GREEN ROOFS IN THE CITY ENVIRONMENT

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Abstract

The purpose of this short study is to present the historical precedents of roof lawns and gardens built in this century, and to show the real possibilities offered by the present level of water-proof building and gardening techniques to improve the city environment. In Europe, particularly in the last decade, the available amount of information on 'green roofs' has increased significantly. The first domestic attempts in the field of 'green roofs' were made in the recent years, but the building profession has not been friendly towards this structural, ecological solution, and it was considered somewhat curious. The main reason for such an attitude is that the available international information (based on experiences, debate papers, studies, guidelines, handbooks etc.) has not reached those professionals, potential investors, and builders whose decision is necessary for the widespread acceptance of 'green roofs'.

1 CONCEPT AND HISTORY

The concept of roof gardens can be traced back virtually to the earliest building activities of man. Throughout the course of history we can see a demand for planting vegetation on roofs, among the most famous being ancient civilization's hanging gardens of Babylon. During the Roman Empire and in the Middle Ages green roofs were used by the ruling classes mainly for showing extravagance. In modern times and especially in twentieth century architecture, green gardens are treated as a natural phenomenon. A special implementation of roof gardens can be observed in Northern Europe's native architecture in its tradition of slanted grassy rooftops. Nowadays and in the age of densely populated urban areas the lack of green turf causes concern, and for this reason the proponents of ecological architecture in Europe have been intensively dealt for several decades with the technical and landscaping issues relating to the restoration of green areas. Long considered as uncommon peculiarities earlier in history, the development of the technical-methodological requirements for roof gardens had not been established, and therefore there was hardly any possibility of their extensive spread.

The experiences gained in Europe during the last 15 years in the creation of grassy rooftops and rooftop gardens, have led to such invaluable sources of information that, with the utilization of currently available roofing insulation materials, it is possible to design excellent multi-layered, well-functioning green roofs. For example, the green roof solutions involving a sequencing of layers and use of suitable materials, introduced in Germany, Austria, and Switzerland, can be adapted well elsewhere. The choice of employed plants and care techniques are dependent upon the climate and geographic location, and therefore cannot be directly adopted. In Hungarian green roofs the use of primarily domestic plants or those alien varieties that have long acclimatised should be considered. There is a good chance of

achieving success of grassy rooftops if domestic, uncultivated, heat and dryness tolerant grasses are used.

Up through the end of the 1970's, in Europe, the concept of green roof was understood to be the so called intensive green roof garden. During the last ten years, however, as a result of a change in point of view, the extensive roofs have become widespread. These roofs have given way to a more ecological city planning concept, especially in the design of extensive industrial buildings. Observation of intensive roofs have shown that the direct utilization of roof gardens is negligible.

2 CONSTRUCTION

Cost cutting requirements as well as lighter roof structures have been motivating forces behind the move toward the use of the thin layered, more economically viable extensive green roof solution. The simpler construction and maintenance options have placed the extensive solution in a more favourable position.

The intensive roof gardens developed well where plenty of water and fertilizer were available, but left alone, they didn't last long.

With extensive roof gardens the dry grasses and steppe-type vegetation gained ground as well as the naturally sprouting and enduring plants. It has been observed that the naturally sprouting vegetation is able to regenerate annually without care.

The green roof solutions common in Northern Europe utilized a thicker layer of vegetation. However, much more precipitation is characteristic in these areas then in Hungary, and there is a higher overall level of humidity as well. In Central Europe the weather conditions for green roofs are somewhat less favourable.

The climate is drier and there is a greater fluctuation in temperature. Therefore, in the case of extensive green roofs, the moisture-balance property of the roofs has to be carefully planned. In these cases the different drainage layers play a significant role (see figure 1) as well as the degree of the slope and the usage of drainage method.

There is a good chance of the survival of the so called simpler intensive green roof solution, which, with some care, can be a viable solution even in Central Europe. In this category, under care, we mean the necessary water supply, periodical addition of nutrients, cutting and mowing.

