



## ***Construction Applied to Heritage***



Erasmus+

# Construction Applied to Heritage

3 ECTS

SH

Sustainable Heritage

EC

Elective Courses



## Construction Applied to Heritage

SH

Sustainable Heritage

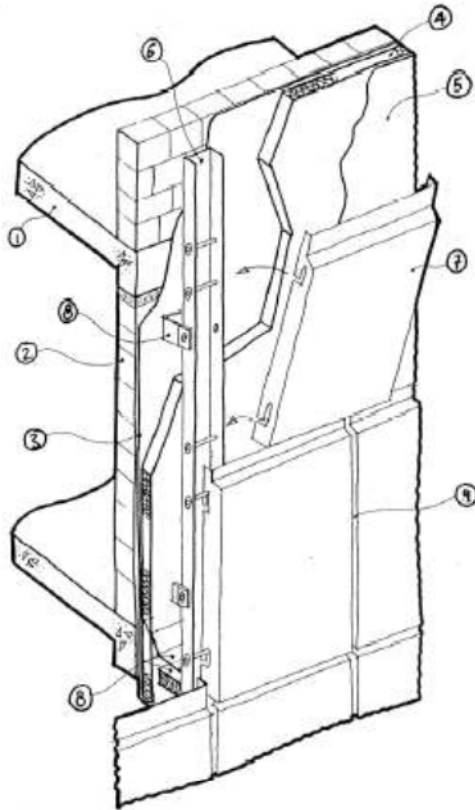
EC

Elective Courses

1. Foundations.
2. Retaining Works.
3. Drainage and Sewerage Systems.
4. The Porous Loadbearing System.
5. The Porous Loadbearing System. Walls.
6. The Porous Loadbearing System. Grid Structures.
7. The Compact Loadbearing System.
8. The Porous and Mixed Horizontal Loadbearing System. Slabs.
9. The Porous and Mixed Horizontal Loadbearing System. Grid slabs.
10. Roofs.
11. Sloping Roofs.
12. Flat Roofs.
- 13. Façades. Porous System. Ventilated Façades.**
14. Façades. The Compact System. Curtain Walls.
15. The Internal Partitioning Layout. Construction Process.

# Construction Applied to Heritage

3 ECTS



## 13 FAÇADES. POROUS SYSTEM. VENTILATED FAÇADES

- Panels system with open joints.
- The performance of the ventilated facade.
- Stone cladding and anchorages.
- Lightweight ceramic facades.
- The execution of the openings. The corners. The upper and lower finishes. The delimitation of the openings.

## FUNCTIONS

PROTECTION

RELATIONSHIPS

## LIVABILITY

COMFORT:

HUMIDITY

TEMPERATURE

BRIGHTNESS

NOISE

SECURITY in the face of:

MECHANICAL ACTIONS:

WIND

RAIN

BLOWS

PHYSICAL ACTIONS: WATER

HIGROTHERMAL CHANGES

CHEMICAL ACTIONS: LIVING ORGANISMS

POLLUTION

FIRE

# EXTERNAL AGENTS RELATED TO FAÇADES

WATER (LIQUID, SOLID, GAS)

THE SUN:

- DAY LIGHT
- HEAT (infrared radiation)
  - DILATATION
  - DESICCATION

CHEMICAL EFFECTS (ultraviolet radiation)

WIND (DIRECTION, SPEED, DURATION)

- DINAMIC PRESSURE
- TEMPERATURE VARIATION
- INNER VENTILATION
- PHYSICAL EFFECTS

ANIMALS AND PLANTS

PEOPLE (NOISE, POLLUTION)

FIRE

SIMPLE WALLS.

**DOUBLE WALLS:**

- WITH INSERTED OUTER LEAF
- WITH THROUGH OUTER LEAF
- WITH HANGING OUTER LEAF

## FAÇADES TYPOLOGY

### **HEAVY FAÇADES. POROUS**

- Simple walls.
- Double walls.
- Double walls with inserted outer leaf.
- Double walls with through outer leaf.
- Double walls with hanging outer leaf.

### **LIGHTWEIGHT FAÇADES.**

#### **- VENTILATED FAÇADE**

A.- Open joint panels system.

#### **POROUS**

- Stone cladding.
- Ceramic cladding.
- Wooden lightweight cladding.
- Concrete.

**COMPACT** - Metallic panels.

#### **- CURTAIN WALLS. COMPACT SYSTEM:**

B.- Studs and transoms system.

C.- Modular façade system.

D.- Structural glass system.

#### **- COMPLEMENTARY ELEMENTS.**

Framing.

Glass.



SIMPLE WALLS.

**DOUBLE WALLS:**

- WITH INSERTED OUTER LEAF
- WITH THROUGH OUTER LEAF
- WITH HANGING OUTER LEAF



## FAÇADES TYPOLOGY

### HEAVY FAÇADES

#### DOUBLE WALLS

- The Anglo-Saxon solution of the CAVITY WALL, with interior load-bearing wall and self-supporting exterior leaf starting from below, with anchorage keys to the internal wall. It is limited to a maximum of 4 floors.
- The Spanish solution of the capuchin wall, with ceramic or metallic keys.

The solutions of non-structural walls differ according to how the support of the outer leaf of the façade on the edge of the slab is solved:

- **Inserted leaf:** Both leaves are inserted between two successive slabs.
- **Through outer leaf -heavy-:** The exterior leaf is supported by cantilever brackets projected in front of the edge of the floor slab.
- **Hanging outer leaf -light-:** the support system on the slabs is replaced by a system of anchors (hanging and retention).

SIMPLE WALLS.

**DOUBLE WALLS:**

- WITH INSERTED OUTER LEAF
- WITH THROUGH OUTER LEAF
- WITH HANGING OUTER LEAF

## FAÇADES TYPOLOGY

### HEAVY FAÇADES

#### DOUBLE WALLS WITH INSERTED OUTER LEAF

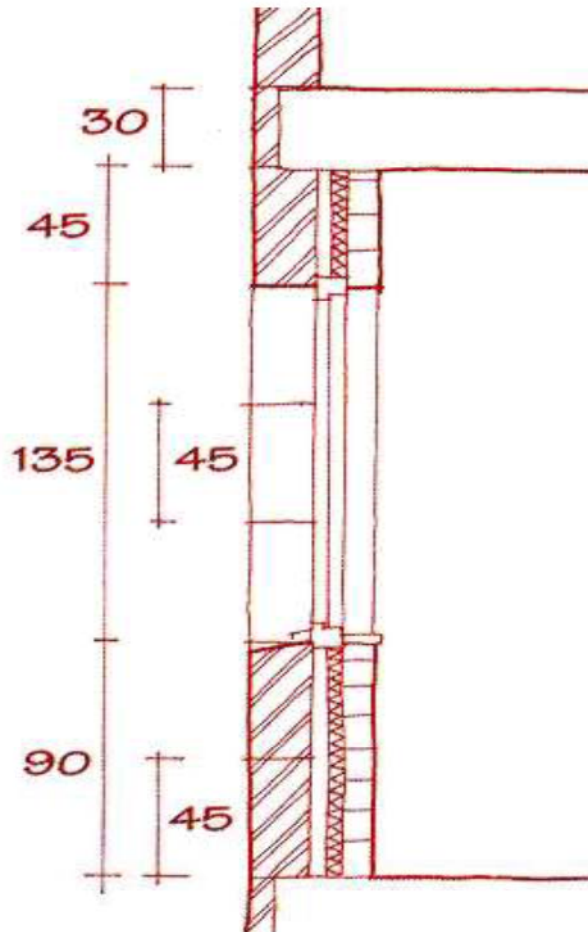
Both layers are inserted between the successive slabs.

