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EVOLUTION OF FLAT ROOFS

BY

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Abstract. Roofs are constructive subassembles that are located at the top of buildings, which toghether with perimetral walls and some elements of the infrastructure belongs to the subsystem elements that close the building. Roofs must meet resistance requirements to mechanical action, thermal insulating, waterproofing and acoustic, fire resistance, durability, economy and aesthetics. The man saw the need to build roofs from the oldest ancient times. Even if the design of buildings has an empirical character, are known and are preserved until today constructions that are made in antiquity, by the Egyptians, Greeks and Romans with architectural achievements, worthy of admiration and in present time. General composition of civil construction has been influenced throughout the evolution of construction history by the level of production forces and properties of building materials available in every historical epoch. For over five millennia, building materials were stone, wood and ceramic products (concrete was used by the Romans only as filling material).

Key words: flat roof; envelope; green roof; membrane.

1. Introduction

Roofs are construction subassembles, located at the top of buildings, which together with the outer walls and some elements of the infrastructure are part of the subsystem elements that close the building.

The main role of the roof is to close the building and to create an interior environment protected from the outside; the roofs are separating elements and at the same time a permanent contact with the environment, performing the role of effective barrier against aggressive factors of external environment: temperature variations, humidity, rain and wind, noise, dust, nuisance.

In roofs structure can be distinguished, most of the times, the following main parts, differentiated by function:

a) strenght structure;

b) layers of thermal insulation, to ensure slope vapour barriers, etc.;

c) wrapping and annexes work (water collecting system, ventilation, ornaments).

For roofs classification be may adopted different criteria namely: the slope used, roof shape, higrotermic behavior, type of roof framing or cover.

Depending on the slope, roofs can be

a) pitch roof, with big slope (21....50%) or with medium slope (8....20%);

b) flat (terraces), uncirculated with slope 2....7% or circulated with slope 1.5....4%

2. Design of Flat Roof

Roofs must meet resistance requirements to mechanical action, thermal insulating, waterproofing and acoustic, fire resistance, durability, economy and aesthetics. Roofs structure are set in relation to these functions taking into account the partitioning of the building, its structural strength and general conditions to be provided in the last level rooms.

To fulfill these functions, structural elements (resistance) and nonstructural elements of the roofs must meet several performance requirements: stability and strength, durability, fire safety, tightness, higrothermic and acoustic comfort a.s.o..

Composition of the roof unit is established in conjunction with the functions that must comply and with the requirements of performance required, taking in to account: the subdivision of the building, the structure strength of construction, the wanted architectural design, the quantity of the rainfall in the area, a.s.o..

Mainly, the roof unit contains the following main elements differentiated by the functions they fulfill:

a) wrapping, with waterproof protective role – can be wooden, card-board bituminous slate, ceramic, metal, galvanized sheet metal, galvanized, aluminum, lead or copper, plastic materials;

b) insulation, with thermal protective role against heat input, including due to strong summer heat and heat loss in winter time;

c) vapour barrier, layers or diffusion channels, to avoid penetration of water vapour, through migration, in thermal insulation;

d) accessory elements, associated to roof, with role to collect and dispose the rain water, perimeter closure, evacuation of water vapour in the atmosphere, lighting.

The functionality of the roof is complex and can be expressed as a set of specific functions as

a) function of water-tightness from precipitation;
b) function of higrotermic protection;
c) function of acoustic protection;
d) function of lighting;
e) function of strenght.

Roofs with low slopes find themselves, in contemporary architecture, broad fields for application, both in residential buildings, social-cultural as well as in industrial applications.

Adoption of flat roofs, with slope less than 6° or 10.5%, is determined by technical design, economy and the architectural appearance of the building.

Flat roof shall be so designed as to avoid deformation, craking of the slab and vertical load bearing elements; under the action of large temperature differences (it is necessary to limit them to 30°C).

It will be avoid large deformations in the secondary elements that support the envelope, thus reducing air and water tightness.

