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Research paper

Design Features of Thermomodernization of Combined Roofs

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Abstract

Characteristic damages Groups of public buildings combined roofs are distinguished. The recommendations on the thermal modernization of combined roof structures are given. The heat-shielding properties of the combined roofs structures, their moisture state are studied. Recommendations for additional insulation of these structures are given, which allow bringing the heat-protective properties of the considered constructions to construction regulations.

Keywords: *thermomodernization, combined roofs.*

1. Introduction

In modern conditions, the problems of preserving the operational properties of the country's buildings and structures, their repair and reconstruction, and the extension of their service lives is the most important problems has been. The roofs flowing and unsuitable for operation cause huge damage to public buildings and the country's economy as a whole [1-2]. Accelerated destruction of the building structures of coatings and walls under the influence of water requires additional investments for their restoration.
The most common multi-layer roofs of rolled and mastic materials in our country are not distinguished by high long-life durability (5-7 years). In the process of exploitation, they are subjected to various aggressive influences, gradually lose their original properties and in a few years repair or replacement is required [3-8].
A variety of methods for repairing of multi-layered roofs used in the repair practice and construction are not effective enough, since, as a rule, only the damages themselves are eliminated, and not the causes of their appearance. In addition, many of these methods are quite expensive and labour-intensive, and practically none of them economical, reliable, resource saving and safe.

1.1. Analysis of the Latest Sources of Research and Publications

G.G. Farenyuk, G.M. Ageeva, R.A. Timchenko, A.V. Shevchuk researched the modern aspects of ensuring energy efficiency of construction and reconstruction. At present, the authors' scientific potential includes: basic principles for the implementation of energy efficiency policies in Ukraine: energy planning as the initial element of energy efficiency management [9]; monitoring of energy efficiency in Ukraine; the development of programs to improve the energy efficiency of public buildings. Methods of studying the thermal characteristics of complex design knots are presented in the paper [10]. Features of thermomodernization of cold roof spaces are considered in the work [11].

In the scientific works of foreign scientists the attention is paid to the issues of global energy efficiency (C. Henningsen [12]), problems of buildings energy efficiency (W. Forster, [13]), practical and theoretical issues of energy conservation; Problems of building stock thermal modernization in organizational, legal, social, financial and technical aspects.
In the work of S.Servigne, [14] theoretical and practical tools have been developed for the model of energy efficiency studies of buildings. The authors are guided by models for collecting initial data on energy audit. The concept is designed to receive data and to their multidimensional structure. The proposed method [14] considers the energy efficiency of buildings in connection with physical phenomena and user behavior.

1.2. Allocation of Previously Unresolved Parts of a Common Problem

Restoration of the reinforced concrete and stone structures performance should be carried out in accordance with known methods [15], and that is not the subject of this article. At the same time in our opinion, repair and thermal modernization of the roofing carpet has several, poorly understood issues, which we will consider below.

1.3. Formulation of the Problem

The purpose of the work was to identify the characteristic defects, damage to the combined roofs, and determine the recommendations for restoring the operational properties of the space structures.

2. Main Body

The basic typical damages of the combined roofs can be conditionally divided into groups:
- washout of mortar and general brickwork destruction of walls in places of external drainage (fig.1, a, b)

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- weathering of mortar in brickwork, brickwork destruction of the parapet, ventilation ducts, superstructure walls above the elevator shaft (fig.1, c, d)
- destruction of parapet plates (fig.1, c, d)
- separation of the carpet covering from the parapet, ventilation ducts, superstructure walls (fig.1, c, e)
- leakage of the carpet covering in places of metal racks installation, outlets of sewer risers, etc. (Fig.1, f)
- stratification, bloating and tearing of the coating carpet (fig.1, f)
- destruction of the bitumen coating on the roof superstructures (fig.1, g)

- subsidence or incorrectly executed thicknesses of the existing insulation, violation of the drainage slope and the formation of drainage areas (fig.1, h)
- the existing structure of the coating does not meet the requirements DBN B.2.6-31: 2016 "Thermal insulation of buildings" [4].



Fig. 1. The main typical defects of combined roofs: a, b) brickwork destruction of walls in places of external drainage; c) destruction of the parapet brickwork; d) destruction of parapet plates; e) separation of the coating carpet; f) leakage of the carpet covering in places of metal racks installation, outlets of sewer risers, etc.; g) destruction of bitumen coating on roof superstructures; h) violation of the drainage gradient and the formation of drainage areas.

