



## *GENERAL BUILDING ENGINEERING*

### *FLAT ROOF IN BUILDINGS*



Erasmus+

# ***DEFINITION AND GENERAL DIVISION DUE TO CONSTRUCTION***

Ceiling - it is a ceiling above the top floor, constructed in such a way that it can simultaneously act as a roof. The roofs generally have small angles of inclination and are used in buildings where attic is not necessary. The flat roofs also include terraces.

1. Non-roofed roofs - used in storage and farm buildings (unheated).
2. Warmed roofs - they are used above heated rooms and can be made as:
  - full,
  - vented,
  - ventilated (slotted, tubular, bipartite),
  - terraces,
  - roofs with reverse layer arrangement.

# ***GROUPS OF FLAT ROOFS***

Flat roofs are multi-layer barriers and this fact allows building various types of coverings with varying structures. Therefore, flat roofs can be divided taking into account various criteria:

- The method of connecting subsequent layers → moisture removal → obtaining a slope decrease
- Solid roofs - the layers adhere to each other → no solutions for removing moisture → a fall through the inclination of the supporting structure or the use of a decaying layer
- Ventilated roofs - layers adjoining partially → moisture removal by the so-called channels or fissures → a fall due to the inclination of the supporting structure or the application of a downward slope
- Ventilated roofs - layers separated into two parts with ventilated space → moisture removed from the ventilated space → a drop through the use of openwork walls

# GROUPS OF FLAT ROOFS

Due to the method of protection of the top layer of the flat roof against external factors:

- Roofing without additional protection (multilayer roofing, top layer without sprinkles)
- Roofing with factory sprinkles (covered with sprinkle paper)
- Top layer of gravel laid on the roof covering (roofs with heavy type protection)
- Substrate with low or high vegetation (green roofs)
- Top layer with surface intended for pedestrian traffic or vehicles (parking, terrace)

Due to the type of supporting structure of the flat roof:

- massive ceiling - each ceiling meeting the load capacity criterion may provide a foundation for any flat roof,
- truss girders,
- full or openwork girder
- Due to the order in which the thermal insulation layer is laid:
- Thermal insulation below the waterproofing layer, roofs with the traditional sequence of layers,
- Thermal insulation above the waterproofing layer, inverted roofs,

# ***FLAT ROOF WITHOUT THERMAL INSULATION***

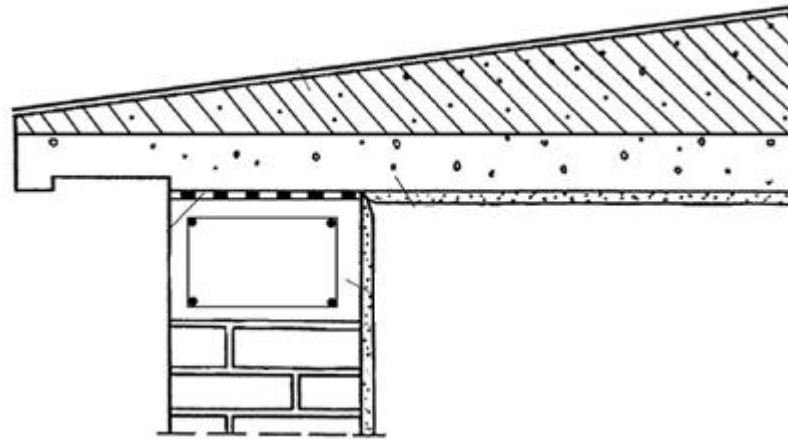
They have the simplest structure. The supporting element is any kind of ceiling (most often on steel or reinforced concrete beams).

Directly on the roof is made a layer shaping the roof slope, amounting to at least 3%. Depending on the average thickness of the layer, the following materials are recommended for its implementation:

5 cm cement mortar,

8 cm light concretes on expanded clay aggregate,

15 cm backfill of expanded clay or slag with a cementitious surface primer.

