



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



Erasmus+

# Construction Applied to Heritage

3 ECTS

SH

Sustainable Heritage

EC

Elective Courses



## Construction Applied to Heritage

SH

Sustainable Heritage

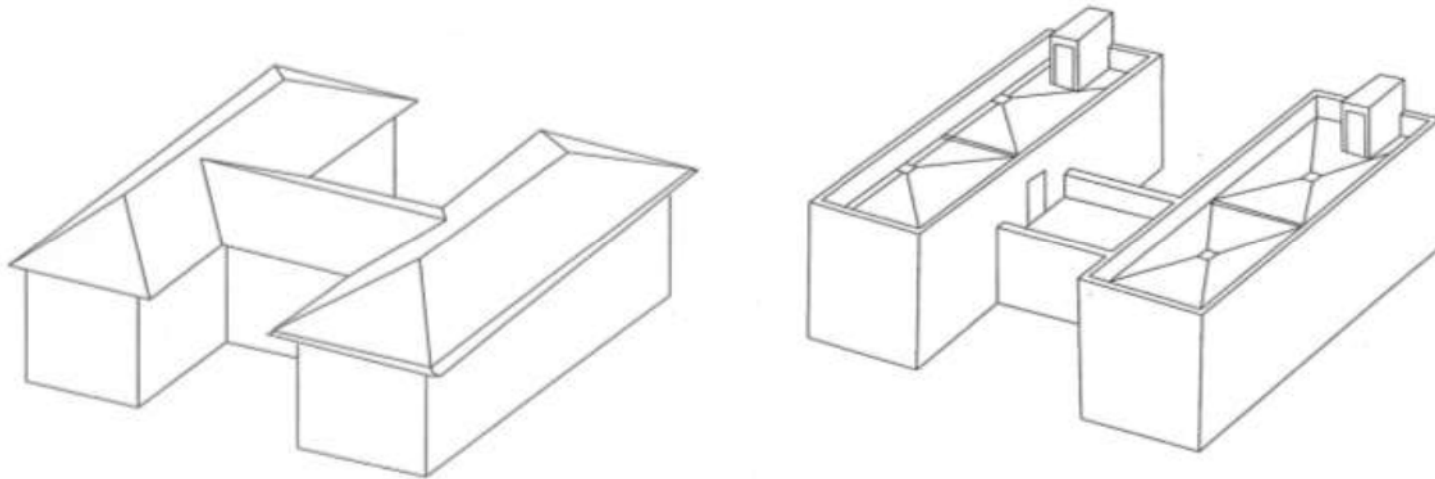
EC

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



## 10 ROOFS

- TYPES ANALYSIS

- Analysis by components of high slope and low slope roofs.
- Types of plans.
- Formation of slope in roofs of high slope.
- Structural base.

- FACTORS CONDITIONING THE FORMAL AND CONSTRUCTIVE SOLUTIONS FOR ROOF

- Design.
- Mechanical performance.
- Water and airtightness.
- Conditioning.
- Durability.

## BASIC CONDITIONS

The roofs of buildings must meet certain basic conditions:

**-Roofs must have enough mechanical resistance and stability** in the face of:

- Mechanical actions.
- Thermal actions.
- Wind actions.

The deformability and movements of its components will be compatible between each other and with the rest of the building.

**-Roofs must be water and airtight** to provide:

- Waterproofing of the building in the face of water (any state and situation).
- Evacuation easiness.
- Wind protection.

**-Their design and organization will prevent them from originating:**

- Filtrations.
- Absorption.
- Condensation dampness.

**-Roofs must possess a certain thermal insulation degree:**

- That limits heat and cold transmissions.
- That impede the loss of thermal energy.
- As a defensive factor against the appearance of condensation moisture.
- That defends the building against expansions – uncontrolled contractions.

**-Roofs must possess an acoustic insulation degree and must fulfill the conditions of protection against fire**

## DESIGN CRITERIA

The election of a roof type will impose some determining factors in the generality of the building due to:

- The general design.
- The relation of each component or element with the rest of elements and with the totality.
- The relationship of the roof with the rest of the constructive elements and with the rest of the

**Special care must be taken for:**

**-Connections or unions of the resistant base of the roof with the general structure of the building:**

- Support on loadbearing wall.
- Support on loadbearing beam or main beam.
- Support on piers.
- Type of support
  - Fixed (embeded).
  - Roller (articulated).
  - Pinned.

**-The connection of the support of the roof sheating with the resistant base.**

**-The connection of the roof sheating with its base on:**

- limits:** Eaves, perimeter.
- unions:** hips, valleys.

## ROOF COMPONENTS

Commonly and in a very elementary way, roofs are formed by the following components:

- RESISTANT BASE.
- SYSTEM OF SLOPES.
- SUPPORT OF THE ROOF SHEATHING.
- ROOF SHEATHING.
- DRAINAGE SYSTEM.
- CONDITIONING
  - Thermal insulation
  - Vapour barrier
  - Waterproofing, ...



## CLASIFICATION BY COMPONENTS:

### RESISTANT BASE

It fulfills a resistant function.

It is responsible for maintaining the dimensional parameters.

It avoids the existence of deformations by excesses of rise that could make difficult the water drainage.

### SLOPE STRUCTURE

Its function is to create an sloped surface that allows the drainage of rainwater.

Depending on the system adopted, the roofs can be structured as follows:

- **Aired or ventilated** Built on a board, or with a system that allows air circulation. These roofs are also known as:

- Cold roofs.
- Double layer roof.
- Aired chamber roof.

- **Not aired** Built on lightweight concrete. These roofs are also known as:

- Warm roofs.
- Single layer roofs.
- Not aired roofs.

## CLASIFICATION BY COMPONENTS:

### ROOF SHEATHING

Its function is to create a finishing plane. Therefore, it is the meeting zone between the roof and the external environment. This layer is responsible for the weather protection of the rest of the layers.

According to the possible uses adopted, roofs can be classified as:

- Not accessible roofs:
  - Heavy waterproofing protection.
  - Lightweight waterproofing protection.
- Accessible roofs:
  - Heavy waterproofing protection.
  - No slope and flat roofing.
  - Green roofs.
  - Ecological roofs.
  - Sloped roofs.

## CLASIFICATION BY COMPONENTS:

### THERMAL INSULATION

Acoording to the relative position of every element the roofs are named as:

#### Traditional

In traditional solutions, the thermal insulation function is to avoid thermal energy losses from the surrounded spaces.

#### Reversed

In inverted solutions, in addition to fulfilling the above function, it avoids thermal variations that the waterproofing membrane may suffer, reducing the material fatigue phenomena and increasing its durability.