Based on international green roofing practices, as well as domestic green roofing experiments, it can be determined that currently green roofs are realistic alternatives for the replacement of developed former green areas. The great number of existing flat roofs and those under construction can be converted into ecologically functioning surfaces.

Grassy roofs and roof gardens provide an advantage over insulated roofs and roof terraces. One important advantage is the pleasant, tranquil view. Green surfaces are especially desirable for lessening the rigid, box-type effect of buildings. In the 1920's Le Corbusier, in his acclaimed thesis on modern architecture, already pointed out the potentials for expanding the active living areas with roof gardens.

Nowadays, the demand for the development of a healthier urban environment is getting more and more urgent since air pollution is nearing the limits of tolerance. The evaporation and oxygen producing effect of the planted vegetation on the roofs of buildings can contribute to the improvement of the microclimate. Evaporation controls the air temperature and humidity, the air becoming cleaner with the increased production of oxygen.

Dust removal effect of vegetation is also significant ensuring more favourable and cleaner living conditions. With the retention of precipitation and the delay of run-off, the green roof decreases the strain on the gutter network. Green roofs planted with vegetation have an increased insulating capacity which improve the balance of energy of the buildings, leading to energy savings. There is no doubt that green roofs cost more and a stronger heavier roof structure is needed. It should be noted, however, that the roof insulation layers held down by the gravel load do not exceed the stress load of the extensive green roof layers.

Figure 1:

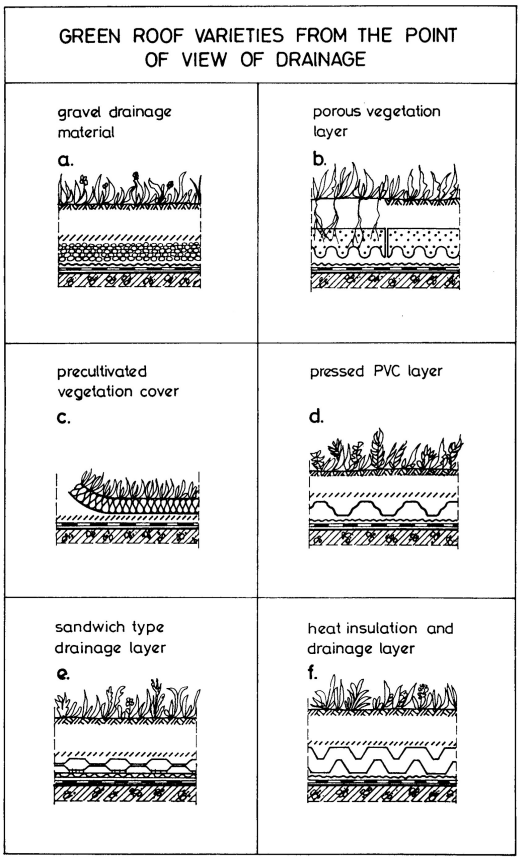

figure 1.

Therefore, we can ask - gravel or grass? - when speaking about the anti-precipitation insulation load on the roof. From an ecological viewpoint there is no doubt about the correct answer. Usually green roofs are classified according to function, type of vegetation, and the thickness of the vegetation layer.

In the case of extensive green roofs we are talking about hardy, dryness tolerant flora above an insulation layer developed with a thin membrane of soil mixture and a water retaining membrane, not suitable for supporting human weight constantly. The thickness of the extensive green roofs is less than $20cm$, and the typical surface mass is less than $150kg/m^2$.

In the case of extensive green roofs, the vegetation layer is made up of dryness tolerant grasses, short rock garden plants, and steppe flora. Usually these do not require regular care, except during the transplanting period. In the case of simpler extensive roofs, the insulation installers, after some training, are able to build up the vegetation layer and do the planting.

Characteristic of the intensive green roofs is that they have a thicker vegetation layer above the roof insulation than the one on the extensive roof, and therefore it can fully be utilized as a roof garden.