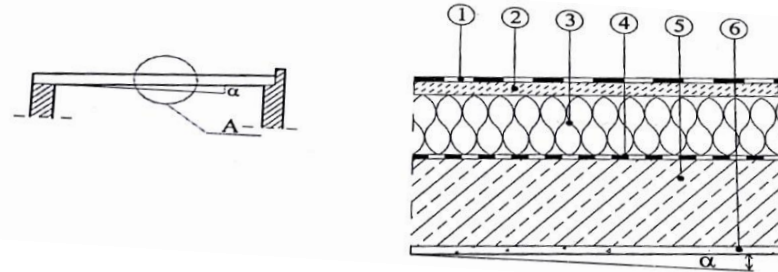


*Scheme of a non-insulated flat roof. [5]*

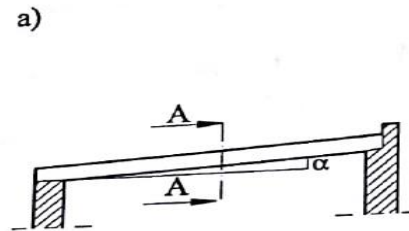
# FLAT ROOF THERMAL INSULATION

A feature of this construction is the method of obtaining a roof slope drop, which takes place by laying with a fall of the entire ceiling or girder of a fixed height (full or lattice). Another way to get a tilt is to tilt only the top truss belt.

- In the first case, the supporting structure of the flat roof can be any ceiling that will carry loads,
- In the second embodiment, the support structure can be any lattice girder on which the foundation is placed on the purlins, e.g. from trapezoidal sheet, on which the remaining layers of the flat roof are arranged.



Scheme of layers of a flat roof, insulated on the ceiling. [1]

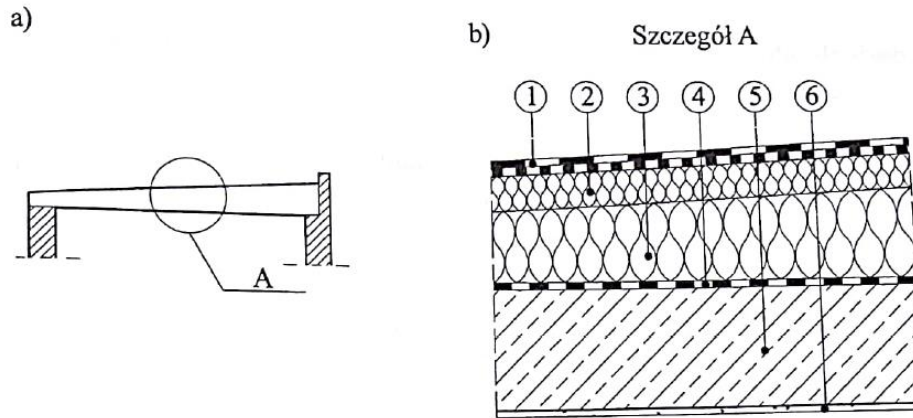


Scheme of full insulated flat roof layers on a steel girder. [1]

# FLAT ROOF THERMAL INSULATION

This solution eliminates the need to give a roof pitch already at the stage of carrying the supporting structure. Here, the horizontal ceiling is always horizontal, and the declining profile decides about the size of the slope. The downward layer can be formed in many ways.

Previously, the roof drop was made of lightweight concrete, loose materials or mortar, and lastly wedges were used from insulating materials (mineral wool, styrofoam)



*Scheme and layout of full insulated flat roof layers with a downward slope. [1]*

# VENTED ROOF

This is a modified version of the flat roof. Its feature is that it has an additional layer with a special structure that allows the creation of an air gap that covers moisture and allows it to dry out.