Providing flat roof against cracking will increase the water tightness of the building during operation.

Concept for flat roof as a whole and in detail (in the evacuation areas mourning) must ensure tightness to water from precipitations.

To ensure indoor thermal comfort conditions and to avoid risk of condensation will be adopted an effective thermal resistance of component layers of the flat roof greater then the thermal resistance necessary from condition of minimum heat loss in order to save energy during operation.

It will be ensure normal operation humidity by avoiding superficial condensation and inside the flat roof.

Stresses on the flat roof can become from outside or inside the building, namely

a) water from precipitations;
b) sunlight action;
c) variations of temperature;
d) action of wind and snow;
e) fire action;
f) occasional movement (during repairs) or permanent movement of human;
g) from inside, acts high air humidity.

3. Evolution of Flat Roof

The buildings are designed to provide people the necessary conditions for carrying out their material and spiritual activity. The development of a society, from economical and social point of view, is reflected on the technical level of constructions too.

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until today constructions that are made in antiquity, by the Egyptians, Greeks and Romans with architectural achievements, worthy of admiration and in present time.

General composition of civil constructions has been influenced throughout the evolution of construction history by the level of production forces and properties of building materials available in every historical epoch. For over five millennia, building materials were stone, wood and ceramic products (concrete was used by the Romans only as filling material).

In many places on earth, a roof protects primarily the effects of rain. Depending on the nature of the building or structure, roofs can protect the building from heat, sun, cold or wind.

Characteristics of a roof depend on the design purpose of the building or structure that protects, but also the local geography. Thereby local traditions, existing materials, practices and local laws are limitations that determine the architectural design and construction itself.

In tribal societies of the primitive commune house was simple and at first improvized in caves or built, if one may say, of wood and leaves. The first house belonged to Chief distinct community and the rest of the settlement was built around them or it, if the community was more limited. The houses of this period were very simple, with clear geometric shapes and repeated, very common ones being rectangular or round. Building materials were those provided by nature – wood, earth, stones and leaves.

One of the first roofs was made from earth (Figs.1 and 2) and covered with vegetation, making it practically most part of the time from the relief area that he was located.

Fig.1 – Earth lodge (Glenwood, Iowa)

Fig.2 – Earth lodge (Ocumulgee).

Evolution of flat roofs has depended largely on the environment in which the building was built (climate area) but also on the materials and technology used (Fig.3).

Fig.3 – Neolithic dwelling (3100…2500 BC), Scotland .

Antiquity was the moment when construction of houses began to have clear rules and regulations, when it was laid the foundation of what today we call architecture, when simple improvisations proved themselves insufficient. In ancient Egypt everyone who is not part of upper class was living in small houses, built of burnt brick, with cubic shape, with two to four rooms, with no

second floor. The rich could afford spacious homes, but with the same general plan and used the same building materials. In the Middle East construction depends very much on available materials (Figs. 4 and 5). Where they could manufacture cheep brick most of the houses were in hive of bees or round shaped. Where stone prevails and the wood was hard to find and very expensive homes were of stone, including roofs (Fig. 6).

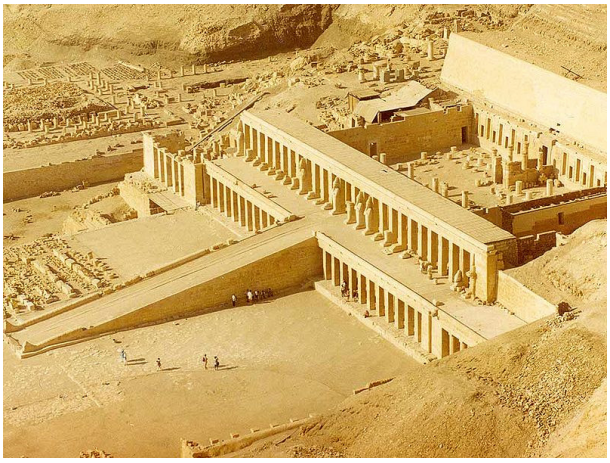

Fig.4 –Queen Hatsepstu temple.