## CLASIFICATION BY COMPONENTS:

### WATERPROOFING

This membrane prevents from water penetration into the lower layers of the roof. The position of this layer establishes two differentiated zones on the roof.

According to the type of material used for waterproofing membranes, roofs are named as:

- Bituminous. Membranes.
  - Adhered system.
  - Non-adhered system, with ballast.
- Plastic. Membranes or coating (paint).
  - Polyethylene.
  - Polypropylene.
  - Polyester.
  - PVC.
  - Thermoplastic polyolefins of ethylene propylene.
- TPO
- Synthetic rubber. Membranes.
  - SBS (Styrene Butadiene Styrene).
  - EPDM (Ethylene propylene diene monomer).

# ELECTION CRITERIA

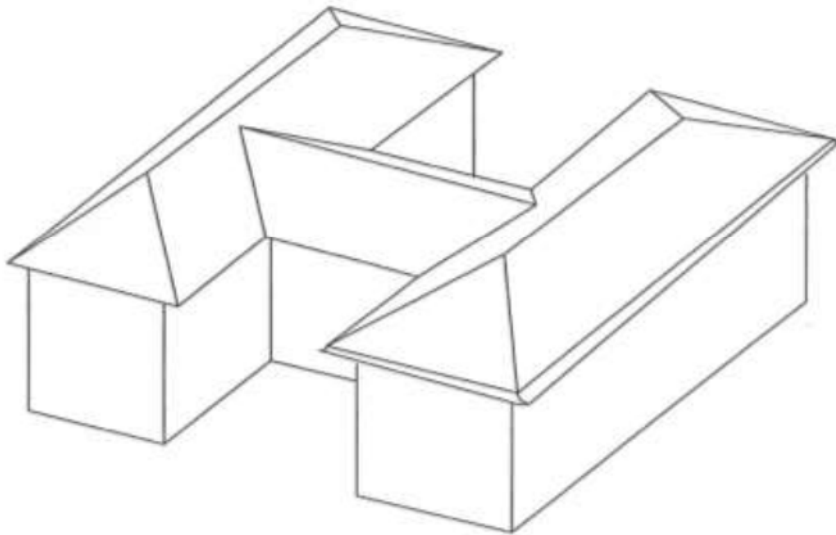
- General criteria: these lead us to establish the typological characteristics of the roof. To determine the type of roof and the main factors to be taken into account in the choice are directly related to:
  - The characteristics of the covered space.
  - Dead load.
  - Thermal and acoustic insulation capacity.
  - Maximum spans between supports.
  - The expressive internal and external possibilities.

There should be borne in mind that roofs can play an important role in natural conditioning, obtaining a good level of natural lighting and ventilation through skylights, which will help in energy saving and in quality of habitability of the space below.

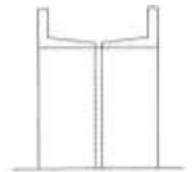
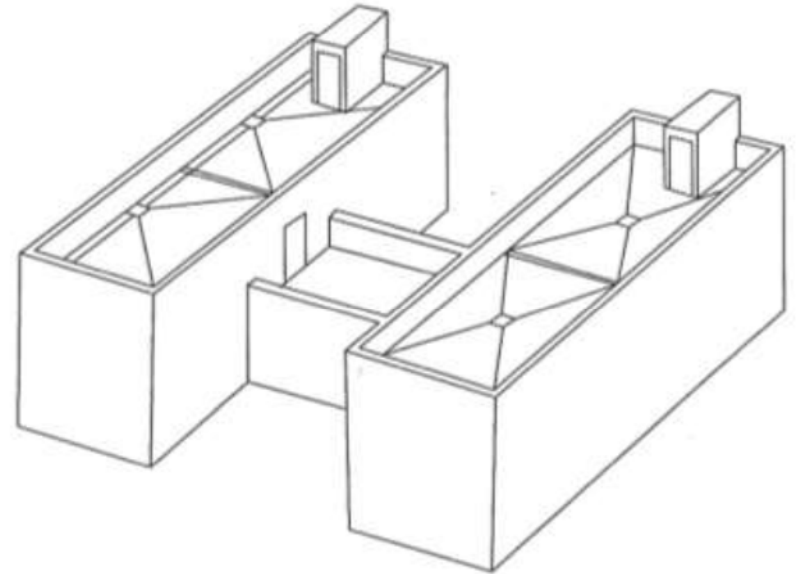
- Technical criteria: those that singularize and determine the detailed aspects established by the recognized typology. They should be taken into account when deciding on the specific aspects of the type of roof chosen:
  - Compatibility of components.
  - Movements due to thermal effects.
  - Interaction of the structure with the roof sheathing.
  - Stability and mechanical resistance.
  - Fire safety.
  - Watertightness.
  - Safety of use.
  - Protection against noise.
  - Energy saving and thermal protection.

# MORPHOLOGICAL CLASSIFICATION

## HIGH SLOPE ROOFS



## SMALL SLOPE ROOFS



## ROOFS TYPES ACCORDING TO FORM

- HIGH SLOPE OR SLOPING ROOF.

Slope  $>15^\circ$

They usually drain to the outside of the building.

- SMALL SLOPE OR FLAT ROOF.

Slope  $< 5^\circ$

They usually drain to the inside of the building.

Possibility of being recoverable for transit and use.

# GENERAL CONSTRUCTIVE ORGANIZATION FOR A ROOF PLANE

## - SINGLE LAYER ROOF (Without insulation):

- Waterproofing.
- Resistant base.

## - SINGLE LAYER ROOF (With insulation):

### -On the resistant base:

- Waterproofing.
- Thermal insulation.
- Vapour barrier.
- Resistant base

### - Under the resistant base:

- Waterproofing.
- Resistant base
- Thermal insulation.
- Vapour barrier.

## - DOUBLE LAYER ROOF (With insulation):

- Waterproofing.
- Resistant base
- Thermal insulation.
- Vapour barrier.



# TYPES OF ROOFS ACCORDING TO THEIR RESISTANT BASE

## **-Flat**

- Slab:
  - Horizontal.
  - Sloping(obliquely).

## **-Straight bars bundles** (with isolated bars):

- Traditionals
- Gable roofs portal frames.
- Sloped main beam.
- Contemporary solutions.

## **-Bars grid** (triangled):

- Flat bars.
- Main beams.
- Trusses: with or without tie beam
- Space frames.

## **-Bent bars set:**

- Traditional solutions.
- Ruled surfaces: surface of revolution, surface of no revolution.
- Not ruled surfaces: surface of revolution, surface of no revolution.