The air gap can be made of perforated roofing felt. A worse solution is only partial adhesion of undercoat to the substrate. [2]

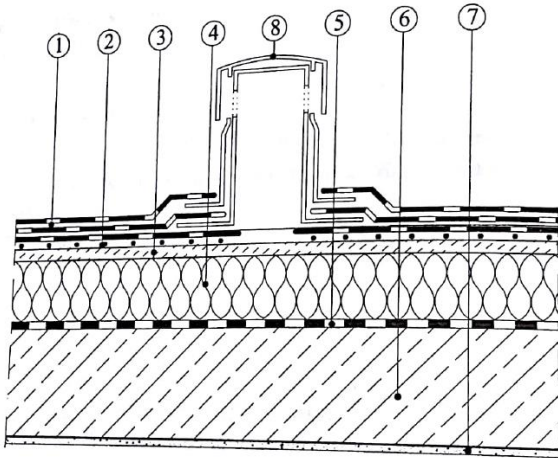


Diagram and arrangement of the ventilated roof layers. [1]

Under the influence of the sun, the roof surface heats up to approx. 80 ° C. This activates the moisture movement in the partition. Moisture after reaching the critical pressure value looks for an outlet outside. If the cover is tight, the first damage occurs - bubbles, cracks. When the temperature drops in bubbles, a negative pressure is created and humid air is sucked in. Repeated process leads to deformation of the cover and its damage. To remove moisture from the cover, fireplaces are used. [4]



# ***DISADVANTAGES OF FLAT ROOFS***

There may be many reasons for the degradation of this type of construction, but the most common errors are design and workmanship. If moisture gets inside the barrier and stays there for a long time because the drying of the layers is difficult, the following effects may occur:

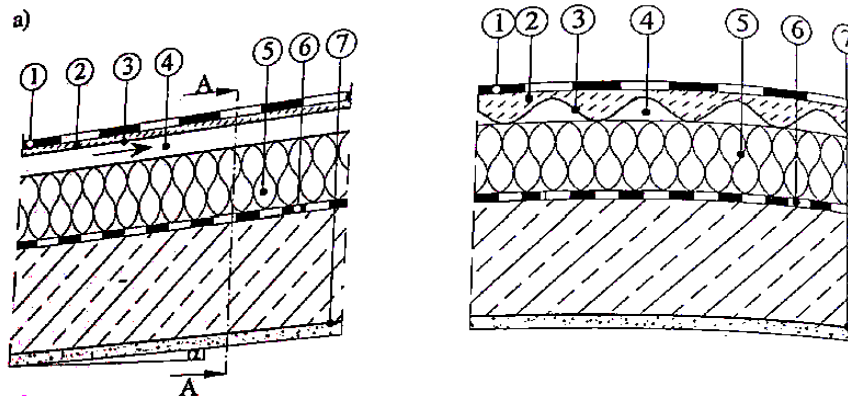
- Deterioration of thermal insulation due to moisture in the thermal insulation layer,
- Leakage of the coating layers from the ground and premature destruction (freezing, blistering)
- Development of other degradation processes, peeling of paint coatings, mold growth

Also dangerous for people's safety is eavesdropping of eaves on roofs that are drained outside

# LAMINATED CEILINGS

Used when it is necessary to remove moisture from deeper layers than just from under and more than in the case of venting.

The channels can be created, for example, by means of corrugated plates and have a much lower moisture-wicking capacity than slit ceilings. This difference results from the larger surface area of the channels formed by means of corrugated plates. Another way of forming channels is the use of specially hollow thermal insulation boards.



Scheme and arrangement of the flat roof layers. [1]

# LAMINATED CEILINGS

Air gaps are formed when additional elements are placed on the ceiling structure, eg: open channel roof panels. The boards are laid with the longer side along the slope on the spacers made of rigid insulating material (eg aerated concrete blocks) or directly on the insulation layer when it has adequate strength.