The choice of the most rational repair method of multilayer roofing is quite a complex and responsible task, since the most of the defects and damages of the waterproof carpet are hidden in its internal layers, and the lack of objective and complete information about the technical condition of the roof often causes the operators and repair workers to choose not the best technological solutions, and deliberately inflate volumes and, as a consequence, the cost of repairs (to reduce the risk of renovated new roof leakage). Therefore, the definition of the integrated technical and economic indicators of the materials consumption and the estimated repair performance of public buildings roofs shown the value of particular relevance. To restore the operational properties of the roof covering, it is necessary to dismantle the roll roof covering with an asphalt screed, to carry out the vertical roof re-planning with a layer of lightweight concrete to ensure a slope for drainage from the roof.

To remove the broken brick, the parapet laying around the drainage holes should be disassembled to a width of 800 mm. It is necessary to equip the drainage from the roofing steel with the tray in the gap. The water intake funnel is fixed at a distance of 120 mm from the wall surface. The end surfaces of the rupture in the masonry should be plastered with mortar, 20 mm along a metal mesh and decorated with 2 layers of waterproofing. Fencing in the place of the rupture to arrange with a strip steel 40x5 mm, length 1200 mm on the screw (fig.2, a.). The destroyed parapet slabs should be dismantled and the parquet brickwork should be raised in 4 rows and the damaged parapet slabs should be repaired. In addition, it is necessary to raise the ventilation duct openings no less than 50 cm from the level of the new roofing carpet. Carry out the finishing of the parapet with 2 mm galvanized roofing steel on a 40x5 screw with a pitch of 300 mm. The width of the sheet is 500 mm.

The combined roofing should be insulated with plates of basalt wool with the thickness of 150 mm (according to the calculation for climatic conditions in Poltava). The basis for the heat-insulating layer is the surface of the vapour barrier layer (fig. 2, b.). Mechanical fastening is carried out together with the roofing inner layer with the help of anchors. The installation anchor of the anchor in concrete should be at least 50 mm. Through the thermal insulation drill a hole, the mechanical fastening with a dowel is pressed into the drilled hole.

When fixing the roofing carpet directly to the surface of the heat-insulating layer, the use of an air layer is excluded, therefore, the main elements of ventilation systems are recommended to adopt a system of fly-feathers (aerators). Roof aerators are designed throughout the roof surface evenly (1 piece to 50-60 m^2), at the highest points along the roof slope and valleys. In the lower layer, at the location of the aerator, cut a hole of 120mm in diameter through the heater to the vapour barrier layer. The hole is covered with the expanded clay. For better adhesion of the horizontal part of the aerator to the roofing carpet, apply sealant to its surface. Aerator additionally fix the screws to the screed base: 6 self-tapping screws along the entire circumference of the aerator skirt. Then put on the top layer of the roofing carpet, so that the aerator is of the end fence place of the two roofing panels, the opening should be 150 mm.

Roof carpet should be double. The lower layer, as a rule, is a roll roofing material and a waterproofing waterproofing bitumen-polymer waterproof for mechanical fastening to the base. The top layer is a roll roofing material and waterproofing bitumen-polymer water-resistant with coarse-grained sprinkling from the front side and a polymer film or fine-grained powder from the side, are being welded.

In places where the roof joins the parapets, walls, ventilation ducts, pipes, it is necessary to level the vertical surfaces with cement-sand plaster and arrange the transition rollers to them from the roofing wedge with a slope of 1:1 and a width of 100 mm. Cover the main carpet with a roller and cover with three raised on the vertical surface, additional layers of ruberoid, which smoothly cut off below the roller. Add additional layers to the presentation and cover with a steel apron, which you shoot with dowels. Along the watershed lines (in the valley and on the ridge) over the carpet, two additional strips of roll coating should be glued: the lower one is 800 mm, the upper one is 1000 mm.