## **-Masonry work:**

- With ribs.
- With plates.

## **-Tensioned sets:**

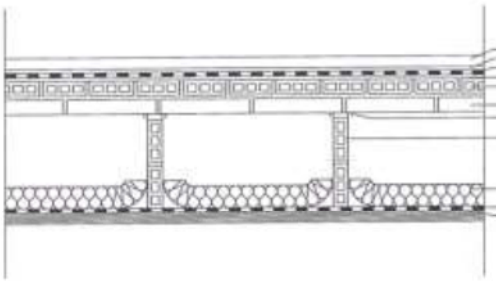
- Cables.
- Suspension cable.

## **-Gas filled spaces with difference of pressure.**

## LOW SLOPE ROOFS

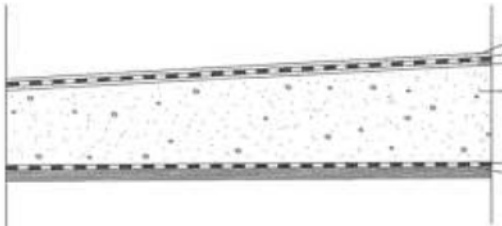
- BASE STRUCTURE
- PLANE STRUCTURE
- ROOF DECKING MATERIAL

### SLOPES SYSTEM. MINIPARTITIONS



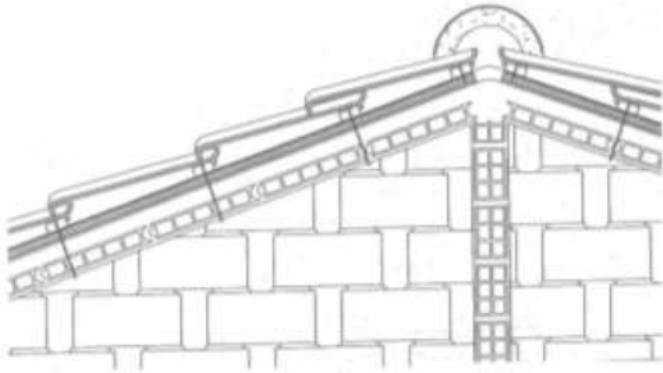
### SLOPE FORMATION

### SLOPES SYSTEM. LIGHTWEIGHT CONCRETE



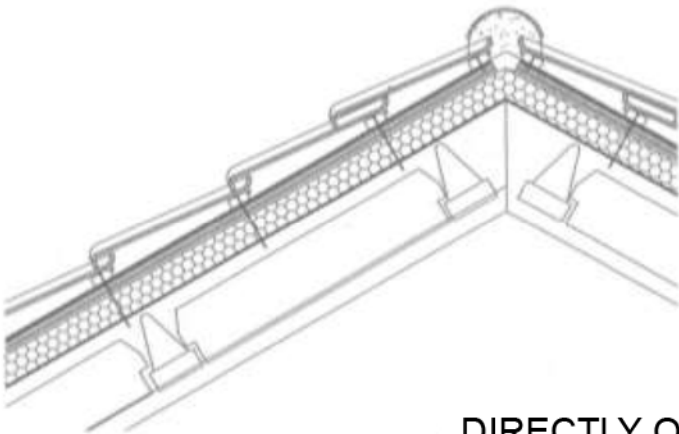
## HIGH SLOPE ROOFS

- BASE STRUCTURE
- PLANE STRUCTURE
- ROOF DECKING MATERIAL



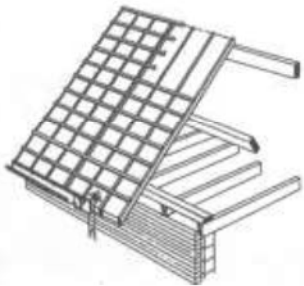
INDIRECTLY ON THE SLOPE PLANE

## SLOPE FORMATION

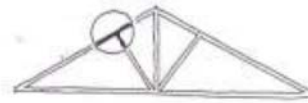


DIRECTLY ON THE SLOPE PLANE

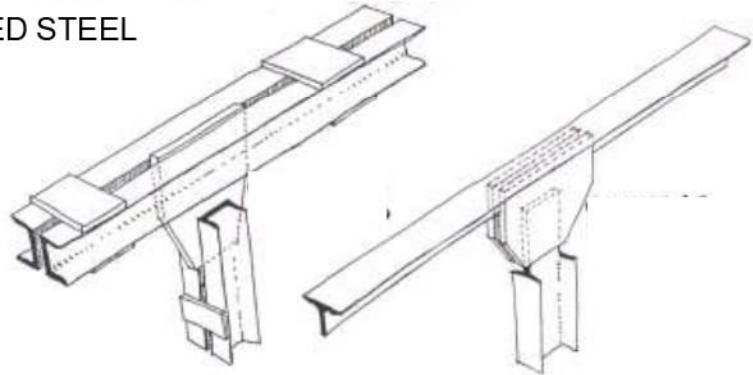
## SLOPE FORMATION (BARS)