Removal of moisture by vented gaps is carried out by depositing excess moisture in gaps or ducts, which are connected to vents in the ridge and at the eaves. The drainage of gaps and channels is similar to the operation of gravity ventilation. [4]

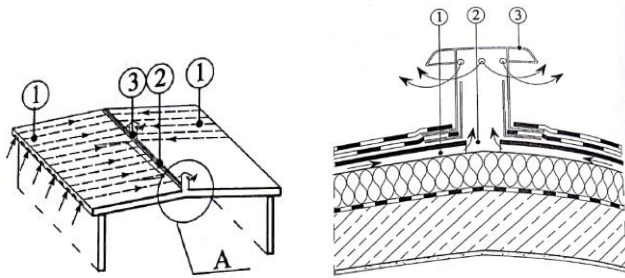


Diagram and arrangement of diaphragm layers. [1]

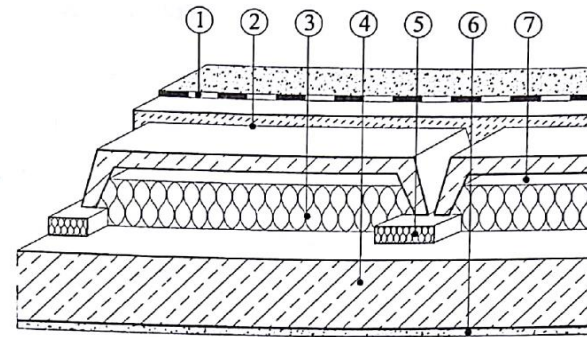
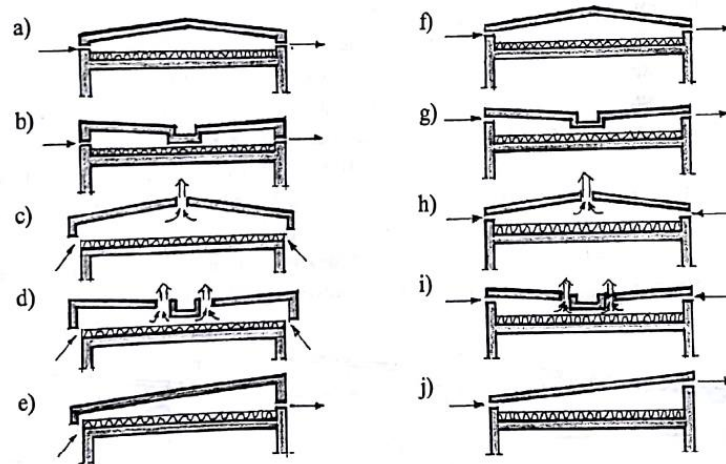


Diagram and arrangement of diaphragm layers. [1]

# TWO PARTED VENTILATED FLAT CEILING

Ventilated roofs best protect rooms against excessive heating in the summer, heat losses in winter and freezing due to the free air exchange between the ventilated space and the outside air. They are especially recommended for rooms with steam pressure above 2130Pa (eg baths, tanneries). [3]



