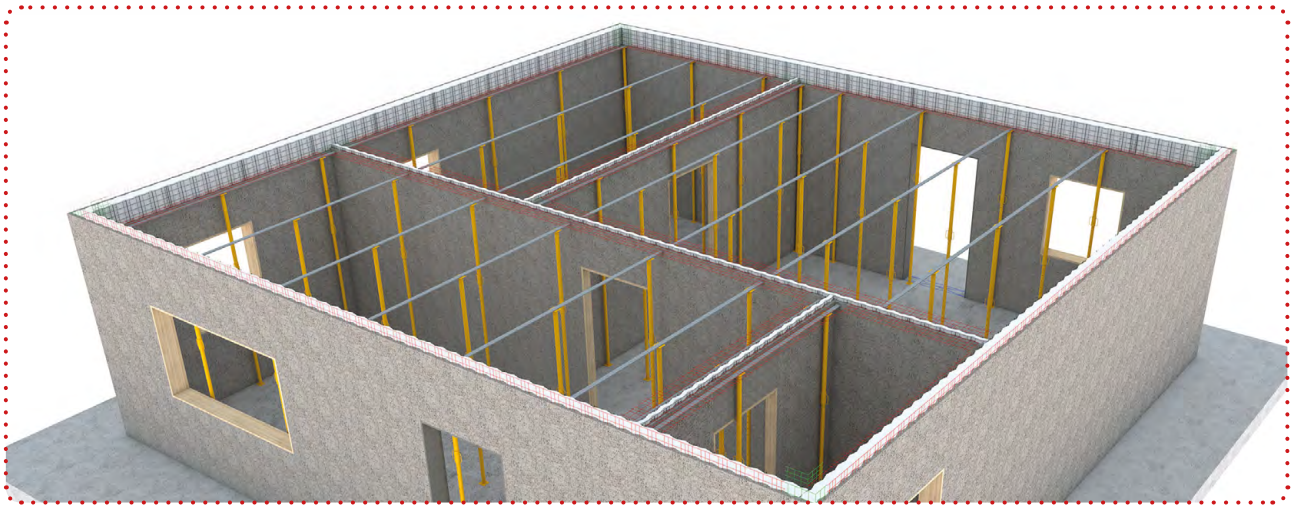
The quality control of the concrete will be governed by the provisions of the EHE or equivalent standard in force.

18

Assembly of slab panels

Placement of Girders

The assembly of the set of girders and post-shores is made either traditional or pre-armed with any system type Mecanoflex or similar **(18a)**.

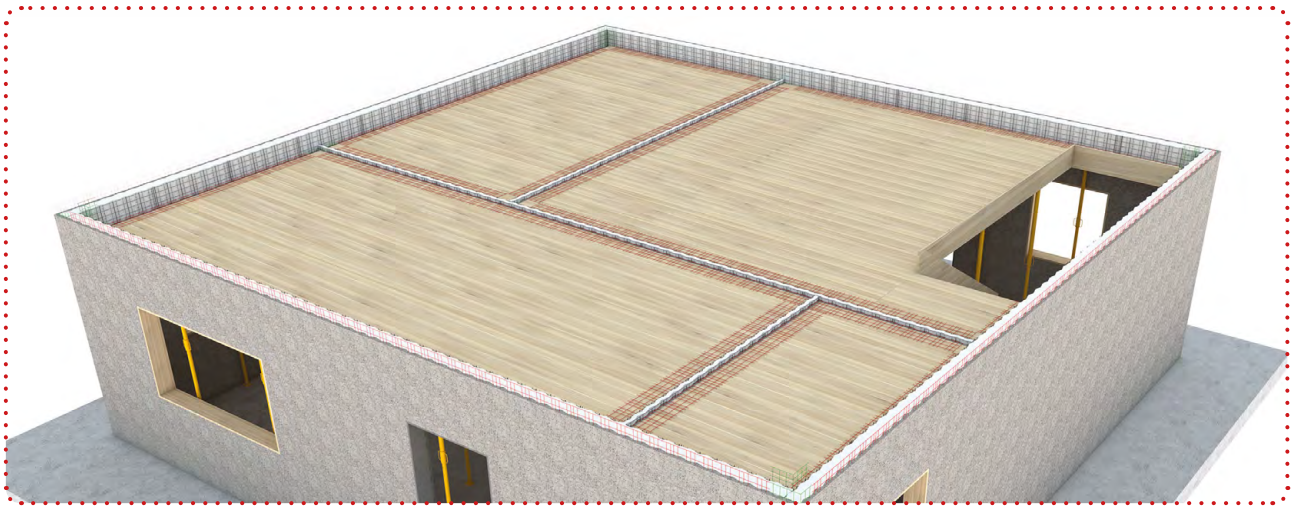


18a

Placement of formwork

Then the formwork with shuttering boards or phenolic boards will be placed according to need and it will proceed to its cleaning and application of formwork removing products.

The level of placement of the formwork will be considering the 30 mm of concrete cover under the panel, placing the formwork panels always below the angular mesh of the floor **(18b)**.