ISOLATED BARS



WELDED STEEL

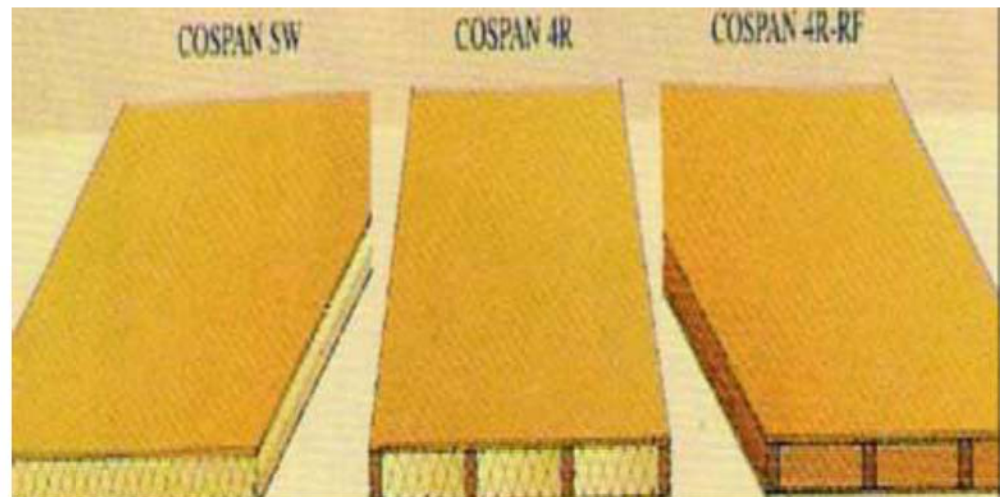


TRIANGULATE LAYOUT BARS

## HYDROFUGED TIMBER BOARDS

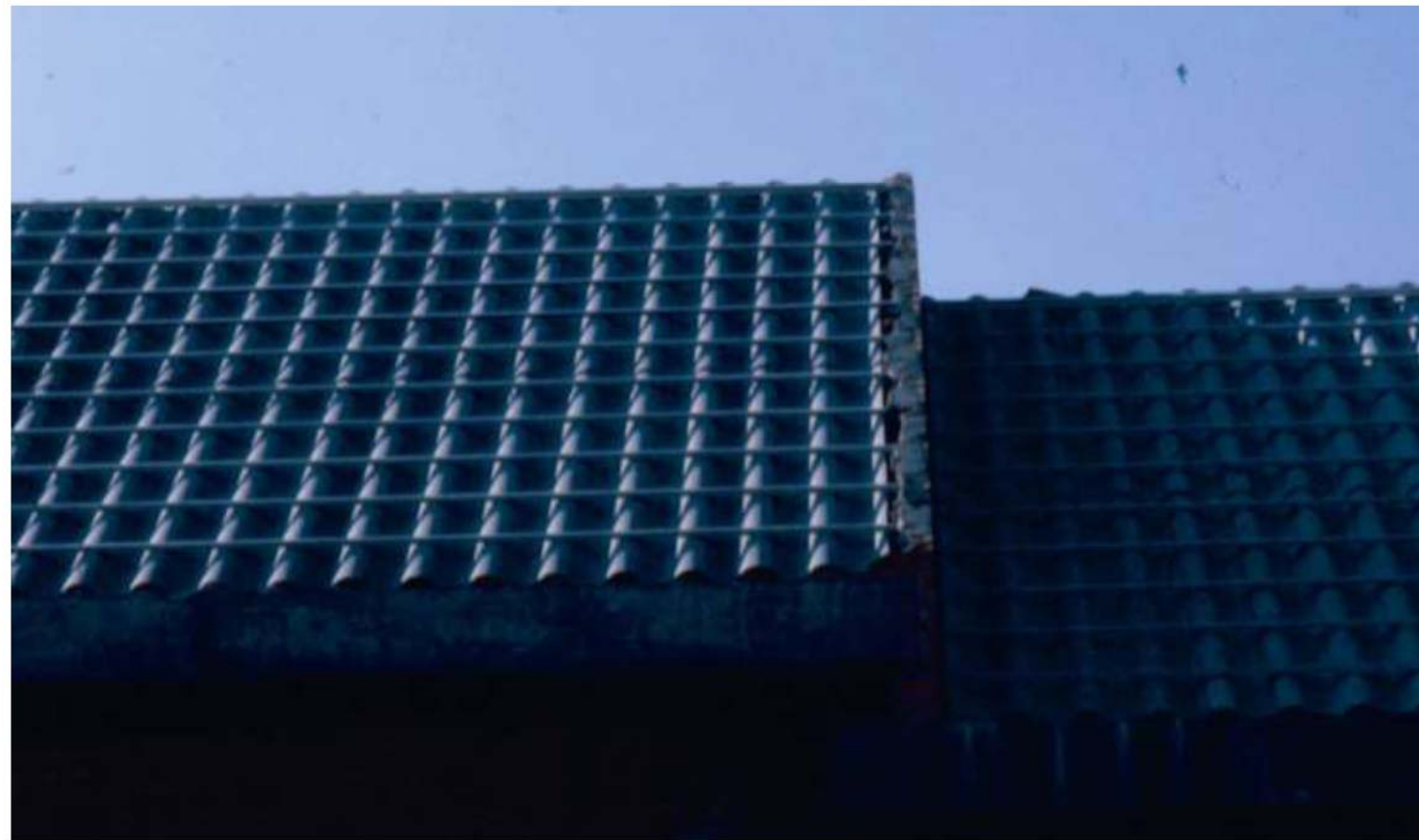
The roof panels are made up of several layers:

- External face: water-repellent agglomerate of:
  - Pressed wood
  - Wood veneer.
  - Phenolic pressed wood.
- Core: thermal insulation (extruded polystyrene XPS).
- Lower surface: fire-resistant water-repellent agglomerate, phenolic plywood or wood friezes.



## RIPPLED BOARD

It leaves additional small air chambers under the corrugated board.



## WATERPROOFING

When the slope is  $< 25\%$  and depending on the type of tile used for the roof cladding, to waterproof the board is necessary.

- Rippled board

  - Fiber cement.

  - Fiber bitumen.

- Waterproofing membrane

  - Bituminous

  - PVC.

  - Chlorinated rubber.

  - Polymers.