It is the current conventional façade: heavy outer layer sheet of facing + air chamber + inner partition wall.

The outer sheet is plastered inside with cement mortar to improve the watertightness, since the humidity can reach its full thickness and reach the chamber.

The outer sheet rests directly on the edge of the slab, with a small overhang to cover the front of the slab with the same appearance as the rest of the façade. In this solution, the support always interrupts the continuity of the outer layer, the insulation and the air chamber.

It is necessary to check that in the calculation of the floor slab is limited to the deformation of the edge (either beam or strap) so that it is compatible with the rigidity of the brick wall.



SIMPLE WALLS.

**DOUBLE WALLS:**

- WITH INSERTED OUTER LEAF
- **WITH THROUGH OUTER LEAF**
- WITH HANGING OUTER LEAF

## FAÇADES TYPOLOGY

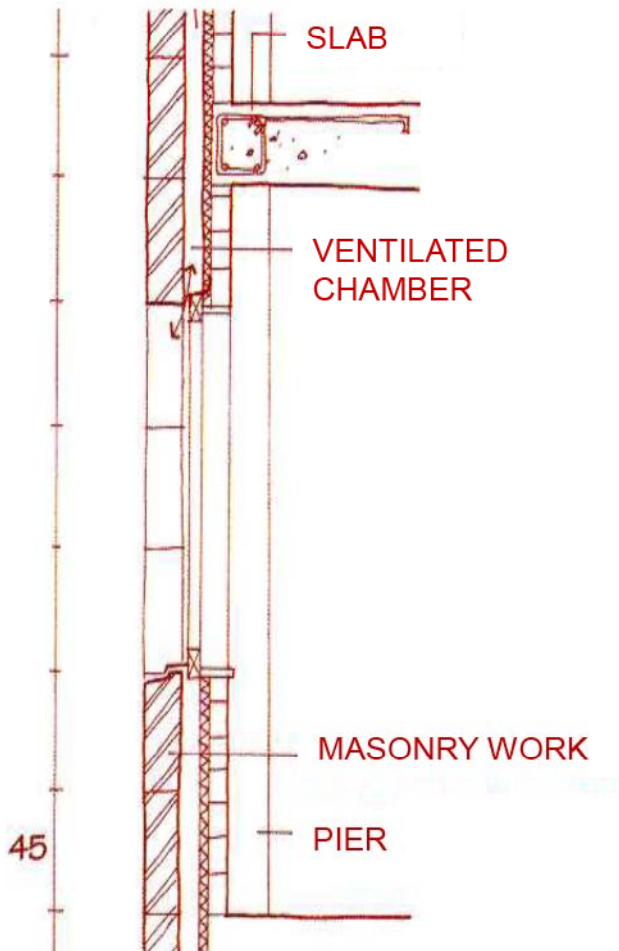
### HEAVY FAÇADES

#### DOUBLE WALLS WITH THROUGH OUTER LEAF

The outer sheet is supported by cantilever brackets in front of the slab edge. The bracket can be a L-shape metal profile, a concrete heel protruding from the slab itself or a sturdy and resistant ceramic bracket.

These brackets reduce the thermal bridging.

In this solution, only the outer layer or the insulation can pass through. The air chamber is interrupted by the supports on each slab level. In rainy climates, a solution for the bottom of the chamber must be provided (waterproof flanching and water outlet).



SIMPLE WALLS.

**DOUBLE WALLS:**

- WITH INSERTED OUTER LEAF
- WITH THROUGH OUTER LEAF
- **WITH HANGING OUTER LEAF**

## FAÇADES TYPOLOGY

### HEAVY FAÇADES

### **DOUBLE WALLS WITH HANGING OUTER LEAF**

Solutions for outer leaf hanging from the interior support:

- Concrete panels.
- Ventilated stone façade: Facade tiles with open joints, anchored to direct fixings on the internal supporting wall.
- Same, with indirect anchors to a grid studs framework that is fixed at various points to the internal supporting wall.
- Same, with a substructure of profiles fixed to the slabs edges or pier lines.

# VENTILATED FAÇADE PERFORMANCE

Ventilated façade (rain screen) **ADVANTAGES:** :

- **Semi-permeable outer leaf**, reducing the water entering the chamber.
- **Opened air chamber** from below, which allows the evacuation of water.
- The **chamber** must be **open on top** and/or laterally to allow the ventilation and evaporation of water.
- The **thermal insulation** covers the entire enclosure and eliminates thermal bridges.
- The inner leaf and the structure have little **thermal load** and therefore few expansions.
- The outer sheet has a **ventilated chamber** at the back that cools it and reduces its expansions.
- Both inner and outer leaves are **unlinked** and can move independently.

# VENTILATED FAÇADE PERFORMANCE

## EXECUTION OF A FAÇADE WITH SECTORED CHAMBER:

The confinement or sectorization of the chamber:

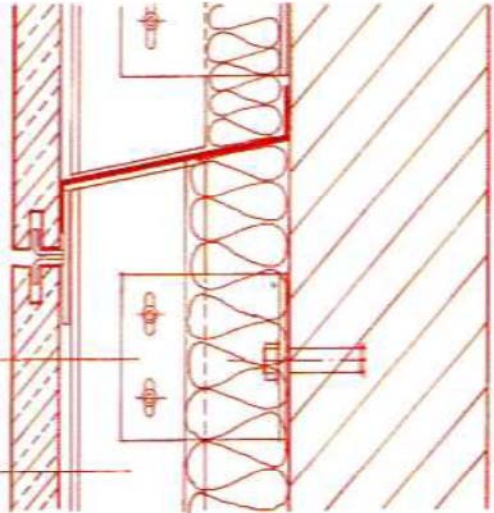
- It must be effective (without cracks that allow the air to escape and modify the internal pressure).
- It will allow the water that has entered through the joints to escape.
- It will leave a chamber between the support and the cladding to facilitate a fast drying.
- Be careful when the chamber meets the openings: avoid infiltrations.