Fig.5 – Mastaba, Egypt.

Fig.6 – Ruins of the Palace of Knossos.

Most buildings which have in their composition a flat roof are found in the Middle East (Fig.7). Flat roof in this area were due to lack of rainfall, besides the role of closing the building at the top and the role of collecting rainwater. Such climatic conditions imposed the embrace of the flat roofs as closing element for the buildings (Fig.8).

Fig.7 – Flat roof from Israel.

Fig.8 – Mosque of Damascus, Syria.

Traditionally flat roofs would use a tar and gravel based surface which, as long as there was no pooling of water, was sufficient to prevent penetration. However, these surfaces would tend to fail in colder climates, where ice dams and the like could blocks the flow of water. Similarly, they tend to be sensitive to sagging of the roof reversing the subtle grading of the surface.

The flat roof has evolved from early roofs covered with sheets of lead, copper or zinc that lasted for more than 100 years. The introduction of the bituminous felt roofing sheet (Fig.9) in the 1960s provided an inexpensive and lightweight material to cover roofs, but the bit felt was prone to leaks and did not last for decades.

Fig.9 – Flat roof cover with bituminous membrane.

The introduction of the flexible polymer sheet provided more longevity and leak protection than bit felt, and should last for 15 years when installed properly.

Thus, evolution of flat roof has reduced to improve these membranes and implicitly resistent to external factors.

Lately developes increasingly more concept type of roof garden or”green roof”. So flat roof evolution was reduced to improve these membranes and implicitly resistant to external factors.

Lately it has developed increasingly more the concept type of roof garden or green roof.

Fig.10 – Green roof.

Throughout history, the green roofs (Fig.10) occurred in those parts of the world where building materials were limited. "Green roof" is considered an European phenomenon, such houses in rural areas are met from various European countries. In Scotland and England phenomenon seems to have a major development in the Orkney Islands (Scotland), green roofs dating from the years 3,600…2,500 BC Construction of this kind is found in some Scandinavian countries, non-European regions such as Iceland and Greenland with a broad tradition in this respect. Some researches show that the United States has adopted this solution for the roof in the Great Plains region.

4. Conclusions

Evolution of flat roofs has depended largely on the environment in which the building was built (climate zone), but also on the materials and technologies used. So they evolved from the first roof made of earth to those made of wood or stone. Once with the reinforced concrete discovery was passed to improve the envelope. The first envelopes were made from sheet of copper or

zinc and then lead, after that it past to covers made of bituminous membranes. Lately it has more and more developed the concept of roof garden or green roof, which is a flat roof covered with a layer of topsoil.

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EVOLUŢIA ACOPERIŞURILOR TERASĂ

(Rezumat)

Acoperişurile sunt subansabluri constructive, amplasate la partea superioara a clădirilor, care fac parte, împreună cu pereţii exteriori şi cu unele elemente ale infrastructurii, din subsistemul elementelor de închidere ale clădirii. Acoperişurile trebuie să satisfacă cerinţe de rezistenţă la acţiuni mecanice, de izolare termică, hidrofugă şi acustică, de rezistenţă la foc, durabilitate, economicitate şi estetică.

Omul a cunoscut nevoia de a construi din cele mai vechi timpuri. Chiar dacă dimensionarea construcţiilor avea un caracter empiric, sunt cunoscute şi se păstrează până astăzi construcţiile realizate încă în antichitate, de egipteni, greci şi romani, cu realizări arhitecturale, demne de admirat şi în prezent.

Alcătuirea generală a construcţiilor civile a fost influenţată în întreaga evoluţie a istoriei construcţiilor de nivelul forţelor de producţie şi de proprietăţile materialelor de construcţie disponibile în fiecare epocă istorică. Timp de peste cinci milenii, materialele de construcţie au fost piatra, lemnul şi produsele ceramice (betonul a fost utilizat de romani numai ca material de umplutură).