# INSULATION

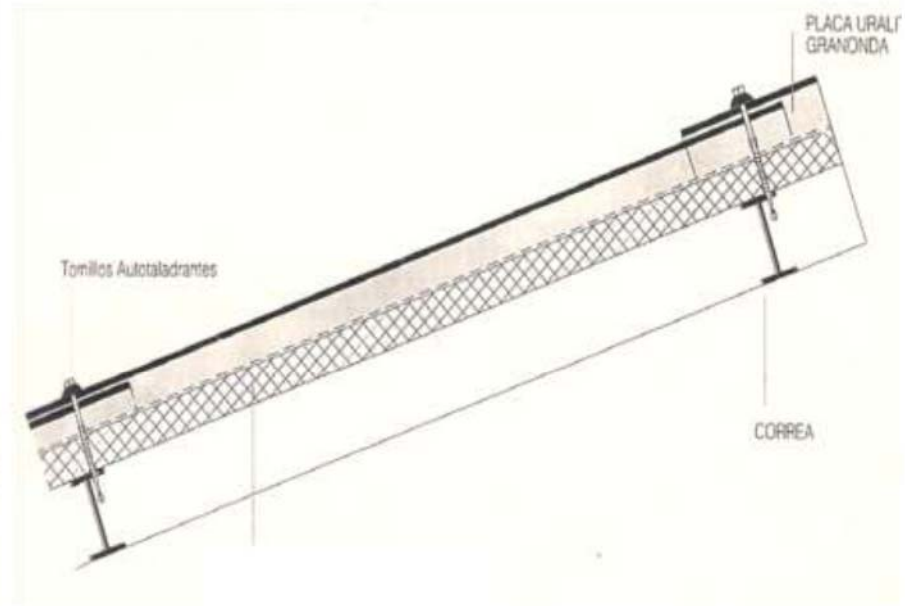
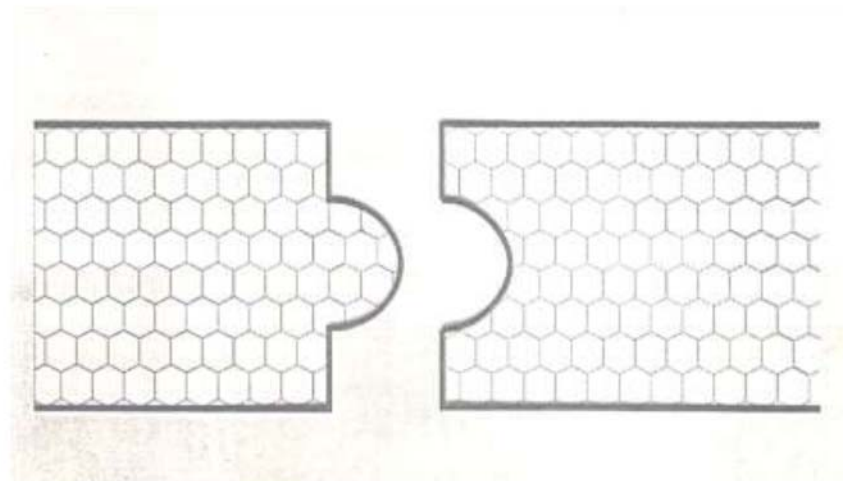
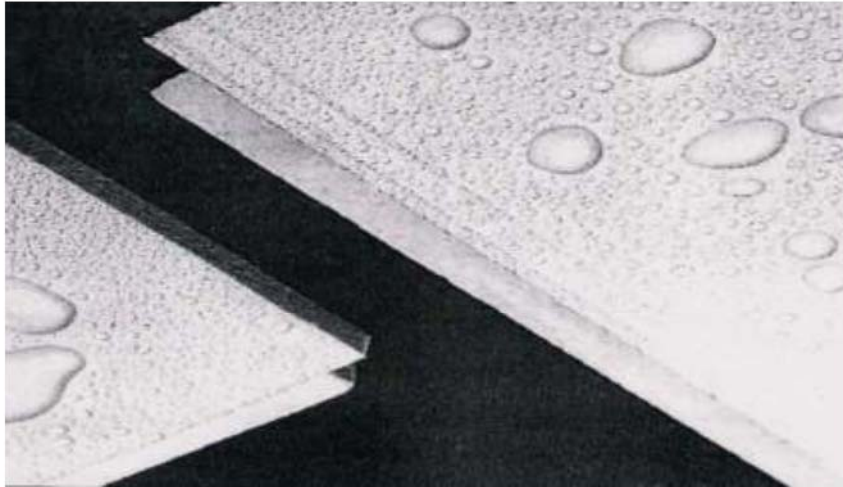
The insulation is achieved with two basic elements:

- The **air chamber**, which is generated between the structure and the slope plane. It can be more or less ventilated (cold roofs). It also allows dissipating the water vapour that comes from the under spaces in winter, as well as the heat of the radiation in summer.
- An **insulation blanket**, laid on the supporting structure. No vapour barrier should be placed underneath them because it would difficult the water vapour to escape into the chamber that is where it has to arrive to dissipate.



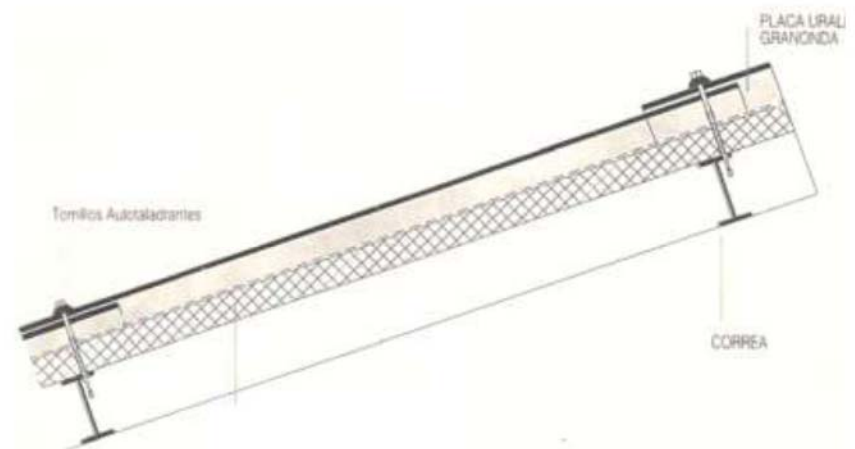
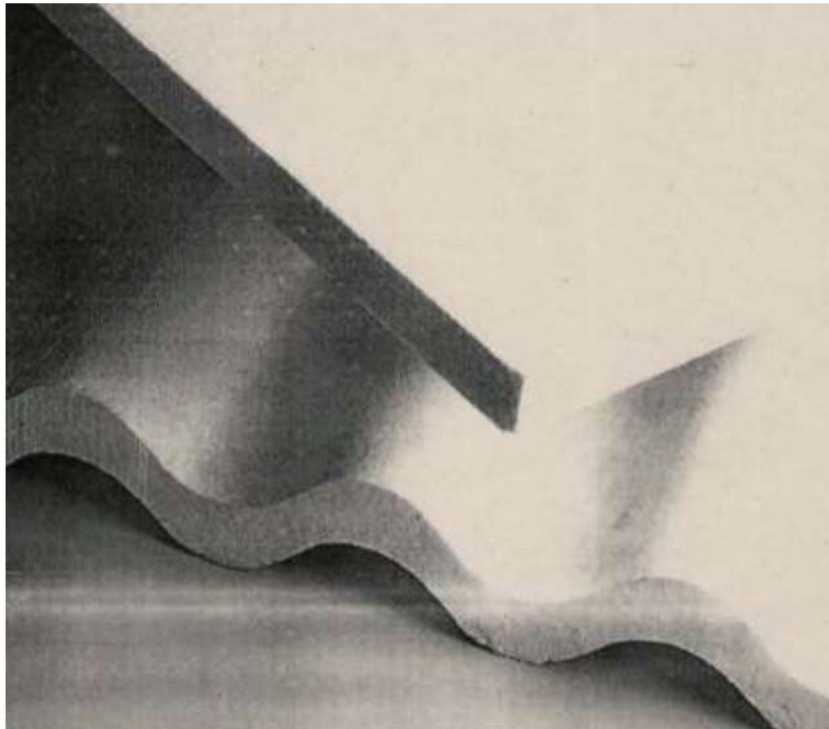
## INSULATION: extruded polystyrene (XPS)

Thermoplastic foam with a homogeneous and closed cellular structure.



