Polski Komitet Narodowy Międzynarodowej Rady Ochrony Zabytków ICOMOS

Fondazione Romualdo del Bianco

Sapienza Università di Roma

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Fondazione Flaminia per l'Università in Romagna

Sustainable Urban Rehabilitation in Europe

GENERAL BUILDING ENGINEERING

GREEN ROOFS

Erasmus+

HISTORY OF GREEN ROOFS

The origins of the combination of greenery with buildings date back to ancient times. The first gardens on the roofs were constructed in the 6th century BC. in Mesopotamia [1].

Hanging gardens of Babylon according to Martin Heemskerck [2].

HISTORY OF GREEN ROOFS

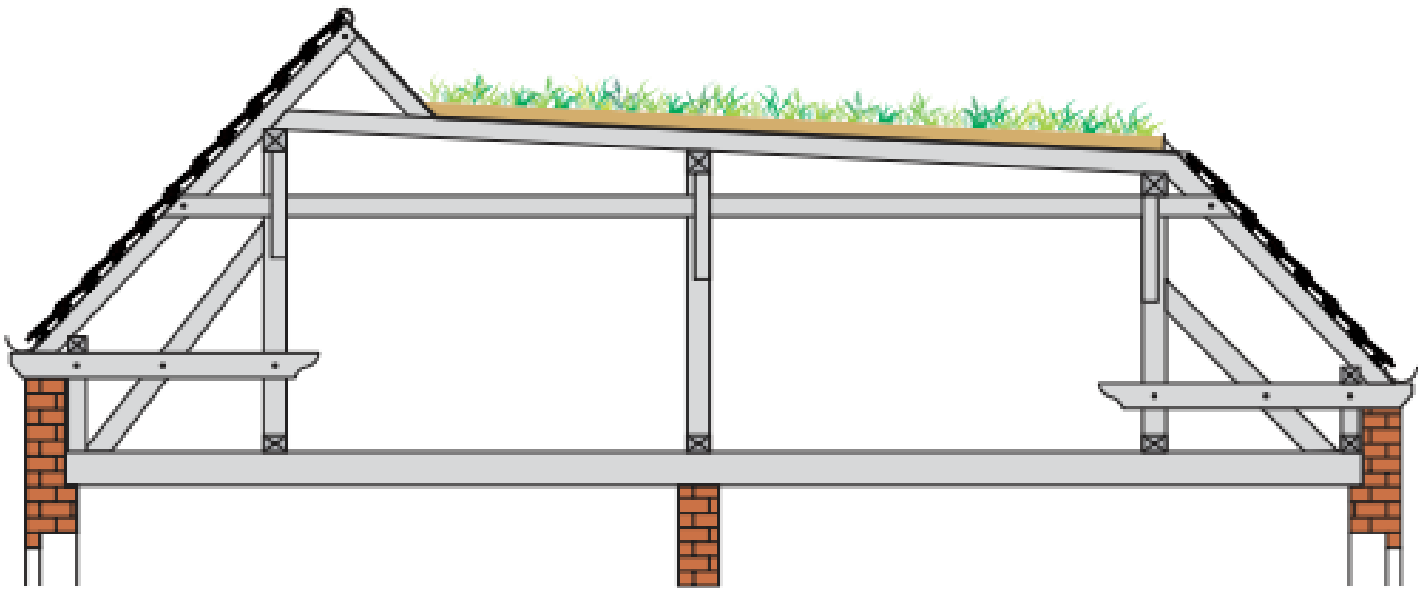
The idea of a green roof is an idea as old as the history of construction. People have covered with sod the huts, mud huts, burial mounds and the first houses [4].

In the north of Europe and the Scandinavian peninsula, turf roofs appeared due to usability and climatic reasons. Roofs overgrown with plants were of special importance there - they protected houses against thermal losses, snowfall and violent winds [5].

Traditional green roofs in the Faroe Islands [6].

HISTORY OF GREEN ROOFS

In the nineteenth century there was a belief that a large amount of uncut greenery in cities gives fire protection, hence Berlin and Silesia introduced greenery to the roofs of buildings, in order to block and nip in the fires of fires [5].