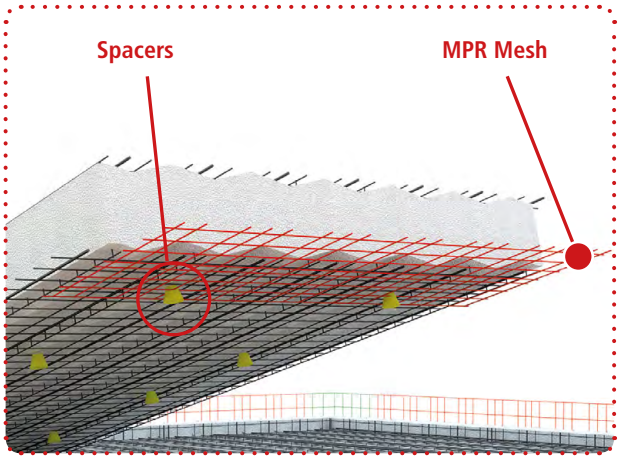


18b

Panel preparation for formwork

The slab panels will be prepared by placing armature spacers of 25 mm in height at each of them at a rate of 3 to 4 per m2 on one side.

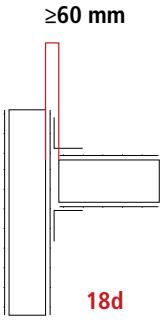
On the floor panels, a flat MPR mesh (mesh with corrugated reinforcement similar to that of the panel) will be placed on both sides to establish continuity between the plates in the longitudinal direction **(18c)**.



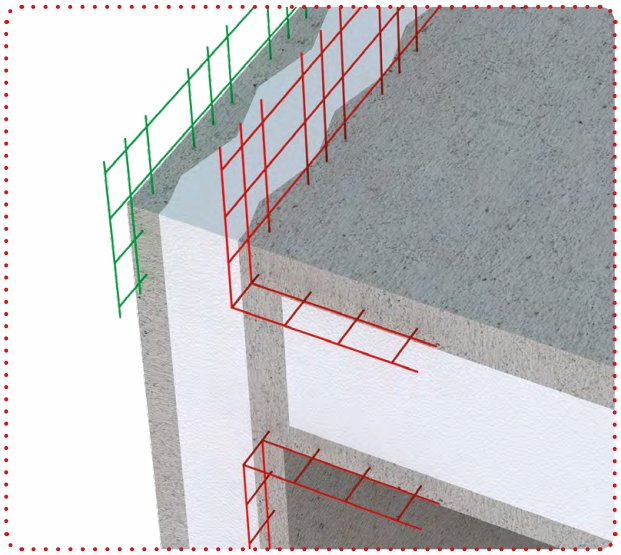
18c

The joining of panels in the transverse direction is done with the panel's own overlap mesh. In case of absence of overlap mesh by panel cut, MP flat mesh will be placed in the transversal direction to give lateral continuity to the panel.

It is very important to remember that in the case that the building has more than one height, a space of at least 60 mm must be left between the panels of the floor and the wall, in order to give continuity to the concrete face, floor to floor **(18d/e)**.

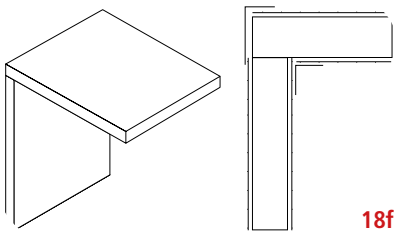


18d



18e

This should not be done on the deck floor to avoid the thermal bridge. Where wall and floor joints are butted **(18f)**.



18f

The stripping of metal bands and beams in slabs should be carried out prior to the pouring of the lower layer and placement of the slab panels in case the slab panels have reinforcement.

Concreting of Floors and Roof Phases

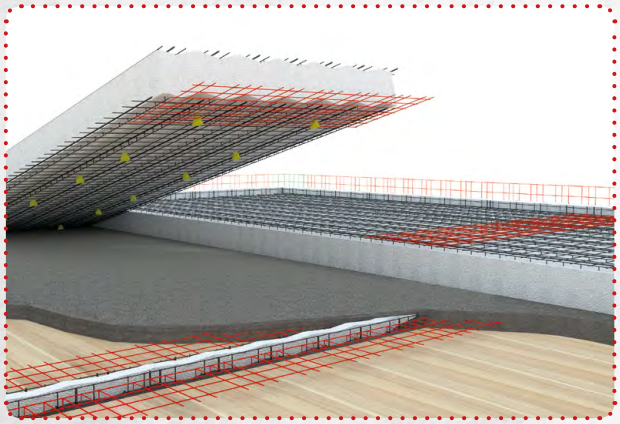
Recommendations of Baupanel® System*

19

Lower concrete pouring and laying of slab panels

Next, a thick layer of 50 mm thick concrete is poured over the formwork, simultaneously with the laying of the panels, previously prepared with their separators and flat mesh (MP or MPR).