Vertical sectoring:

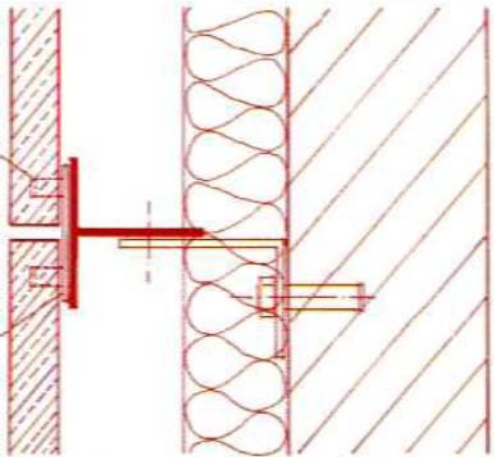
- Anchorages using stainless steel or extruded-aluminium T-shaped profiles can be used.

Horizontal sectoring:

- Z-shaped profiles can be used.



**VERTICAL SECTION**



**HORIZONTAL SECTION**



# OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM

## LIGHTWEIGHT FAÇADE:

- Self-supporting
- Light (little thickness, little weight)
- Multi-layer
- Dry-assembled
- Based on large panels or pieces.

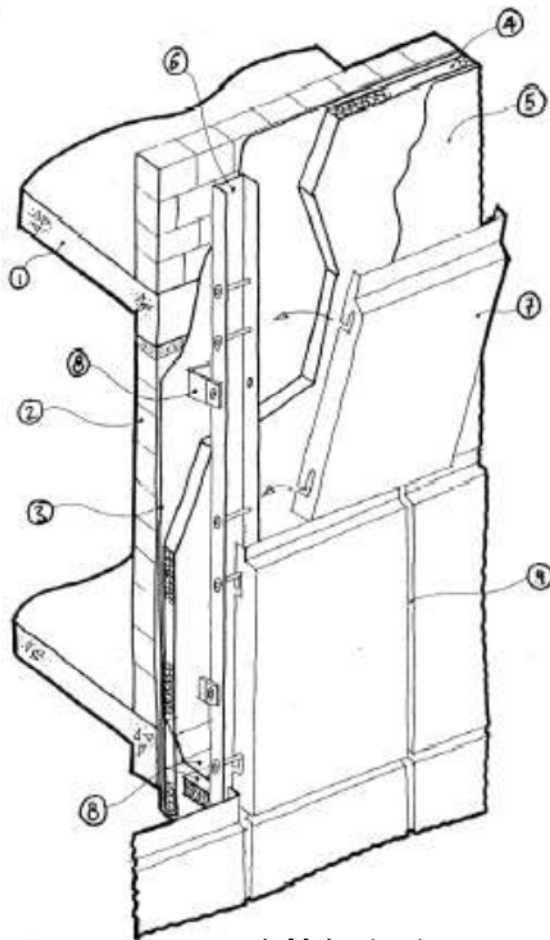
### ELEMENTS:

SUPPORT.

ANCHORAGE SYSTEM.

JOINT.

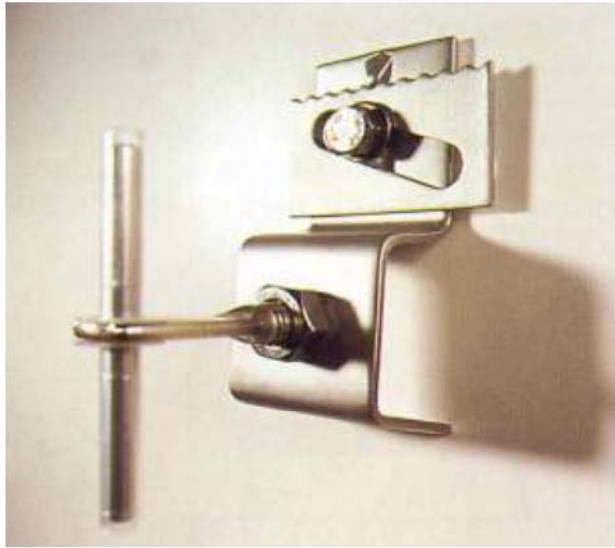
PANEL.



1. Main structure.
2. Structure supporting the enclosure.
3. Vapour barrier.
4. Insulation.
5. Vapour membrane (optional).
6. Auxiliary structure for pannels.
7. Open joint pannels.
8. Infiltrated water evacuation flashing.
9. Joint between pannels: open.

FAÇADE SUPPORT:  
- **ANCHORAGES**  
- JOINTS

# OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM



## LIGHTWEIGHT FAÇADES ANCHORAGES

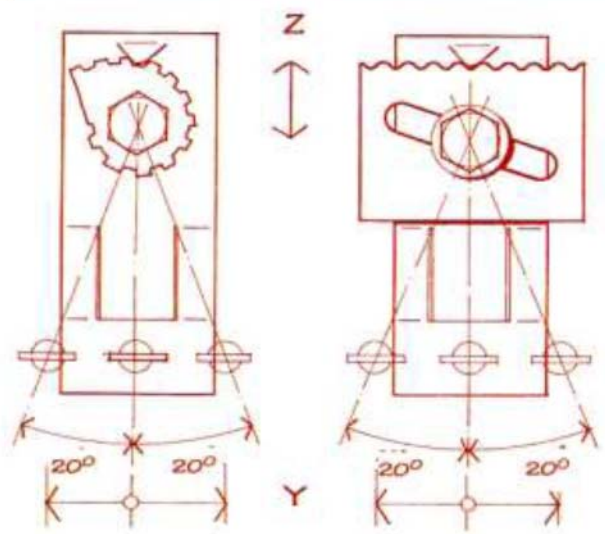
- **Direct:** on substrate wall or at the back of it.
- **Indirect:** on framing structure or.

Materials:

- Aluminum
- Galvanized steel
- Stainless steel.

Assembly:

3D position regulation:  
Line-up, plumbing vertical alignment or leveling.





## VENTILATED FAÇADE

### OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM

- STONE CLADDING FAÇADES
  - TRADITIONAL CLADDING
  - VENTILATED CLADDING
- LIGHTWEIGHT CERAMIC FAÇADES
- LIGHTWEIGHT WOODEN FAÇADES
- HEAVY CONCRETE FAÇADES

# OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM

## STONE CLADDING FAÇADES

### STONE CLADDING TYPES AND THEIR RESPONSE TO WATER

2 Types of cladding:

- **Traditional cladding façades.**
- **Ventilated cladding façades.**

3 types of water action on stone façades and walls:

- **Rain:** Downward and horizontal penetration of rainwater.
- **Water vapour:** Condensation and/or hygroscopic absorption by wetting the stone.
- **Soil moisture:** Upward penetration by capillarity (stone / mortar / filler). The phenomenon especially affects to the masonry stonework walls.