## INSULATION: Expanded polystyrene (EPS)

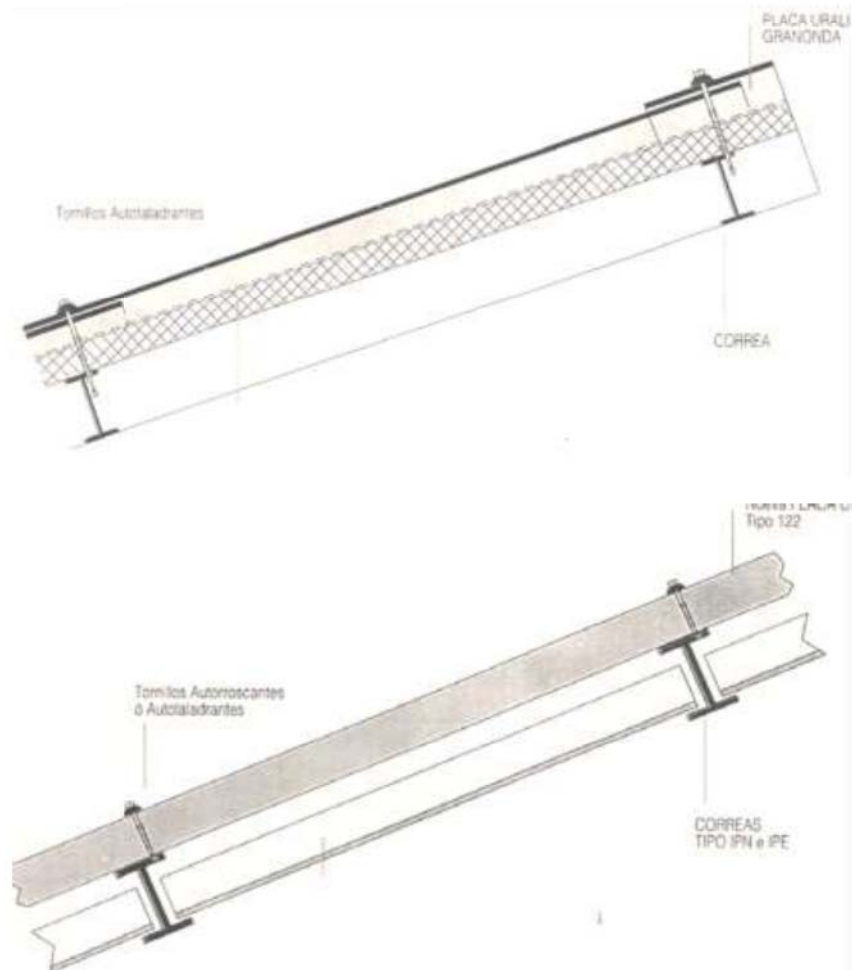
Rigid white thermoplastic foam.



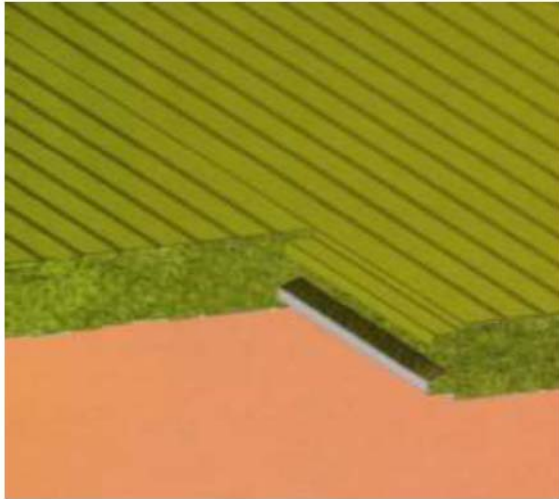
## INSULATION: FIBERGLASS WOOL

Glass wool blanket and panel.

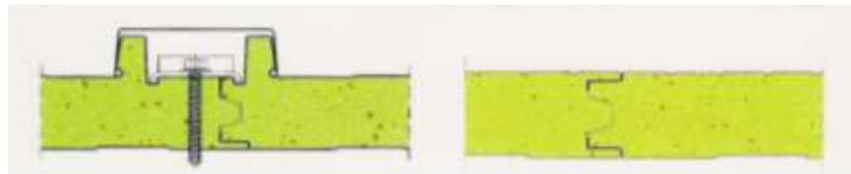
Consisting of glass wool agglomerated with thermosetting resins.



## INSULATION: ROCKWOOL



Roof and façade insulation panels



Roof

Façade

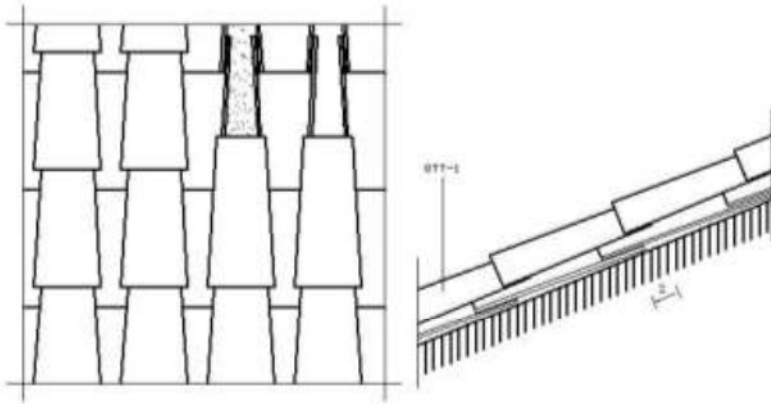
## ROOF CLADDING

- Ceramic or mortar roof tiles:
  - Spanish roof tiles, the oldest and most appreciated.
    - Single pattern. One is placed upward acting as a channel and another is placed downward acting as a cover.
  - Mixed roof tiles, S-shapes, with channel and covering the same piece, some of them double.
  - Flat or French roof tiles, with overlaps hooked on all fronts.
  - Plates, made of different materials, mainly slate, ceramic and fiber cement.
- Fiber cement rippled boards.
- Fiber cement or metal corrugated sheets.
- Metal sheets made of zinc, lead or copper.