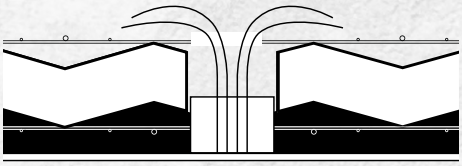
The panels should be submerged in the fresh concrete until they rest on their spacers **(19a)**. The procedure of placing the panel on the fresh concrete should be careful to favor the immersion of the panel in the concrete and fill the lower holes.



19a

The maximum size of the concrete aggregate for the lower layer of the slabs must not be greater than 12 mm.

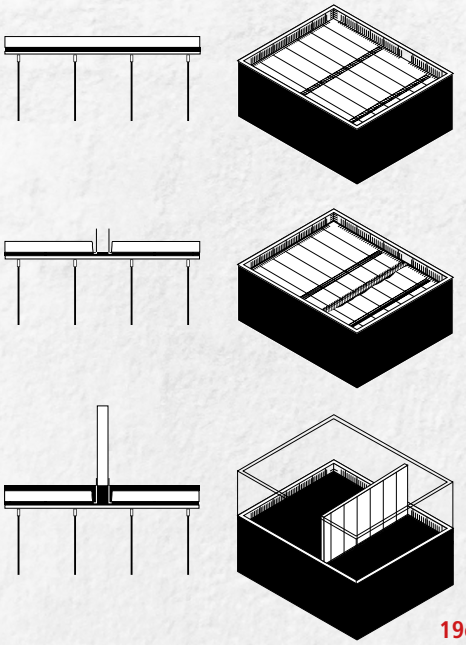
In the event that there is no false ceiling, in this stage will be placed mechanism boxes with a lid, round type for "pladur" in all the necessary light points **(19b)**.



19b

Important note: Before pouring the compression layer, it should be verified that none of the walls of the next floor acts as beams from which the slab that is being mounted hangs. In this case, prior to the discharge, the reinforcements corresponding to the construction detail between these elements must be placed, according to the requirements of each project.

Prior to the concreting of the upper layer, beams should be installed, as well as the stripping of continuity walls and any reinforcement elements established in the project **(19c)**.



19c

Important: When a slab hangs from a wall on the top floor, the shoring should be maintained until those upper walls have been completed and are of age to receive loads.

Concrete pouring in compression layer

Then proceed to the pouring of the compression layer with an average thickness of 61 mm **(19d)**. In case of use of BSF 330 panel, an average thickness of 71 mm will be applied.

Removal of formwork

In general, the stripping can be carried out at the completion of 2 weeks from concreting, leaving some struts with a separation of no more than 2 meters until the age of 3 weeks in which it will be possible to proceed with the removal of all shoring, except for specific needs of each work. The shuttering panels can be removed after 2-3 days from the pouring of the lower layer without undoing the slab.

The formwork removal times will be governed according to what is established in the EHE or equivalent standard in force.

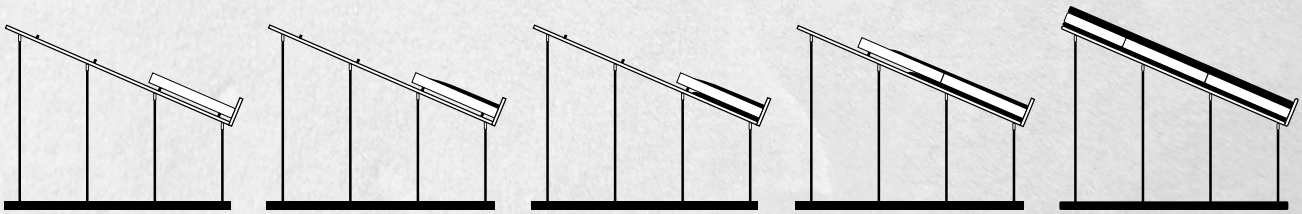
19d

20

Sloped slabs

In case of inclined slabs, the panels are prepared in the same way as indicated for horizontal slabs as well as the formwork, inclined according to the project with its corresponding girders and post-shores. The assembly is started from the lowest point placing the first row of panels resting directly on the formwork on their spacers. Next, the filling of the lower hollow will be done also giving a light load on the upper face to give stability and prevent the panels from rising.

Continue with the next ascending row with the same procedure until the inclined floor is completed. It will only be necessary to complete the thickness of the compression layer.