- TRADITIONAL CLADDING
- VENTILATED CLADDING

# OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM

## VENTILATED FAÇADES STONE CLADDING FAÇADES

Problems:

### - Mechanical.

Reinforced concrete support. Thickness=15 cm.

Problems with the Concrete Block.

Anchoring. Better vertical than lateral.

### - Breakage of plates by shock, suction or pressure.

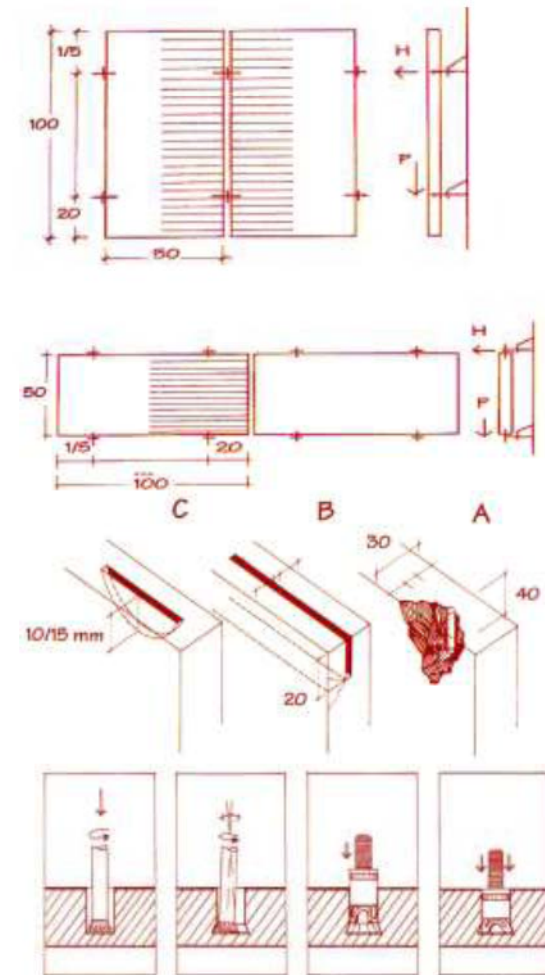
Plates thickness is obtained by test admitting 1/3 of the average of breakage.

### - Fire.

Rock wool with water-repellent coating on the outside.

### - Wind.

Confining and sectoring of the chamber.



- TRADITIONAL CLADDING
- VENTILATED CLADDING

# OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM

## VENTILATED FAÇADES STONE CLADDING FAÇADES

Types or anchorages and fixing:

- **With open joint, anchored to direct fixings on the inner supporting wall.**

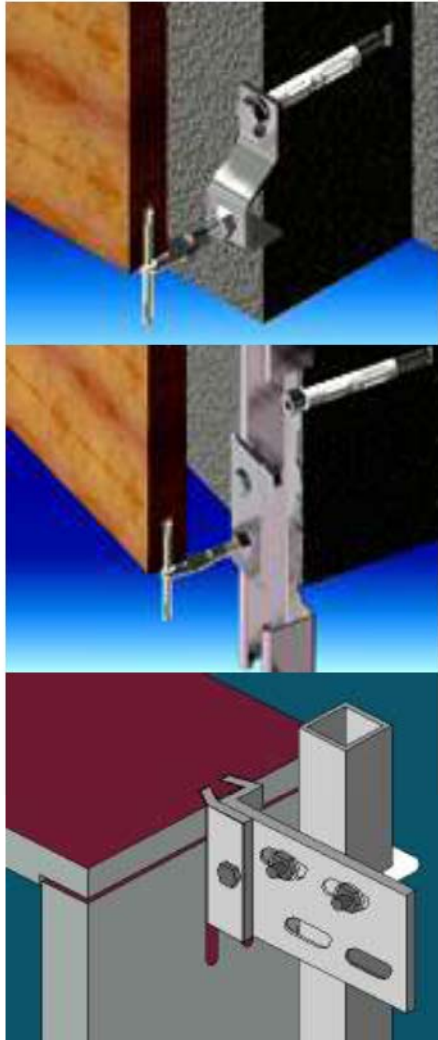
The air chamber is created by the anchorage itself by regulating its depth. The chamber ventilates by a grid of open joints.

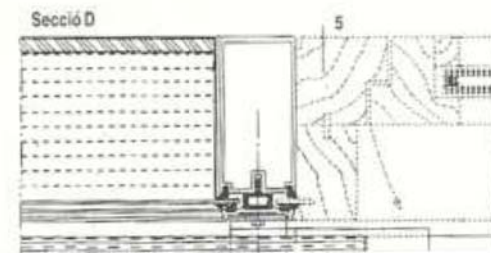
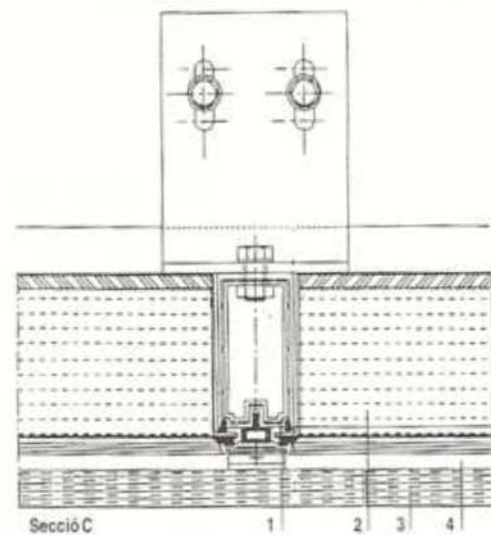
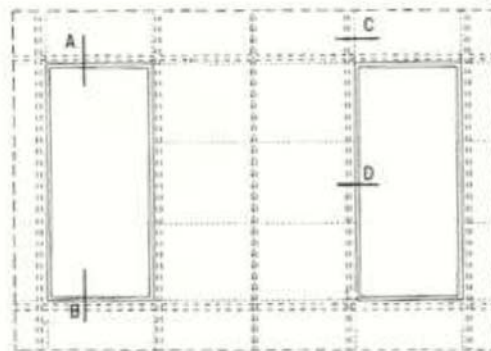
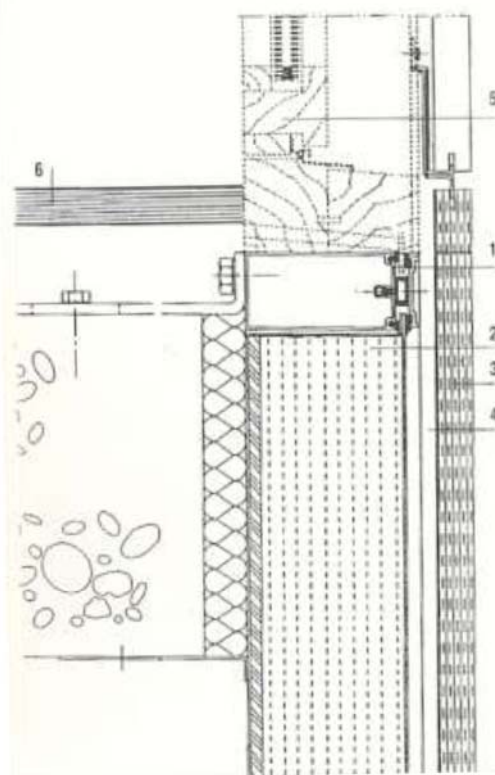
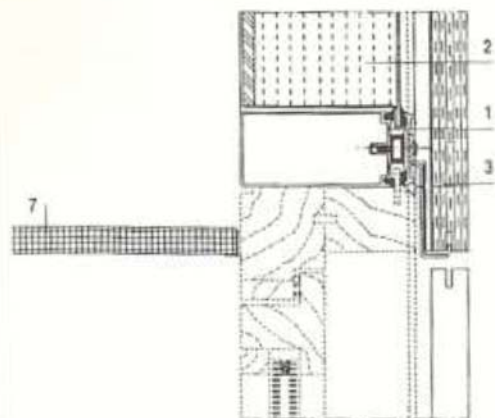
- **With indirect anchors to a studs and transoms framework fixed to the internal supporting wall.**