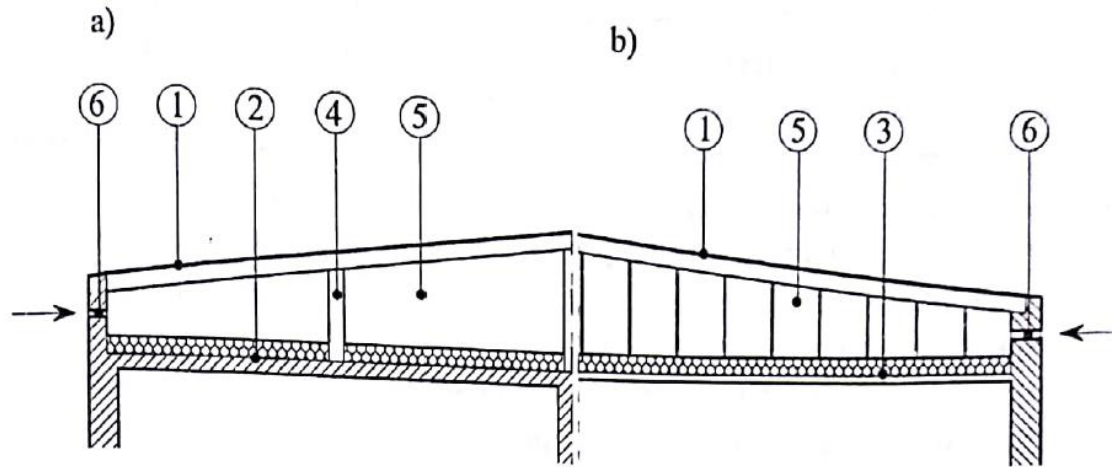
*Ventilated roof [3]*

# TWO PARTED VENTILATED FLAT CEILING

It consists of two parts: upper and lower separated by a ventilated space. A typical flat roof structure is a ceiling construction with thermal insulation (bottom part) and a roof structure with a covering.

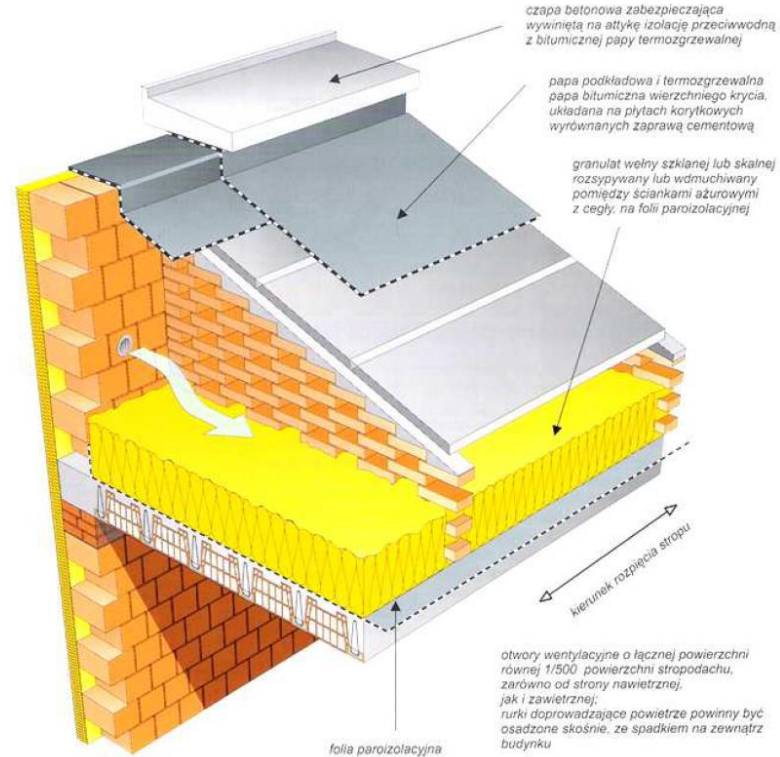
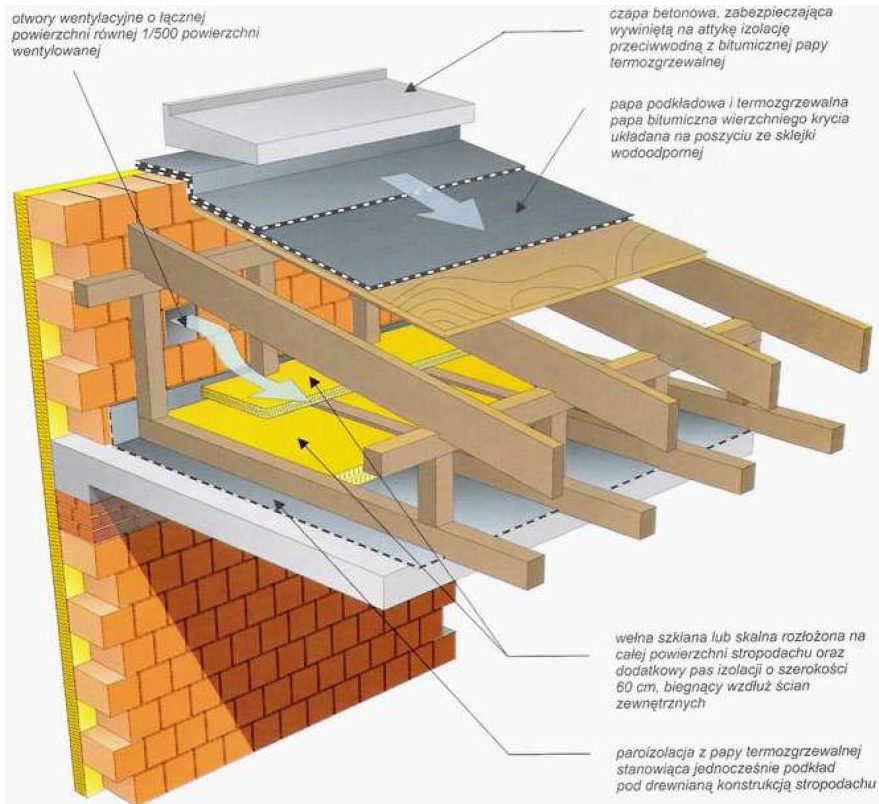
Depending on the method, a distinction is made between:

- flat roofs with a roof based on walls (openwork) laid on the ceiling,
- flat roofs with a light ceiling suspended to the roof structure



Different solutions for two parted ventilated flat roof [3]

# TWO PARTED VENTILATED FLAT CEILING

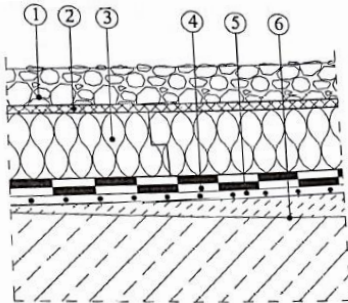


Two parted ventilated flat ceiling [6]

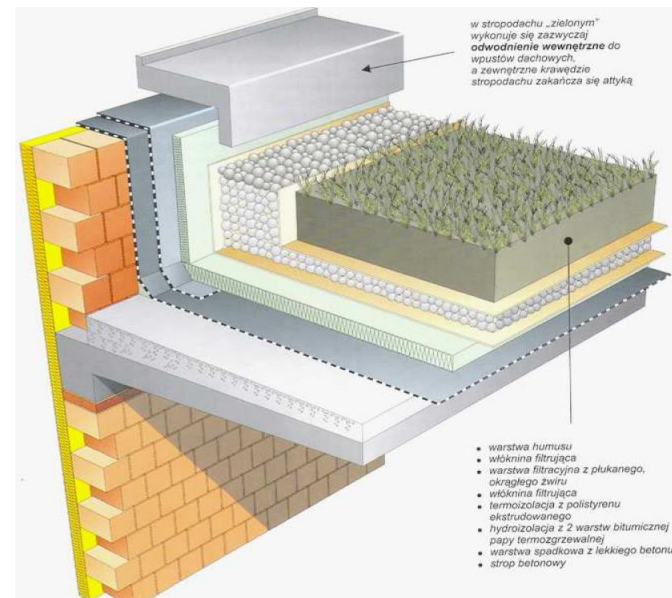
# FLAT ROOFS WITH INVERTED LAYERS

Rested roof is a variation of the traditional flat roof. The difference is that in the roof of the inverted thermal insulation lies above the waterproof layer. The slope of the substrate under the waterproof layer is at least 3%. Waterproof insulation acts as a vapor barrier.

The green roof can be built based on a traditional structure or with an inverted layer system



Layer arrangement in an inverted roof with a gravel layer. [1]



Scheme of a green roof. [6]

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