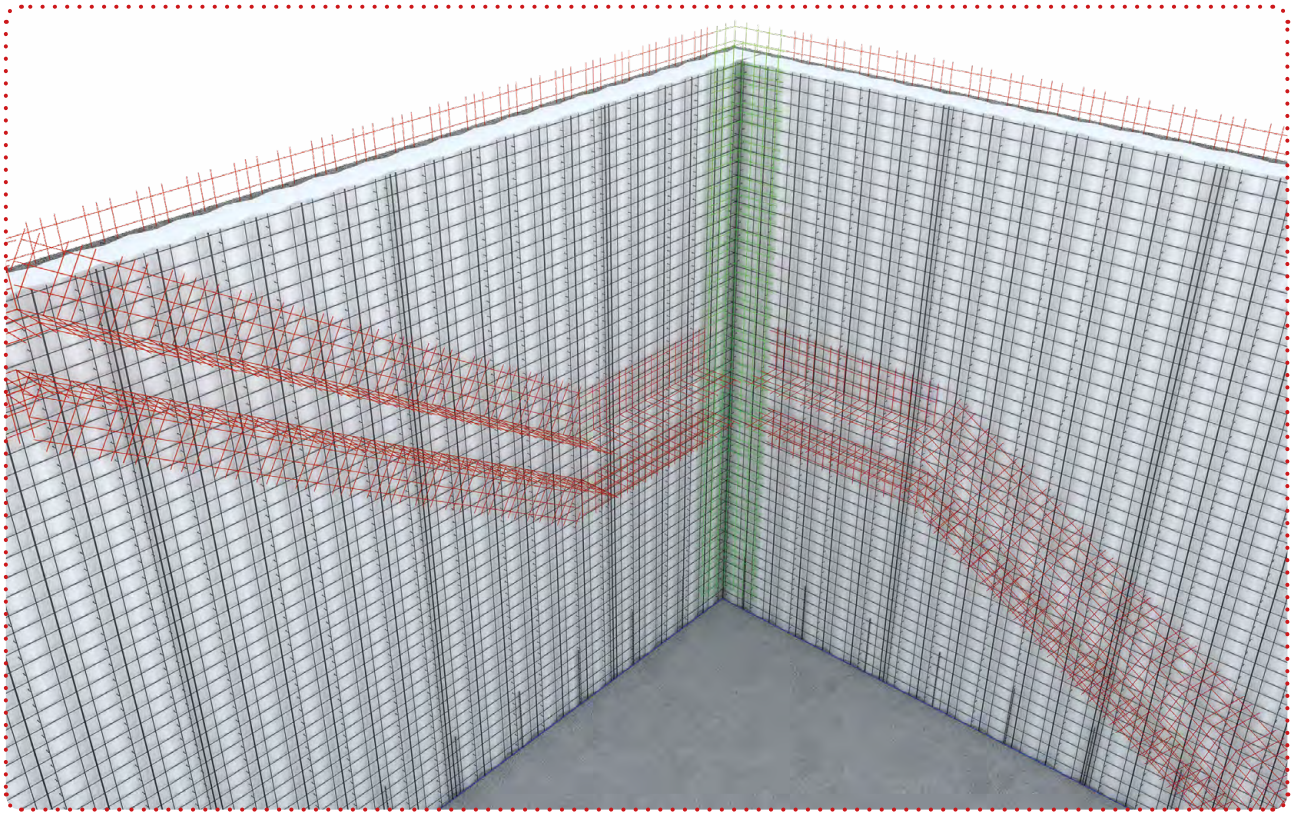
20

*** The phases with instructions for the projection of concrete are only recommendations of Baupanel® for an optimal result.**

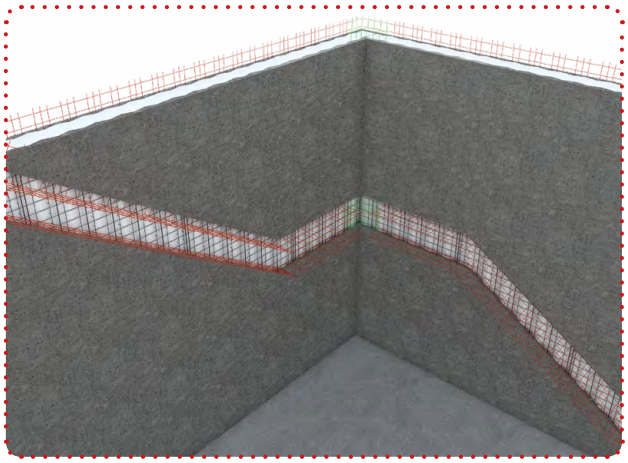
21

Placement of staircases

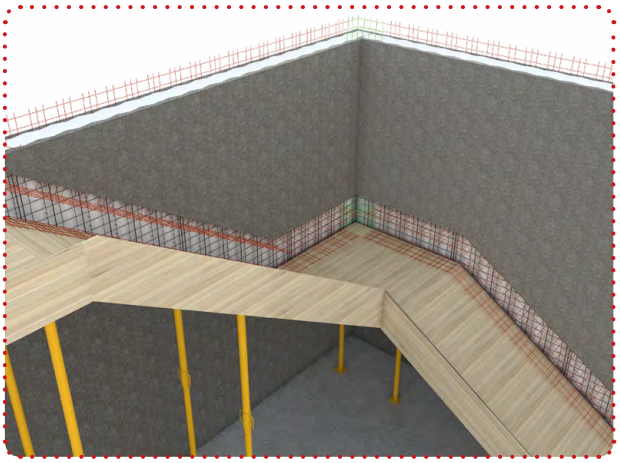
The whole process of the assembly of the stairway will be the same as that of the inclined slabs. Once all the staircase are concreted, the tread will proceed in the traditional way with bricks or mortar.