It facilitates the anchors fixing and makes the installation process more precise and faster.

- **With a substructure of profiles fixed to the slabs edges or pier lines.**

The support layer has been replaced by the profile framework and the internal finish is solved with any lightweight backing solution. (This solution is acoustically weak and may require acoustic absorption material in a second non-ventilated chamber).





# OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM

## LIGHTWEIGHT CERAMIC FAÇADES



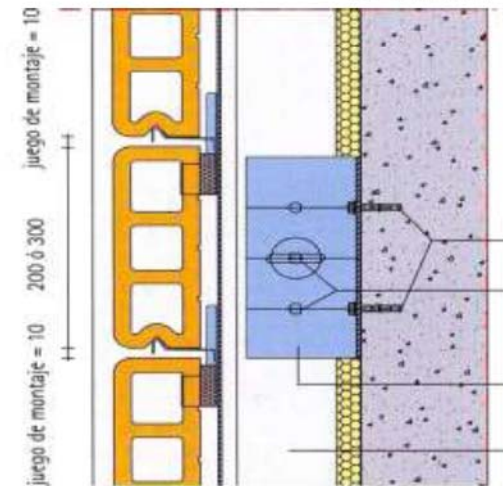
- MODULAR FAÇADES.  
Single track.  
Double track.
- VENTILATED FAÇADES.
- WATER AND AIRTIGHT FAÇADES
- ACOUSTIC FAÇADES.



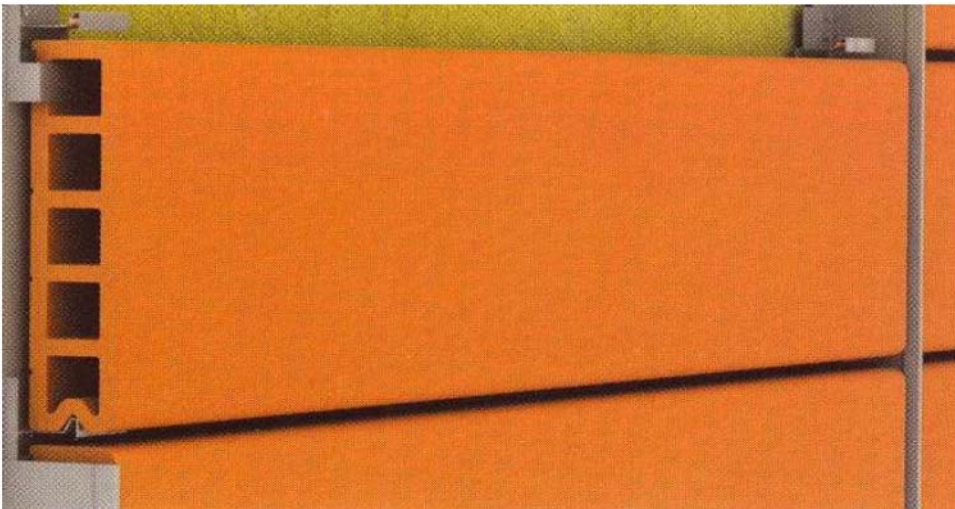
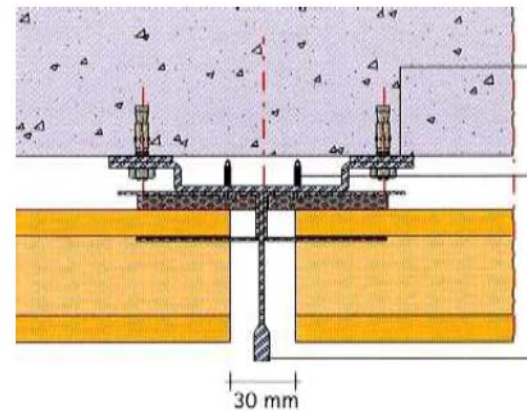
# OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM

## LIGHTWEIGHT CERAMIC FAÇADES

SECTION



PLAN

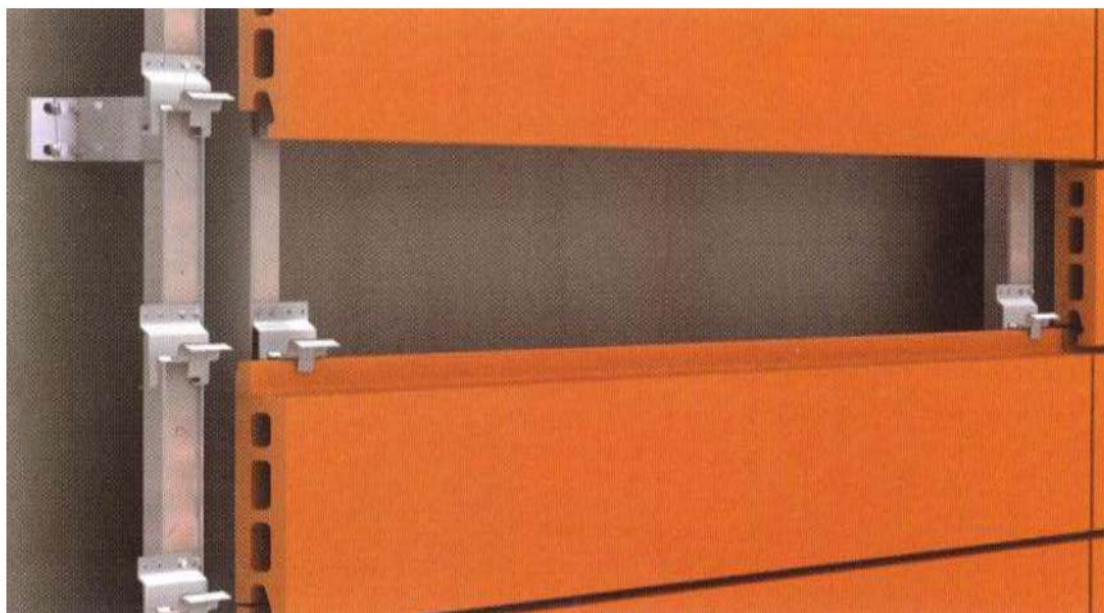
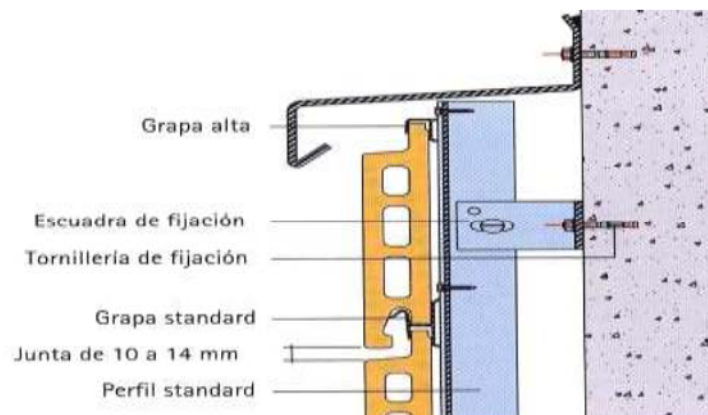


# OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM

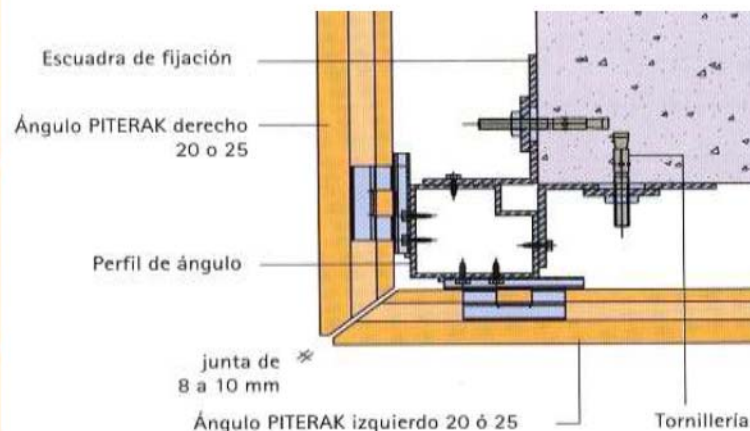
LIGHTWEIGHT CERAMIC FAÇADES

SEALED VENTILATED FAÇADES

DRIP END FLASHING SECTION



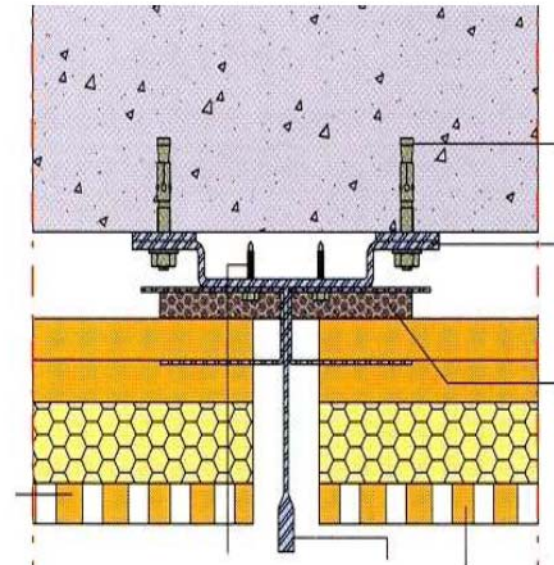
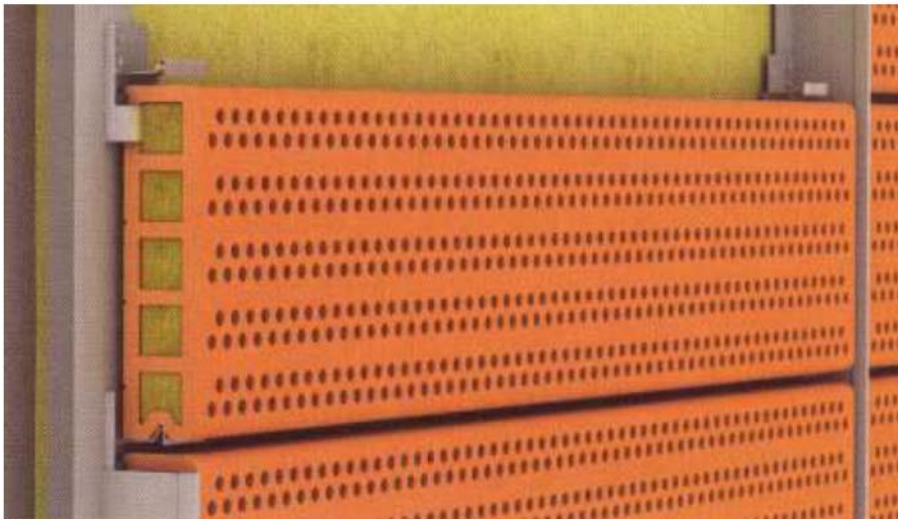
CORNER SECTION