Sealing of the passing place through the coating of cold and hot pipes of small diameter (up to 100 mm), as well as other spot structural elements (anchors, etc.) should be provided by installing on a roofing carpet a metal or plastic frame of 50 mm high with filling in Its cavity along the perimeter of the through pipe or anchor of non-hardening mastic sealant; While cold pipes on the length of the passage through the thickness of the coating should be wrapped with a strip of porous rubber on the mastic, and hot pipes on this section should be passed through a large diameter pipe with the filling of the cavity between them with a hydrophobic mineral powder. Caps of ventilation ducts should be covered with a preliminary anti-corrosion treatment.

Insulation placement of the building cover structure is typical placement for combined roofing. Typical existing coating designs (fig.3, a) do not meet the requirements DBN B.2.6-31: 2016 [4], therefore, to achieve the thermal characteristics of the combined roofing of the normative value, external insulation by basalt wool is recommended, according to the scheme (fig. 3, b), where the thickness of the heater δ3 is determined by calculation.

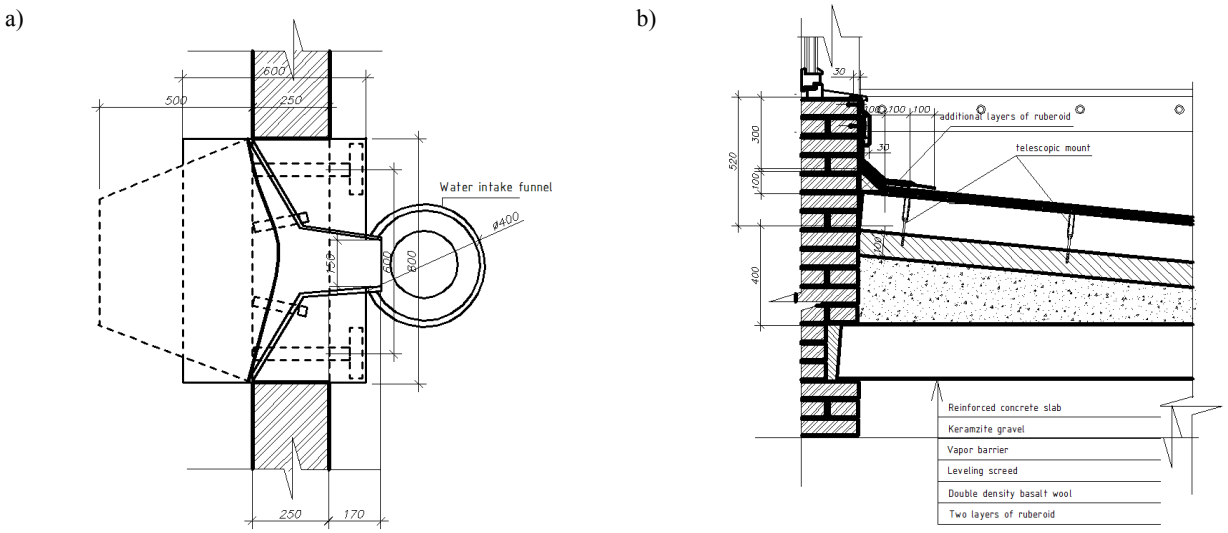


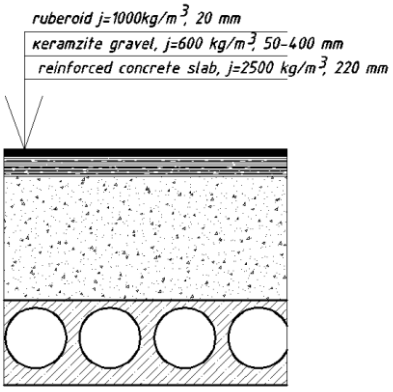
Fig. 2.: The proposed solutions are: a) a drainage unit through a hole in the parapet wall; b) a typical solution of the roofing coating junction to the roof of the combined roof.

To achieve the thermal characteristics of the combined coverage of the normative value for Poltava climatic conditions, it is recommended to insulate with a double density basalt wool (top layer 210 kg / m^3, lower 130 kg / m^3) according to the scheme (fig.3, b) and thickness of 150 mm.

The moisture regime estimation of the combined coatings after thermal modernization was carried out for climatic conditions in Poltava. On fig. 4. The distribution graphs of partial pressures in the thickness of the moisture accumulation period enclosing structure (fig. 4, a) and moisture yield (fig. 4, b) are given.