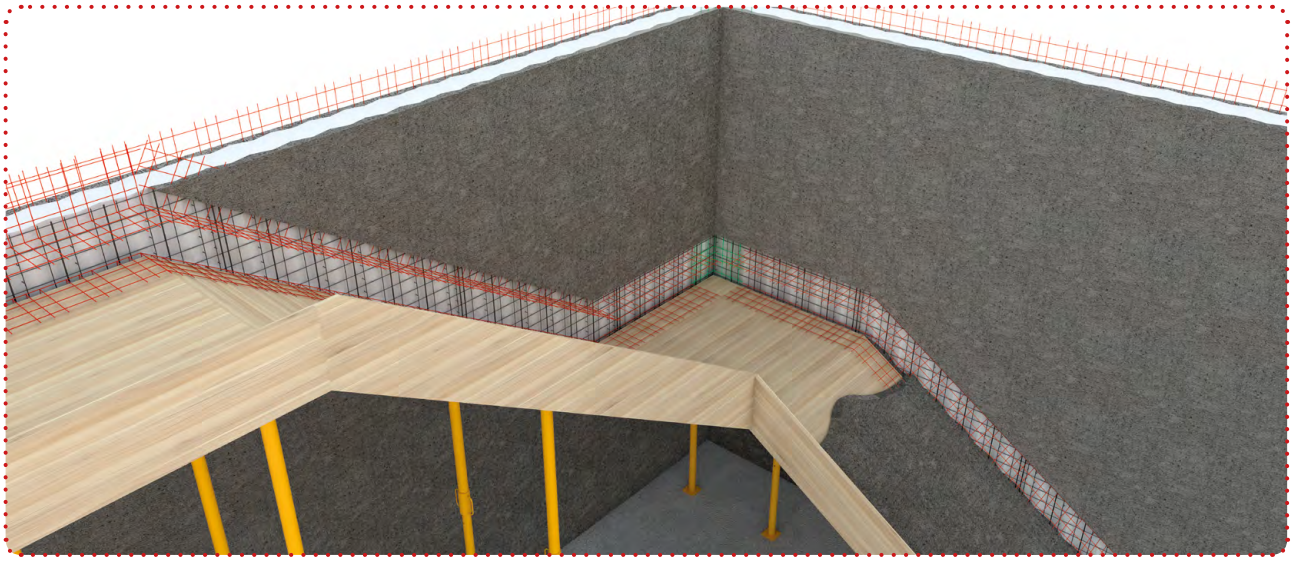
Layout



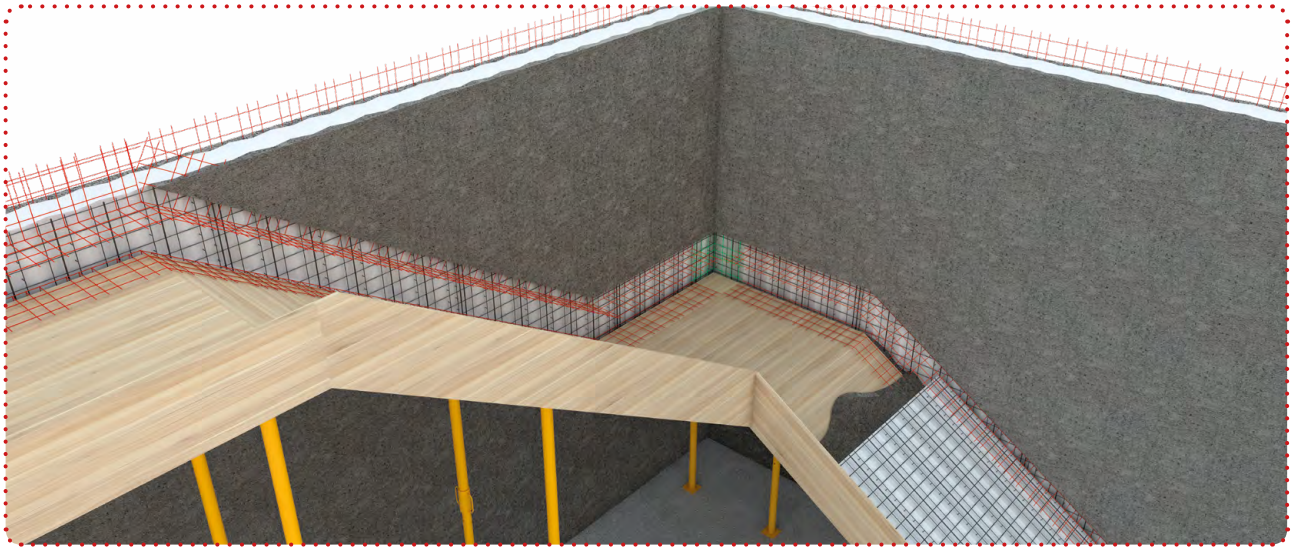
Internal wall concreting



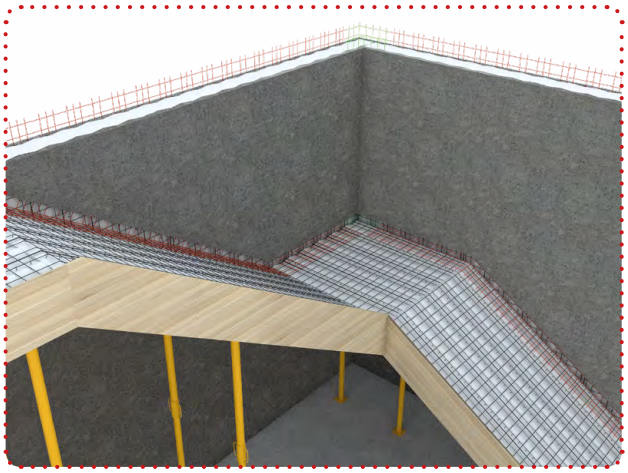
Formwork



Lower concrete pouring on formwork



Start of assembly of panels



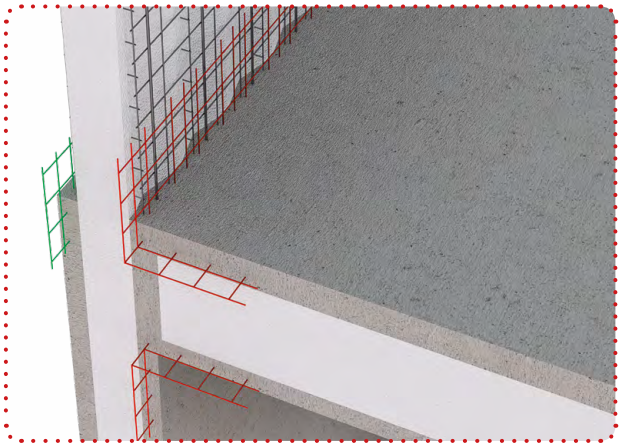
Assembly of panels

Compression layer

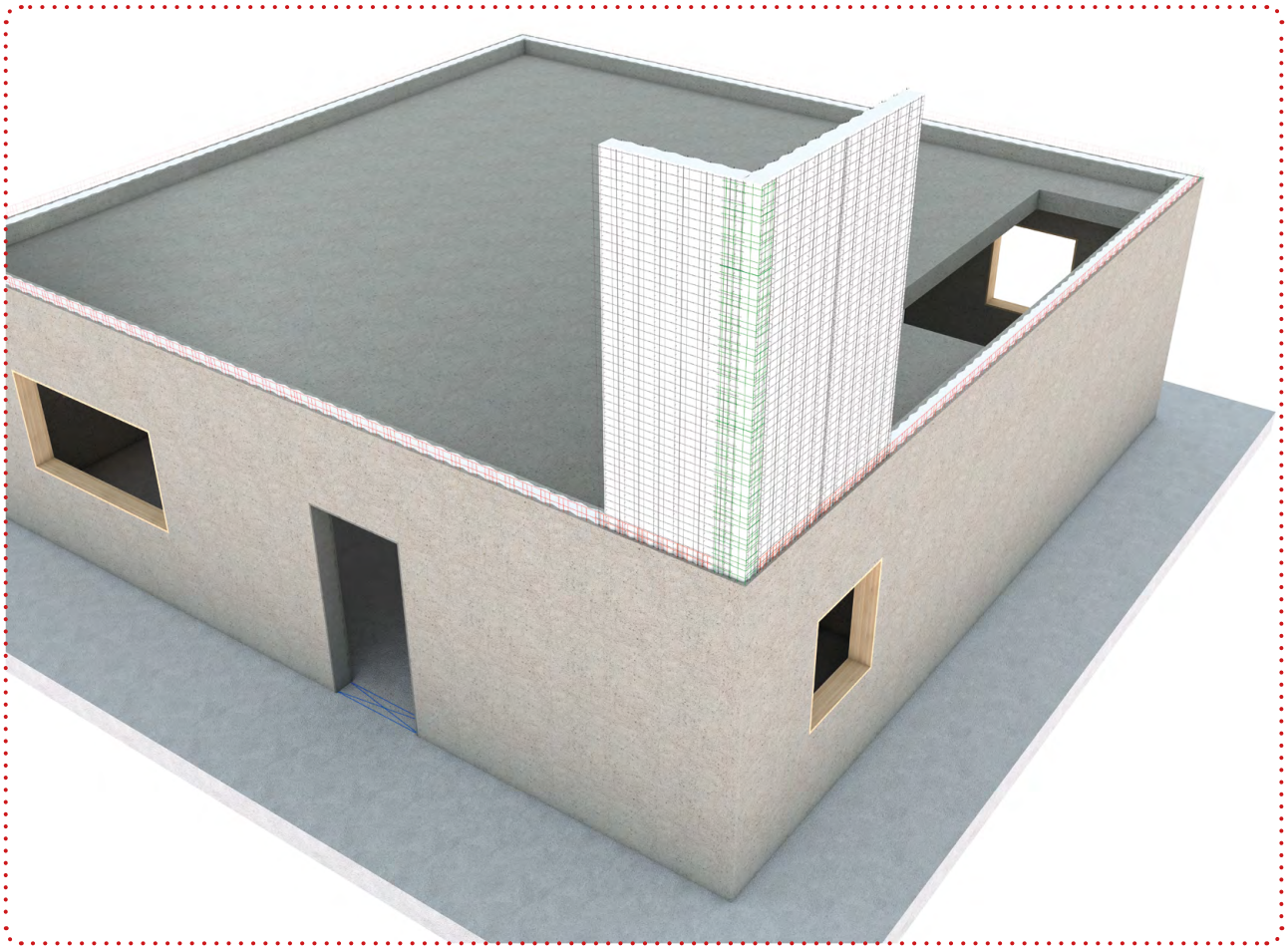
22

Placing of panels next floor

It is now when the building is ready to continue growing in height, placing the vertical and horizontal panels of the next floor following a process analogous to the one contemplated below **(22a/b)**.



22a



22b

The installation company will adopt all the necessary provisions related to the stability of the constructions during the assembly, to the risks of falling of suspended loads, of protection of people and, in general, the dispositions contained in the current regulations of Security will be taken into account and Health at Work, as well as what is specified in the Health and Safety Plan of the work.

23

Placement of panels for party walls

The vertical dividing panels will be arranged in a horizontal position, forming rows and supporting them.

The pouring of the concrete by the backing of the dividing walls will be done with fluid consistency to guarantee the penetration and will not exceed 30 cm in height per ply to avoid damaging the adjoining dividing partitions **(23a/b)**.