An example of a nineteenth-century asymmetrical truss of the so-called the Berlin roof, made as a Holzamesdach screed roof, with a green flat plane, the insulation of which is Holzzement (wood sealant) [7].

HISTORY OF GREEN ROOFS

The conscious application of greening roofs was associated with the development of materials forming the roof layers. In 1839, a Silesian merchant and producer of sparkling wine, Carl Samuel Häusler from Jelenia Góra, made an invention in the form of a wood sealant (Holzzement) - a mixture of sulfur, pitch, pitch of natural rubber, soot and coal dust - waterproofing [8].

Winery of Carlo Samuel Häusler with a functional roof with a cover made using Holzzement [9].

HISTORY OF GREEN ROOFS

In Warsaw in the years 1818-1821, the Kubicki Arcades were built named after the main architect of the building - Jakub Kubicki. The arcades were connected with the Royal Castle, entering the surrounding gardens [5].

Kubicki's arcades. 19th century green roof in Warsaw (photo by Konrad Brandl from 1899, property of the Historical Museum of the Capital City of Warsaw) [2].

GREEN ROOF NOWDAYS

Contemporary green roofs began to develop in the 1920s. They were popularized by the French architect Le Corbusier (1887-1965) in the idea of roof gardens for utility purposes.

The excess of buildings and the growing population of cities and the need to be surrounded by greenery have contributed to the search for new ecological solutions in the construction industry. "Green" technology developed very quickly and today we have practically reliable roof systems [8].

GREEN ROOF - MEANING

Green roofs - all the places on building structures, which recreate the natural ground conditions, allow permanent creation of biologically active areas, closely related to the construction of the building [1].

Green roof of the shopping gallery in Lublin [9].

GREEN ROOF - FUNTION

Green roofs are created to complement the biologically active surface at low expenditure.

The basic functions of green roofs include:

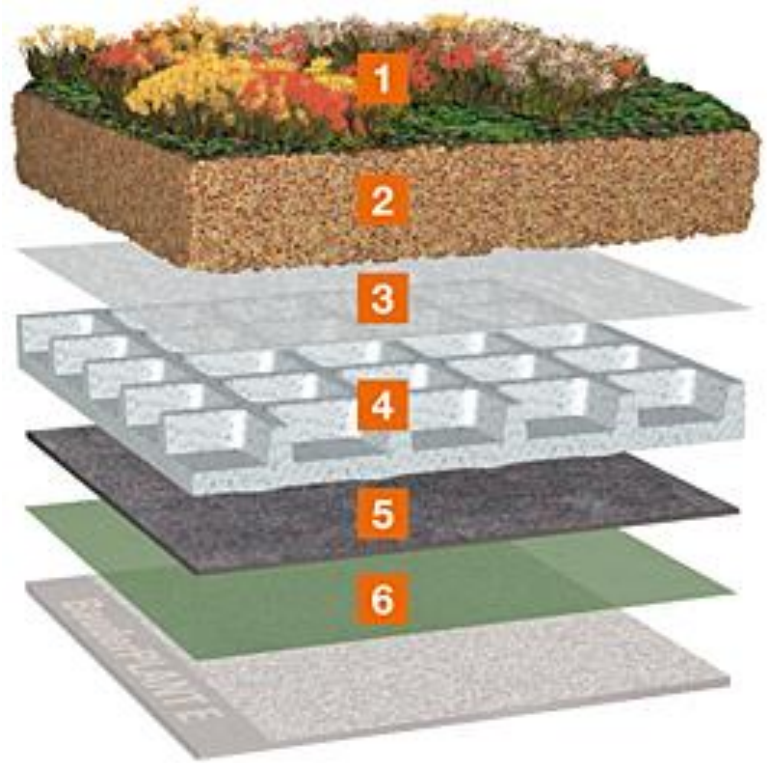
- creation of biologically active area,
- protection of the roof covering,
- reduction of outflow rainwater,
- additional thermal insulation,
- reducing the effect of "urban heat islands",
- absorption of dust and reduction of air pollution,
- increasing the acoustic insulation,
- they regulate the air humidity and reduce the temperature by a few degrees directly above the roof slope increasing aesthetic values [1].