According to the calculations, it has been established that in this variation of the combined coating on the basis of a hollow reinforced concrete slab with an effective insulation (basalt wool), the condensation process of water vapour takes place during four months: December, January, February, March. During other months of the year there is a process of moisture evaporation condensed. It was estimated the increasing of the moisture content in the material in the thickness of the layer of the structure where moisture can condense during the cold period of the year, which is 0.8% and according to DBN B.2.6-31: 2016 [4], the increase in the moisture content of the mineral wool layer during the cold period of the year is admissible. It is recommended to install a vapor barrier layer below the mineral wool insulation layer in order to prevent accumulation of moisture for the combined buildings coatings.

a)



b)

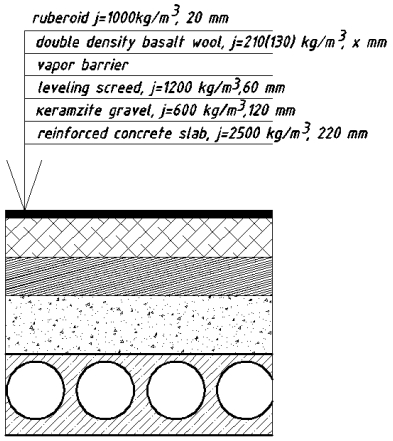
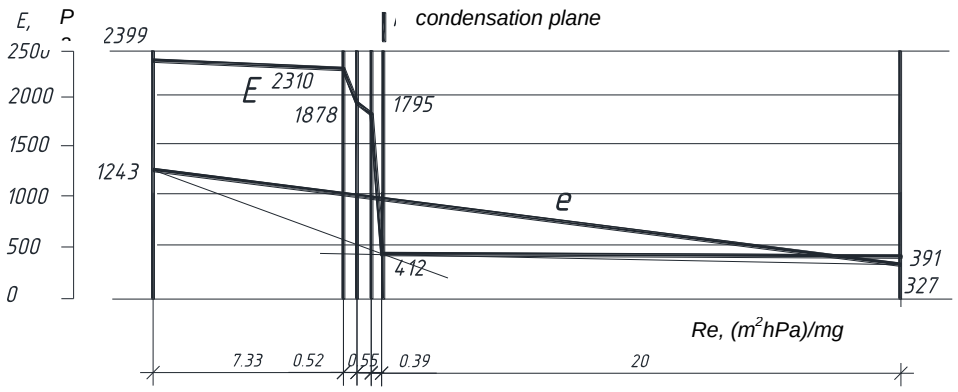


Fig. 3. Examples of typical design schemes for combined roofs: a) existing coating; b) Insulated covering.

a)



b)

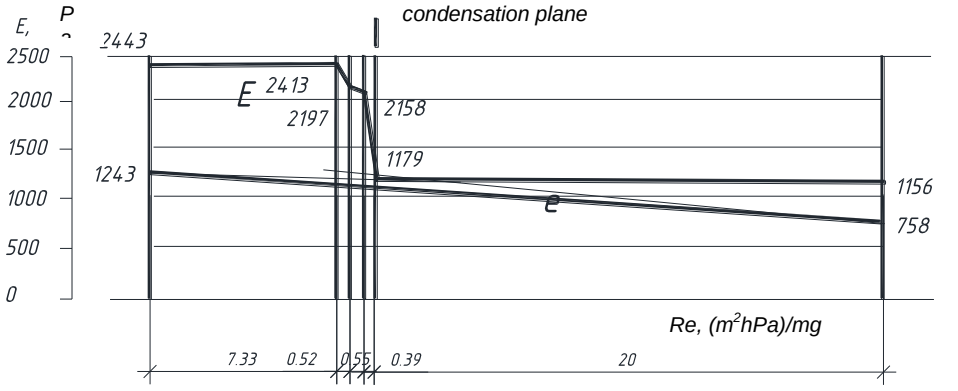


Fig. 4. Graphs of the distribution along the cross-section of the water vapour pressure barriers e and the elasticity of saturated water vapor e and the elasticity of saturated water vapour E: a) the wet accumulation period (January) b) the moisture yield period (April).

3. Conclusion

The proposed constructive solution for repair measures of flat combined roofs of public buildings allows to bring the building's coatings in line with the current building codes and to increase the operational reliability of the building.

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