They are suitable for different types and sizes of plants from evergreen trees and bushes to shrubs. They require regular care and nutrient additives. They can be functional roof and garden areas, and therefore, some of the elements of garden design can be applied, utilizing pergolas, screening, covered walkways, benches, etc. The thickness of intensive garden roof structures is generally more than $20cm$, usually between 20 and $40cm$. Space must be provided for the developing roots of plants with a larger root system. The mass of the surface structure is more than $150kg/m^2$. The development of an intensive roof garden always requires team work, the cooperative effort of architect, designer, structural engineer and landscape architect is essential. Generally, in practice, green roofs are on built-up roofs, since in the case of the two-crust ventilated roofs, the lighter upper crust is not suitable for the support of more load. Exceptions are those extensive green roofs which are only a few centimeters in thickness, which can be built on the lighter upper crust. Also suitable for green roof building are the built-up roof and the insulated roof membrane application too. In cases of roof renovation, keeping the old insulation layers and with the use of new waterproofing plies as well as preparation additional insulation, the basis of a green roof superstructure can be built up. Naturally, the addition of extra weight on the old roof can only be done if the load capacity of the roof support structure has been properly checked.

Theoretically, a green roof can be built up on the surface of any flat roof, if it is waterproof and the ceiling structure can take the load. Naturally the root resistance protection needs to be dealt with. Basically there are two types of root protection. In the separated type of root protection system the membrane is not root resistant, but the FLL resistance test's four year test period has not been completed to date, and for this reason, it is temporarily used with a separate root protection layer. Therefore, in the case of a separated system of root protection, the root protecting layer is placed on a distinct level. In the case of an integrated root protection system, the waterproof membrane itself is proven to be root resistant, so additional protection is unnecessary. For conventional flat roof solutions, the vapour load coming from beneath must be blocked, since the usual ventilation of vapour barrier is hardly possible, and from an aesthetic point of view, ventilation pipes are to be avoided.

For I.R.M.A. type solutions, the waterproofing membrane is underneath the insulation and there is no vapour barrier layer. This way there are less layers and the construction technology is simplified. As is generally known, only closed cell extruded hard polystyrene foam thermal insulation is to be used (Roofmate), with inset and truss in one layer. Compared to the construction of the conventional built-up roof, about a 20% thicker thermal insulation should be used, due to the moistening of the insulation surface, and the cooling effect this causes. A requirement regarding the load carrying roof structure is the proper heat retaining capacity, with a steel-cement structure roof mass of $250kg/m^2$ minimum criterion. Above the thermal insulation the other layers should be installed with materials suitable for ventilation and diffusion of vapours. In choosing the green roof construction solution with insulated roof membrane application, the rising tendency of the insulation should be considered, and therefore a shallow extensive roof might present an obstacle.

With dual insulated flat roofs, the waterproofing is positioned at the bottom layer which is cheaper

and has a poorer quality, and then, after the possibly required root protection layer, comes the top insulation layer, which has to have the same quality as the I.R.M.A. Here there is less danger of rising then with the insulation of I.R.M.A., here too it should be considered. If the dual insulated roof is new, then the vapour barrier layer is omitted (with engineering approval). If the dual insulated roof is used in the renovation of roof insulation, then naturally, the original layers could contain a vapour-block and vapour-pressure equalizer layer too.

In the renovation of old roof insulation, the lighter extensive green solutions are advisable, since generally the load capacity limits have to be considered. In these cases the use of thin sod or a precultivated vegetation cover would be suitable, with periodical care, considering the climate of Central Europe.

3 SUMMARY

For those future home owners, architects, and builders who accept and assert the views of ecological architecture, the green roof system provides the chance to contribute to an aesthetic and healthy environment with the creation of roofs planted with green vegetation. The technical and landscaping requirements are available for the construction of grassy roofs and roof gardens, the only thing needed is that action follows the words and planning, so that with human constructive capabilities, the areas taken from nature are made to come alive again in our immediate environment.

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