Prior to the placement of the panels, a polyethylene or polystyrene sheet must be placed, as appropriate, on the entire common surface of the dividing wall, guaranteeing separation with the dividing building.

It is recommended between the first and second layer to be left for a while (10 min.) So that the concrete of the previous layer has consistency, thus reducing the loads of thrust on the panel and dividing.

The dividing wall must be sufficiently propped up (as shown in the photo) to support the thrust of fresh concrete.

23a

The panels can be assembled sequentially confirm the pouring of the concrete.

23b

Speed and lightness

Lightness

Ease of transport and installation. The weight per m^2 of panel before the application of the concrete depends on the type of panel, and ranges between 3.5 kg/m^2 & 5 kg/m^2. This makes it possible for only one operator to easily move more than $3m^2$ of panel.

Fast Installation

The reduction of the execution time of a work compared to other construction methods can be up to 50%.

Comparison of Baupanel® wall and traditional wall:

	Baupanel® System	Traditional Wall
Thickness	22 cm	31 cm
Thermal Transmittance (U)	0,26 W/m^2 K	0,58 W/m^2 K

Isolation and resistance

Thermal isolation

The U value of the total thermal transmittance of **Baupanel® System** composed of 4 cm thick EPS core with a density of 15 kg/m^3 plus a 41 mm thick concrete layer on both sides (total thickness 12 cm) is 0.77 W / m^2K. If the wall were made with an EPS core 8 cm thick (density 15 kg / m3), the