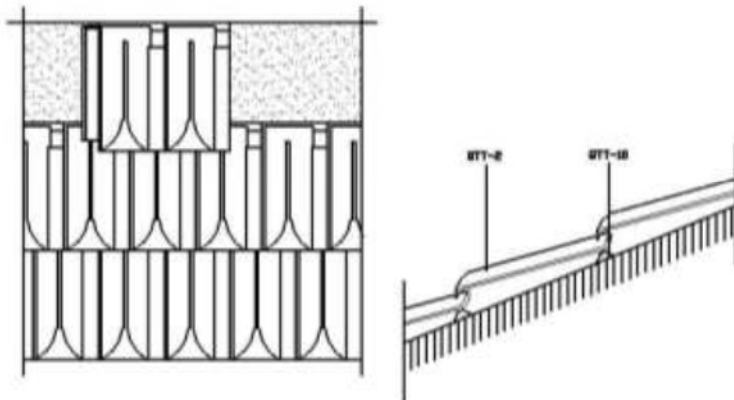


## ROOF CLADDING CERAMIC ROOF TILES

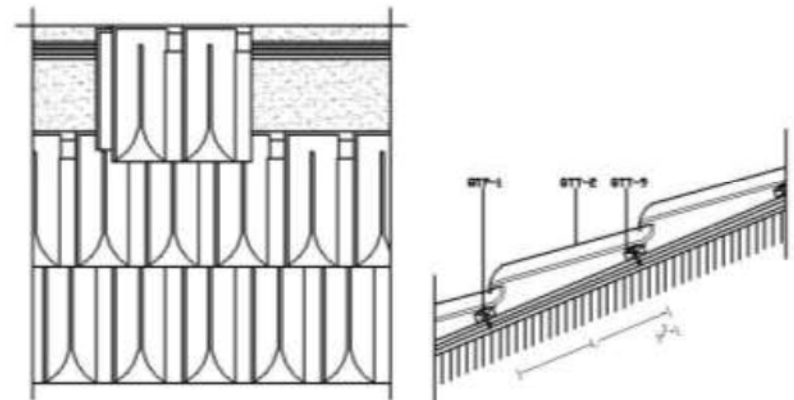
ROOF SLOPE DETAIL  
SPANISH ROOF TILE



FLAT ROOF TILE  
LAID WITH CEMENT MORTAR

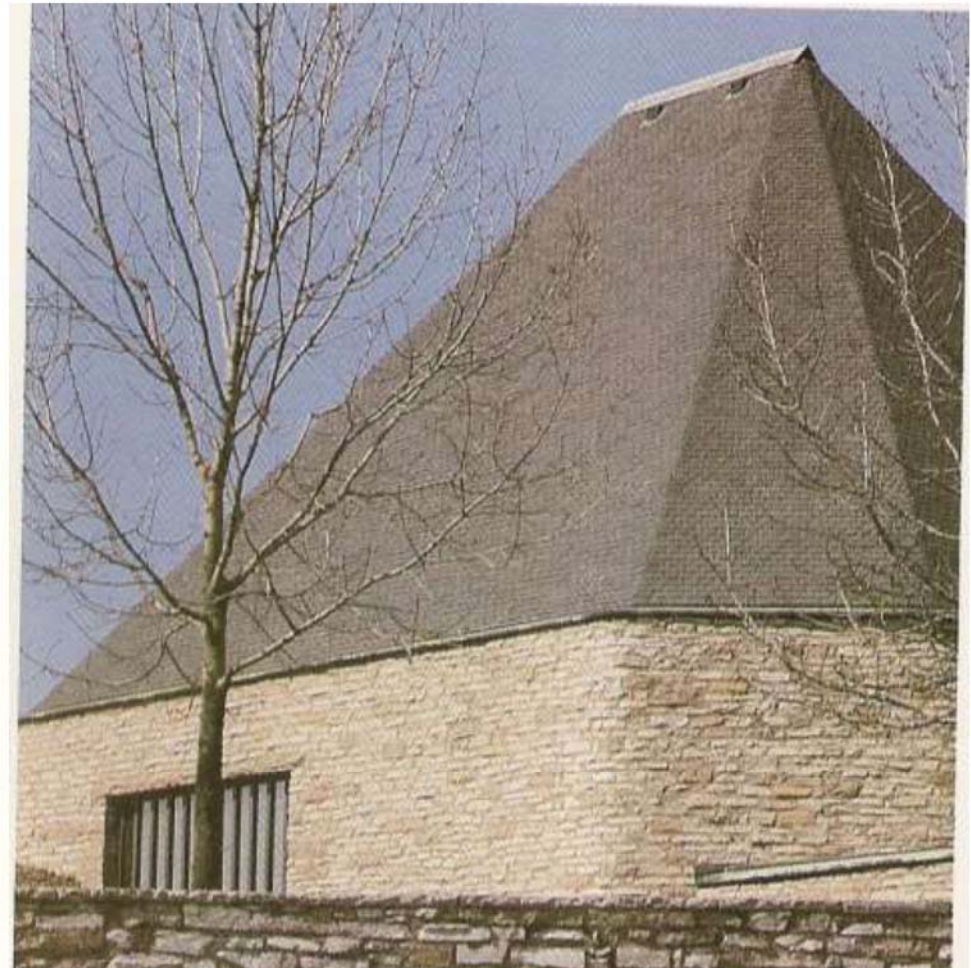
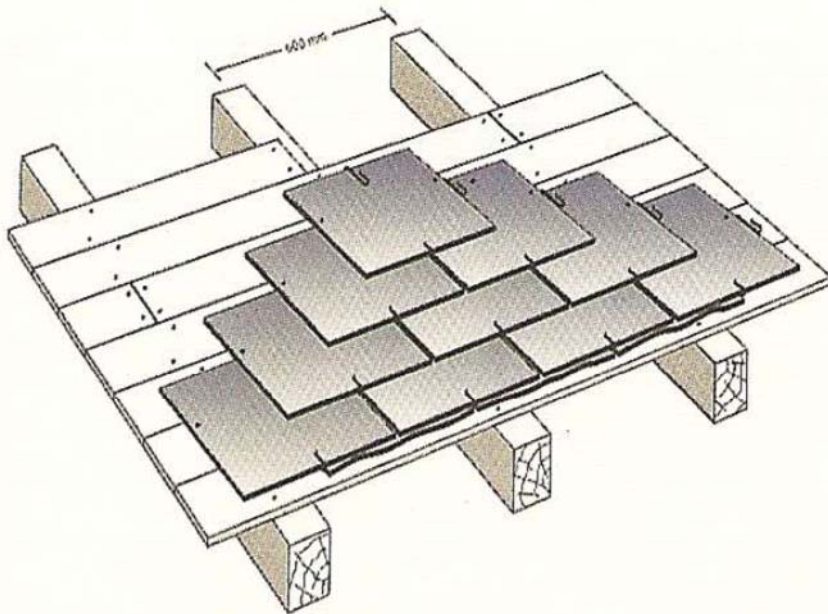