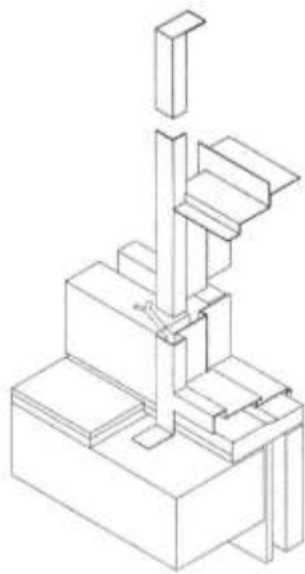




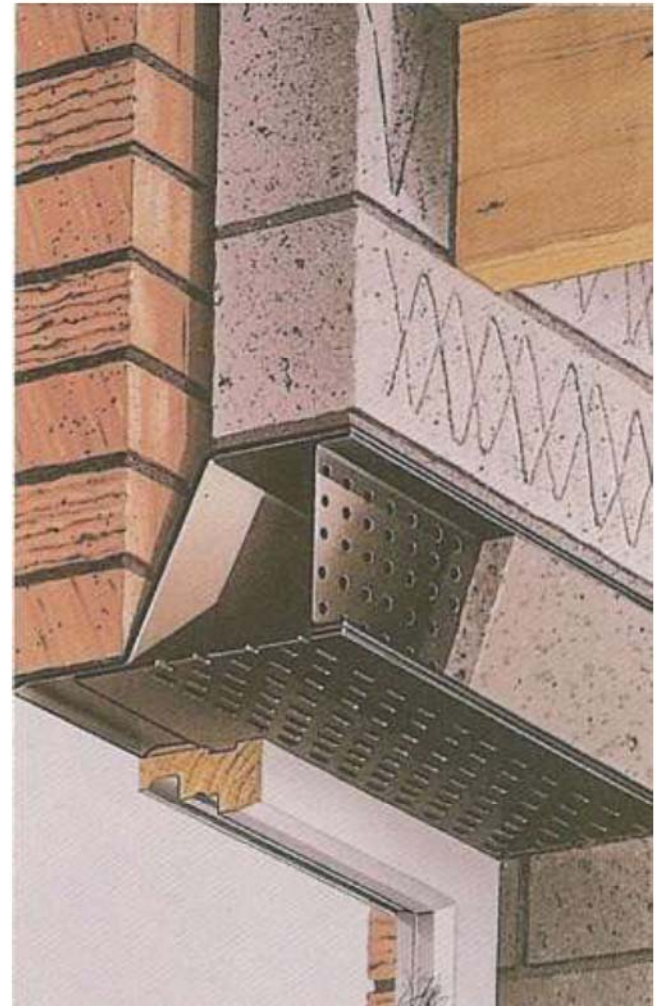
# OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM

LIGHTWEIGHT CERAMIC FAÇADES  
ACOUSTIC FAÇADES





Anglo-saxon cavity wall tradition has developed multiple dintel solutions with bearing capacity of both layers and thermal bridging limitation.



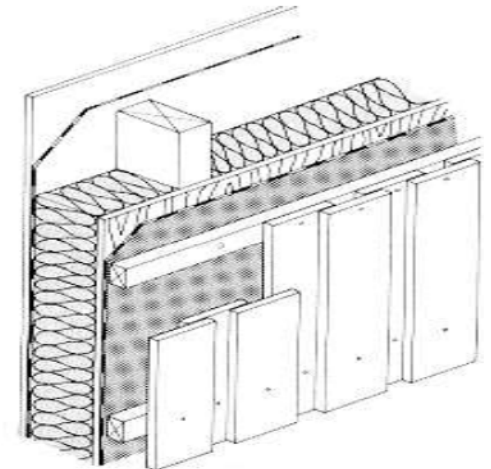
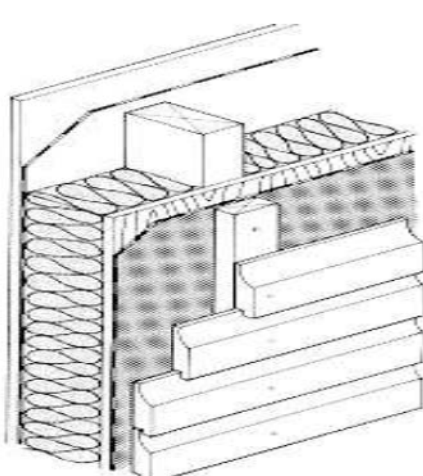
# OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM

## LIGHTWEIGHT WOODEN FAÇADES

The present concept of the wooden façade appears in the nineteenth century connected to the evolution of the saw and industrial nailing.

### TYPES OF LIGHTWEIGHT WOODEN FAÇADES:

- Structure made up of props and sleepers finished with boards joined together in solidarity.
- Cladding with wood on a different type of support.