GREEN ROOF

The green roof is a multi-layered structure. Depending on the conditions of the substrate on which the greening is to be made and planned, the structure may be more or less complex. Six basic elements are the basis for the green roof solution:

- plant layer (1),
- vegetation layer (2),
- filtration layer (3),
- drainage layer (4),
- protective layer (5),
- waterproofing layer (6),

thermal insulation layer.



The structure of the green roof [1].

PLANT LAYER

Due to plant species, the following types of greening can be distinguished:

extensive - the aim of greening an extensive roof is to plant on its surface vegetation characterized by low weights and requiring minimal care and a small space for the development of roots; roof weight <200 kg / m2.

Green roof with extensive greenery [13].

PLANT LAYER

intense low - this type of greening includes perennials, lawns, shrubs that must be subjected to care treatments.

Green roof with green intensive low [14].

PLANT LAYER

intense high - a type of greenery that requires constant care and irrigation. The possibilities of planting all kinds of plants, including trees, as well as creating gardens with small architecture are used. Layer system must be carefully selected in terms of collecting and draining excess water and overcoming problems related to harmful effects of vegetation on the structural layers of the roof.

Green roof with intensive high greening [14].

VEGETATION LAYER

The growing layer makes it possible for the plants to rooting and to grow properly. It has to retain water and nutrients, aerate the substrate and be resistant to erosion caused by atmospheric factors. For the proper development of plants on the roofs, appropriate mixtures are used, so-called substrates.

An extensive substrate used in green roofs [16].

Required characteristics of roofing substrates:

- composed of porous, frost-resistant mineral components (eg volcanic lava, pumice, perlite, crushed brick, slag),
- high water storage capacity,
- ability to retain rainwater in the vegetation layer and guarantee the outflow of its excess from the drainage layer.

FILTRATION LAYER

The filtration layer is used to clean the water penetrating the lower layers. Prevents deposition of fine particles floating in the drainage layer. By protecting the green roof system against silting, it also prevents too much outflow of rainwater from the vegetation layer. Generally for this purpose, polypropylene geotextile with a basis weight of min. 200 g / m2 [1].

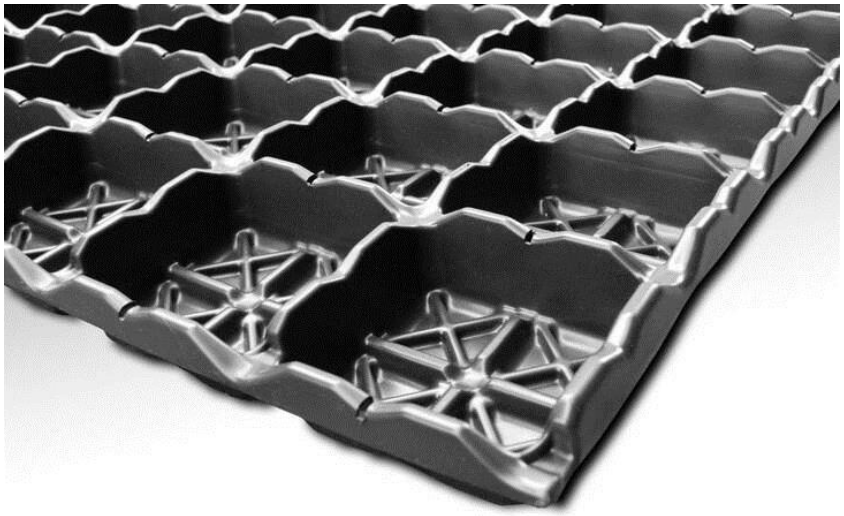
An example of filter geotextile [1].

It also has the ability to accumulate water that can be used by plants.