ROOF SLOPE WITH FLAT ROOF TILE  
SET IN PLACE BY NAILING

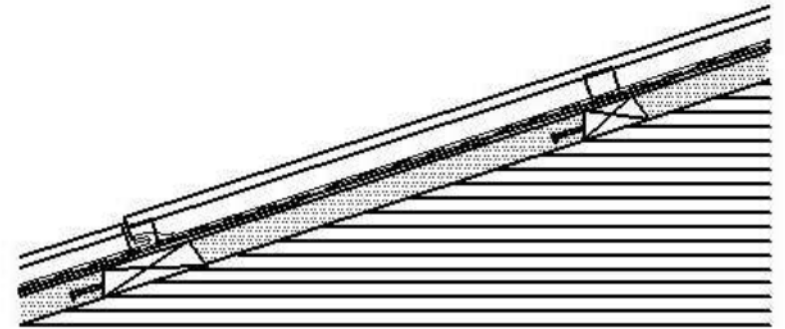
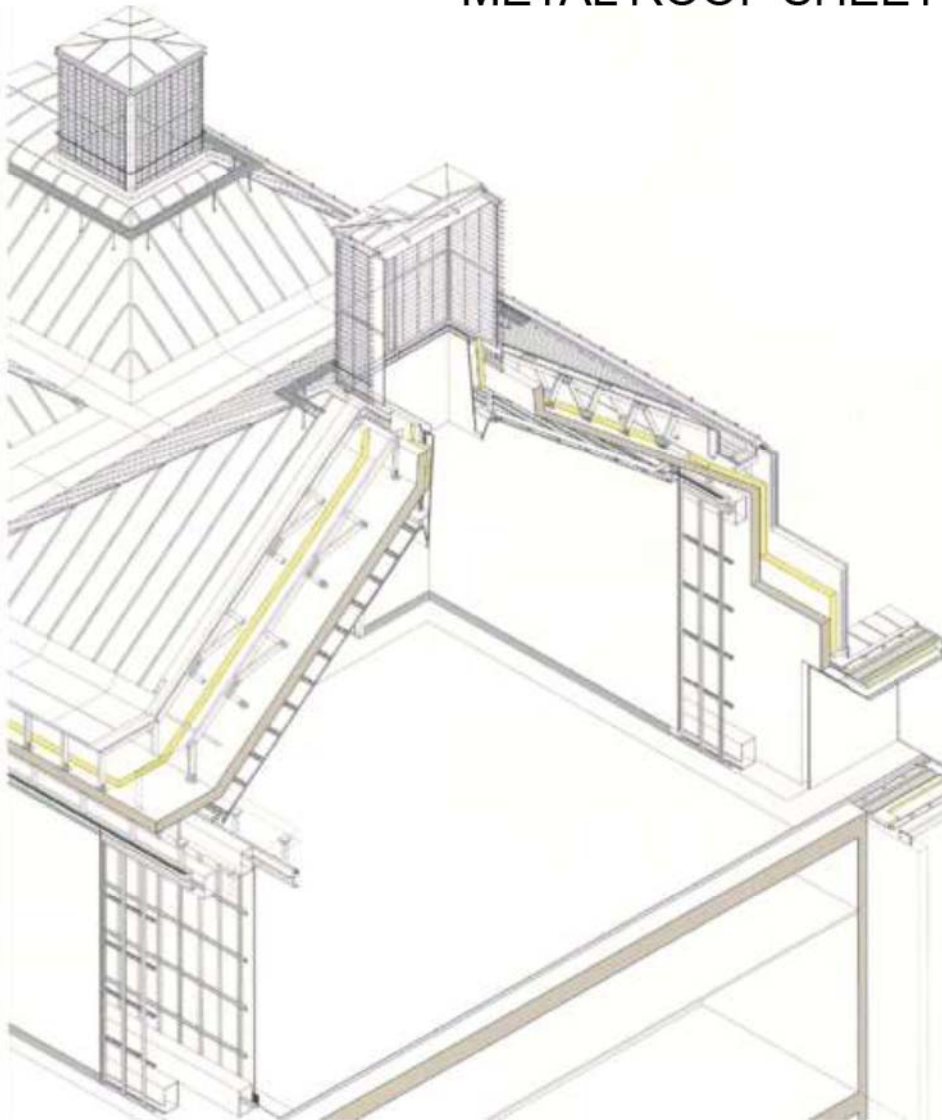


## ROOF CLADDING SLATE ROOF TILES

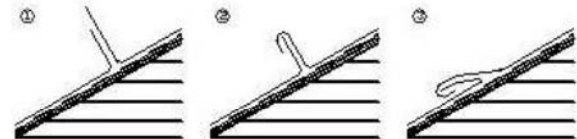
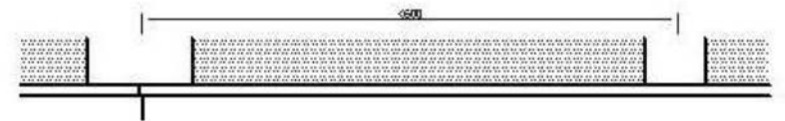
SLATE TILES  
SET IN PLACE DETAIL



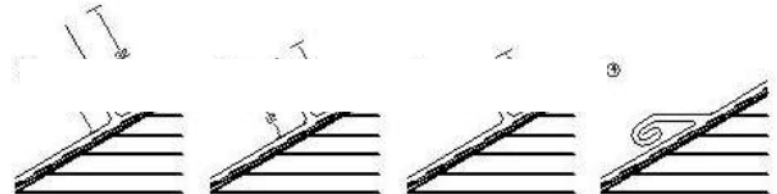
# ROOF CLADDING METAL ROOF SHEETS



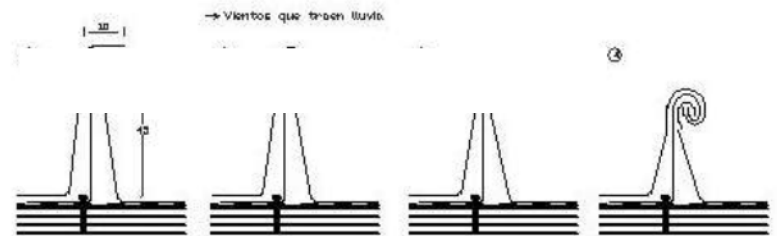
Sección



Unión transversal con engastado sencillo



Unión transversal con engastado doble



METAL SHEETS SUPERPOSITION AND  
FOLDING





**Project "SURE - Sustainable Urban Rehabilitation in Europe"  
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Key Action 2: Strategic Partnership Projects  
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