thermal transmittance U would be 0.42 W / m^2K. These levels of thermal insulation are much higher than those of traditional building enclosures. This translates into an energy savings of almost 40%, both for heating and cooling cycles.

Structural resistance

The laboratory tests carried out at the **Eduardo Torroja Institute** in Spain, as well as others carried out internationally, have demonstrated the great structural capacity of **Baupanel® System**.

The loads in buildings are normally distributed through linear elements (beam-pillar frames), while with **Baupanel®** the load is distributed over the surface of all the elements of the structure generating much lower voltages.

Seismic resistance

The latest laboratory tests carried out at the **Eduardo Torroja Institute** (2017-2018) have demonstrated the ability to withstand a vertical force equivalent to a 10-storey building combined with the horizontal actions of an earthquake of magnitude> 10 on the scale of Richter, exceeding by more than 5 times the maximum seismic acceleration of Spanish regulations.

Fire resistance

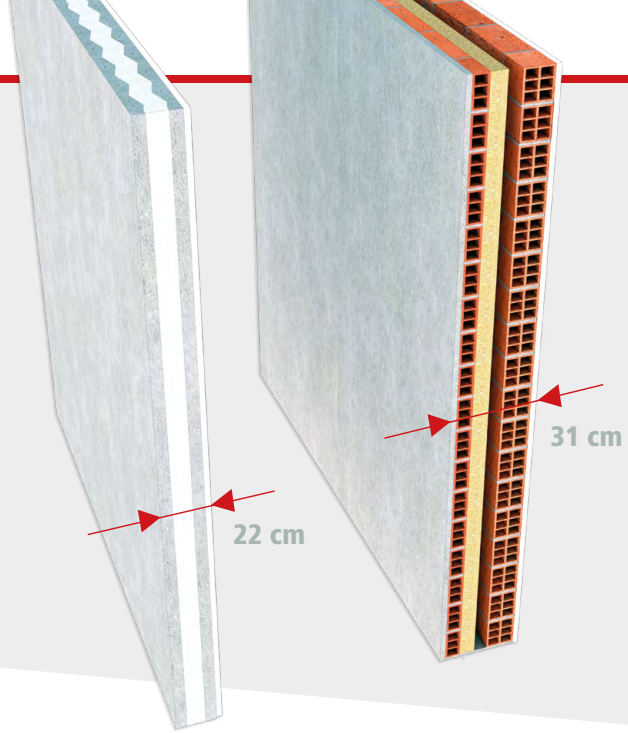
The EPS used in the **Baupanel® System** is the Euroclass E type (self-extinguishing, which prevents the spread of flames). The tests of fire resistance carried out, for example in panels with an 8 cm core, have given values of over 120 minutes, maintaining tightness to flames, smoke and gases, maintaining complete integrity.