DRAINAGE LAYER

The drainage layer is the layer in which the distribution of excess rainwater takes place, which can be directed to the retention system (if there is one) or be discharged with roof drains outside the facility. This layer also aerates the vegetation layer. It can be made of loose materials that collect water in its pores, eg volcanic lava, expanded clay or pumice, or special drainage mats of different heights [1].

Drain mat for extensive greening [16].



Drainage mat for intensive greening [16].

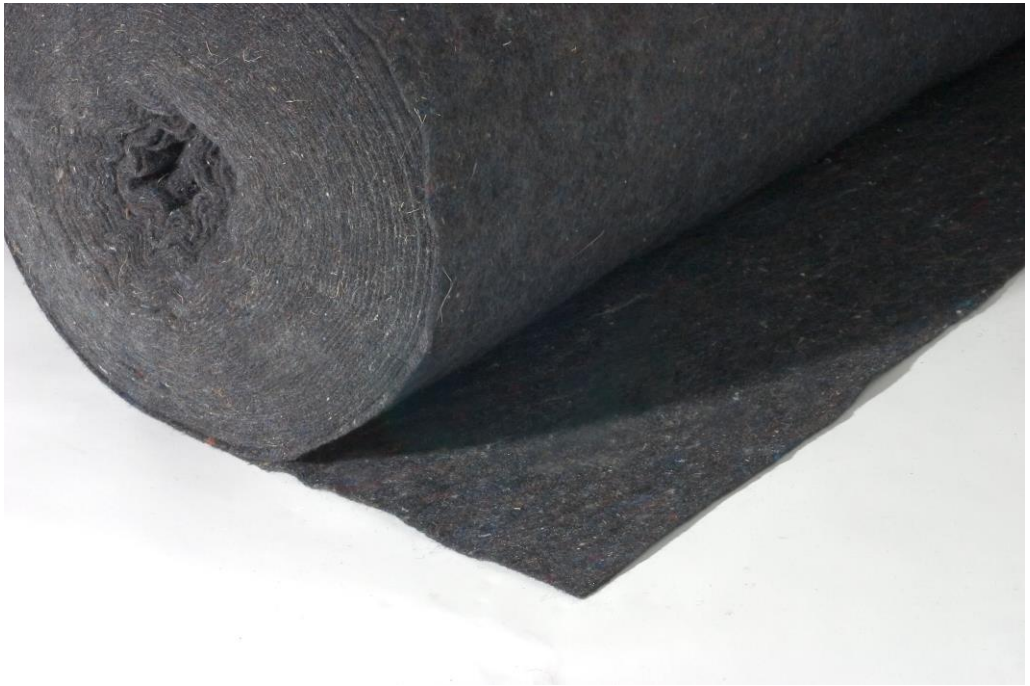
PROTECTIVE LAYER

The anti-rift / separating-protective layer protects the waterproofing insulation and other lower roof elements from the destructive effects of the roots. This layer is a special membrane made of 0.5 mm thick polypropylene or polyvinyl chloride (with extensive vegetation) and 0.8 mm for protection against intense vegetation roots.

Polyethylene backing film [16].

PROTECTIVE LAYER

If the protective layer is made of felt, it should be used felt reinforced with metal foil inserts. As a protective layer also absorbent-protective mats are used, which protect the roof waterproofing against damage, and also store water. In the case of inverted roofs, geotextiles enabling the diffusion of water vapor into the thermal insulation layers are used.



Absorbent-protective non-woven [16].

WATERPROOFING LAYER

Waterproofing features of green roofs:

- waterproof,
- adequate resistance to compression,
- effective protection against overgrowth of plants,
- total resistance to hydrolysis and humic acids,
- full resistance to chemicals and fertilizers,
- total resistance to mold and fungi.

Water protection materials used in green roofs:

- thermo-weldable roofing paper, modified with polymers based on polyester or glass fiber,
- roofing felt resistant to root overgrowing - with a liner made of copper tape or chemical additives preventing root penetration in bitumen,
- self-adhesive bituminous membranes,
- plastic membranes, e.g. EPDM, PVC-P,
- polymer-modified thick films, bitumen sealing compounds, always with a reinforcing insert.

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