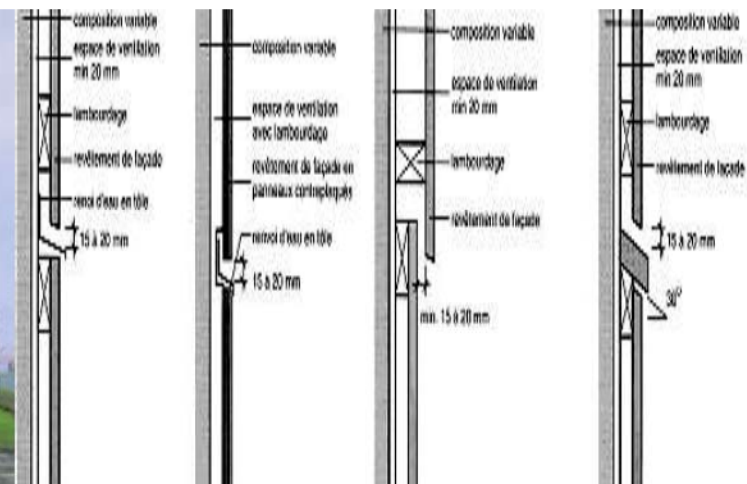


# OPEN JOINT PANELS EXTERNAL CLADDING SYSTEM

## LIGHTWEIGHT WOODEN FAÇADES

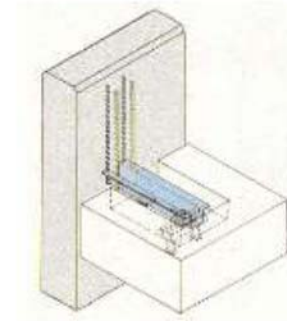
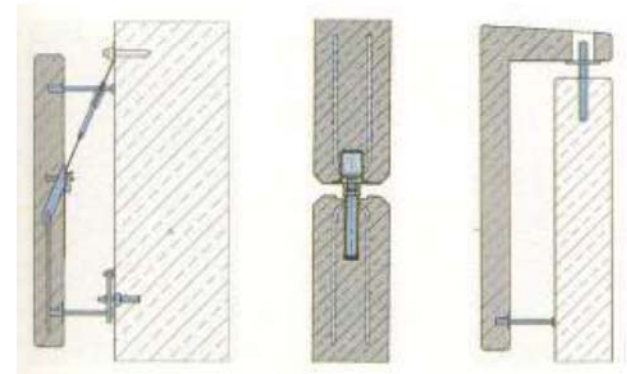
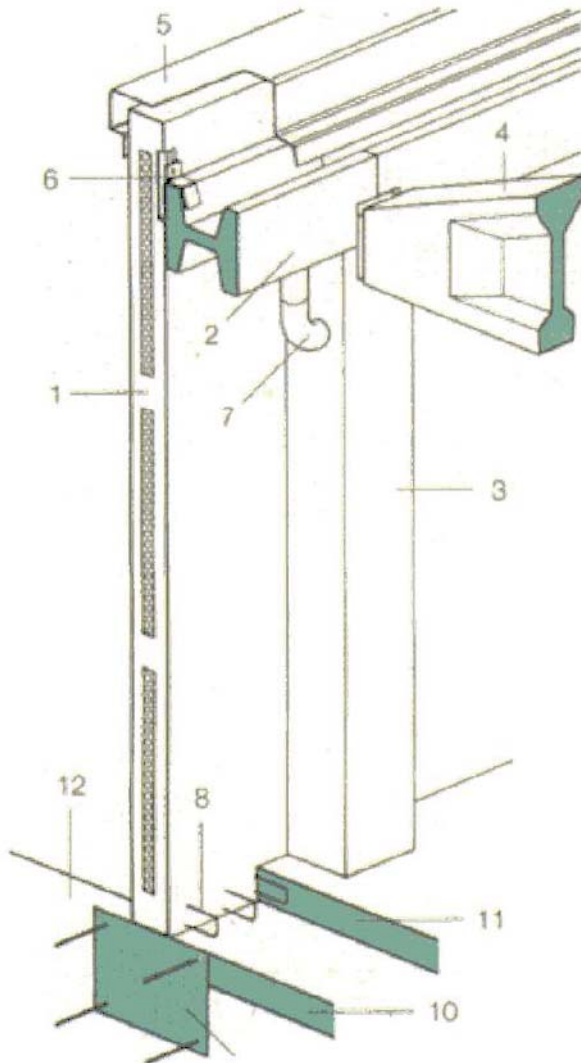
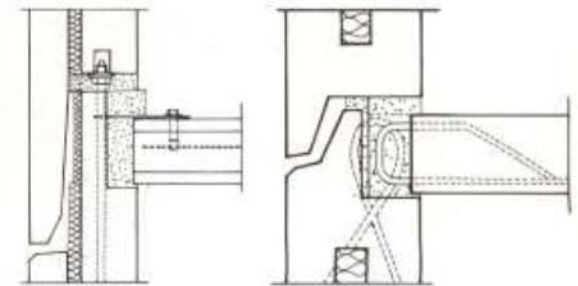
### DISADVANTAGES:

- Absence of thermal inertia.
- Protection against fire.
- Propagation speed 0.7mm/min depending on the squaring type.
- They need a vapour barrier.
- Rapid ageing.
- The edges of the panels must be protected from water accumulation.



## CONCRETE FAÇADES

Conection of panels using poured concrete in the joint. Metal pieces are also used to connect and to facilitate the laying out.

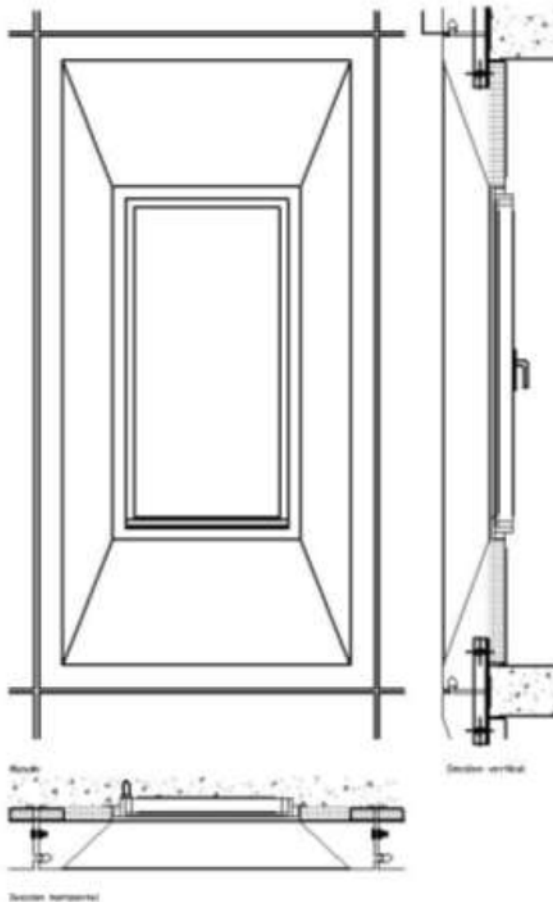


Fixings for concrete panels

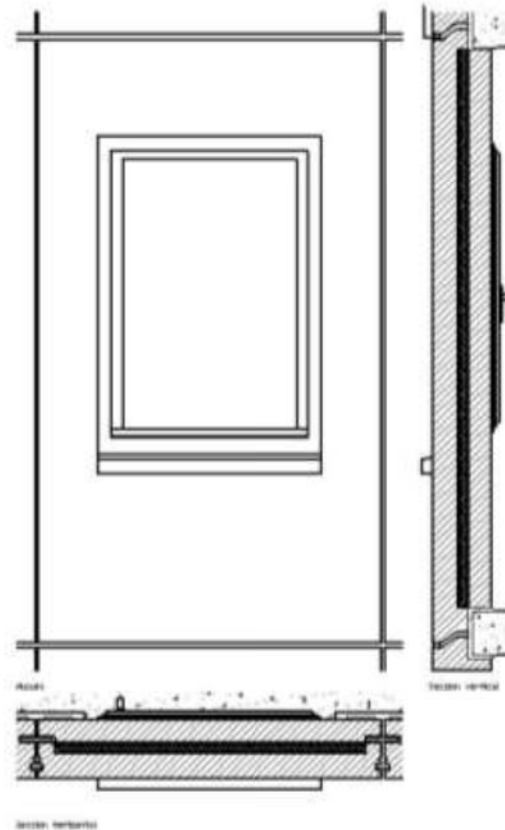
# CONCRETE FAÇADES

## CONNECTION WITH THE LOADBEARING HORIZONTAL STRUCTURE

WINDOW OPENING IN  
PANEL WITHOUT  
INTERNAL SHEATHING



WINDOW OPENING IN  
PANEL WITH INTERNAL  
SHEATHING





**Project "SURE - Sustainable Urban Rehabilitation in Europe"  
implemented in frames of Erasmus+ Programme  
Key Action 2: Strategic Partnership Projects  
Agreement n° 2016-1-PL01-KA203-026232**

**This publication has been funded within support from the European Commission.**

**Free copy.**

**This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.**

**Co-funded by the  
Erasmus+ Programme  
of the European Union**