Energy saving and respect for the environment

Currently the construction sector is responsible for the consumption of 40% of the energy produced worldwide

In addition, 25% of the waste generated in the world corresponds to the construction industry.

However, Baupanel® System has as its main component expanded polystyrene (EPS), an efficient, effective thermal insulation material that plays an important role in reducing CO2 emissions to the



Greater living surface

Greater profitability in the sale by M2

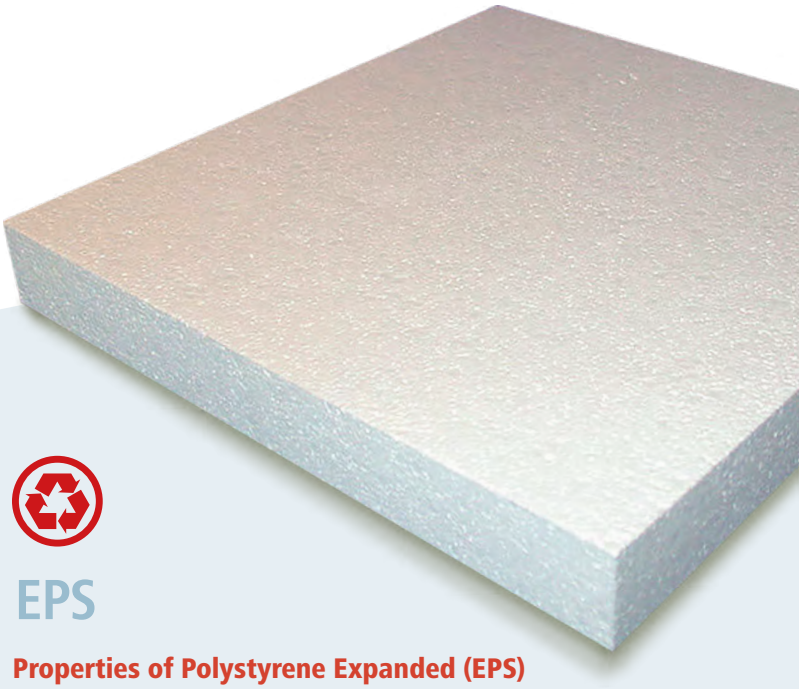
The increase in the living area of any house built with **Baupanel® System** with respect to a traditional one is also of great importance. With equal total built surface, with **Baupanel®** you can increase the useful living area up to 5%. This is because the traditional walls are thicker than the **Baupanel®** walls. It is noteworthy that **Baupanel®** is the only construction system with which single-sheet facades are obtained that meet the most demanding functional requirements of national and international regulations.

Acoustic isolation

A single panel with a 41 mm layer of concrete on each side provides acoustic insulation of up to 40.7 dB (A) depending on the thickness of the panel. When higher values are required, we use our **Bau-CUSTiC®** panel, which allows us to exceed 61 dB (A).

Hurricane resistant

Baupanel® System buildings located in areas with high hurricane risk have demonstrated a great capacity to withstand the most devastating winds, such as Category 5 hurricanes.



atmosphere, making a very positive contribution to the decrease in global warming.

In the production of the EPS CFCs or HCFCs are not used as foaming agents, so that their manufacture does not cause any damage to the ozone layer.

Throughout the lifetime of the building made with Baupanel® System, its external energy input needs are drastically reduced, resulting in a lower consumption of fossil fuels, which in turn leads to a lower emission of CO2 into the atmosphere .

For the purposes of the Energy Certification of Buildings, which is a requirement derived from Directive 2002/91/EC, and from Directive 2010/31/EU, Baupanel® System is an efficient construction system that allows to achieve the highest energy rating [Class A] at an affordable price. This is due to its enormous thermal insulation, which is an added value for both promoters and end users of buildings that will see their energy consumption bills for air conditioning reduced.

EPS

Properties of Polystyrene Expanded (EPS)

Expanded polystyrene is a biologically inert material, non-toxic and stable.

It does not contribute to the formation of methane gas or contribute any other type of greenhouse effect gases. In addition, their waste does not pose any risk of contamination to groundwater.

The expanded polystyrene is 100% RECYCLABLE. During the production of the Baupanel® panels, virtually no EPS waste is produced since the few wastes resulting from block cutting are recycled directly in the same production plant.

The expanded polystyrene used for Baupanel® panels is Class III, self-extinguishing type E that does not spread flames.