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RESEARCH OF THE STRUCTURAL, FORMAL AND AESTHETIC CHARACTERISTICS OF THE FAÇADE THERMAL INSULATION SYSTEMS

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Abstract. *The elements of the structure of the façade thermal insulation systems are exposed to various external actions and it is necessary to design and construct them in a manner which would make them resistant to the detrimental influence of the forces acting upon them. The façade thermal insulation system, depending on the structure, may have various impact on the aesthetic and formal possibilities of a structure, in this way influencing the comprehensive impression of a space and its ambient value. This paper was done in the framework of the scientific-research project "Development of the façade thermal insulation system" at the Faculty of Civil Engineering and Architecture of Niš, which is financed by the Ministry of Science, Technology and Environment Protection of the Government of Republic of Serbia.*

1. INTRODUCTION

The architecture as a process is inseparable from the urban living society [1], and creation of the approprieta living ambient is its constant characteristic. The Architectonic style, manifested through the façades which enwrap the buildings, participates in the creation of an image of the city scape, and in this way, in the aesthetic sense, in the quality of living in the city.

The color and design of a façade, as well as its composition which represents the introduction of order and regularity [2] into the relationships of the composition elements which are the basic factors of construction of the architectonic space, contribute to the formation of the ambient value of the space. The concept of ambient comprises creation of the harmony in using the space, which will create in people the pleasant disposition towards this space [3] and mutual permeability of the buildings, immediate environment and its users.

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A quality formed façade enriches the geometrical form of the building, makes it vivid and contributes to the creation of the visual identity of the ambient, because the façade material and the properties of its appearance are inseparable from the impression of a space.

The façade thermal insulation systems are applied for improving thermal protective characteristics of external building walls. They are relatively easy to construct, and may be applied in the newly built structures, as well as in the energy revitalization of the existing buildings, which is the present trend in many countries. The energy efficiency and the quality of the thermal insulation façade form directly depend on the structure, that is, characteristics of the components, as well on the exploitation conditions [4]. The structure of the façade thermal insulation system also affects its aesthetic and formal possibilities.

2. RESEARCHT OF THE STRUCTURE OF THE FAÇADE THERMAL INSULATION SYSTEM

The façade thermal insulation systems are applied on the exterior of a building, and with respect to the fact that they are exposed to the mechanical, actions, substrate effects, solar radiation, wind action, water and dampness, it is necessary to the adequately design and construct them in order to prevent the detrimental consequences of the said actions.

2.1 Ftis structure types :

There are the following types of the façade thermal insulation systems structure:

- Adhesive fixed polystyrole systems
- Adhesive fixed and anchored polystyrole systems
- Adhesive fixed systems with mineral wool
- Adhesive fixed and anchored systems with mineral wool
- Façade thermal insulation system with the bearing hook
- special structures of the façade thermal insulation systems
  - aerated façade with the façade thermal insulation system
  - façade thermal insulation system with ceramic lining.

In the Figures 1 and 2 the examples of the façade thermal insulation systems with and without anchors can be seen:

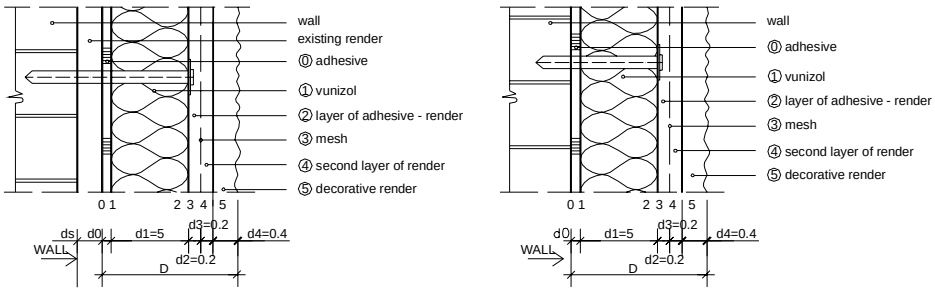

Fig. 1. Façade thermal insulation system with anchors

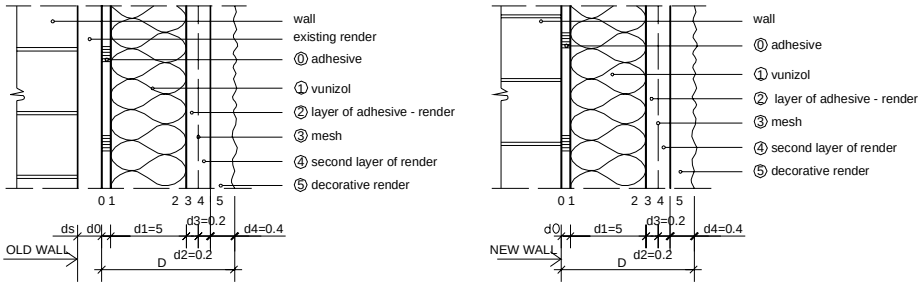

Fig. 2. Façade thermal insulation system without anchors

2.2 The façade thermal insulation systems structure components

The façade thermal insulation systems structure components consist of:

- rendering system
- thermal insulation material system
- anchors – system for mechanical fixing of the thermal insulation system
- façade thermal insulation system adhesion system

2.2.1 Rendering system

Rendering system consist of two layers:

1. inner basic layer (I render)
2. outer protective layer (II render)

The rendering system at the level of the basic render has the "protection – reinforcement grid".

At rendering systems it is possible to apply the thin and thick rendering system.

2.2.2.1 Thin rendering systems

It is possible to construct the thin rendering systems as :

a) Artificial resin system, of total thickness $d_3 + d_4 = 4 – 6$mm.

b) Modified mineral system of artificial dispersion of total thickness $d_3 + d_4 = 5 – 10$mm.

2.2.1.2Thick rendering systems

Thick rendering system is the mineral light system with total thickness d3 + d4 = 8 – 16mm.

2.3 Thermal insulation material system

The thermal insulation render defines the façade thermal insulation system structure type, which can be:

a) a system of expanded polystyrene (EPS)

b) a system of expanded polystyrole (XPS)

c) a system of mineral fibers – plates of mineral wool (FS+).

2.4 Anchors – system for mechanical fixing of the façade thermal insulation system

The anchors, as a system for mechanical fixing of the façade thermal insulation system are made in different sizes and types. The selection of sizes and types is performed on the basis of the structural design, and they are installed if it is required by the design. According to the manner of installing the mechanical fixing system may be:

- ram anchors,
- anchors wich are being screwed.

2.5 Adhesion fixing system for adhesion of the façade thermal insulation system

The adhesives are the materials for binding the façade thermal insulation systems to the basic substrate – the wall, and they are made on the basis of:

a) prefabricated system for application (wet systems)

b) powder dry mixture to be applied after dissolving.

The characteristics of the adhesive material must satisfy all the standards and the thickness of the adhesive application is within d = 2 –3 mm.

3. ANALYSIS OF THE FORMAL AND AESTHETIC POSSIBILITIES OF THE FAÇADE THERMAL INSULATION SYSTEMS

Façade thermal insulation systems, apart from the structural requirements, should, through the aesthetic and formal possibilities, provide a representative character and identity to a structure. Façade facing helps create the primary plastic (surface finishing and colors), as well as the secondary plastic (special elements).

Regarding that this façade thermal insulation system is a supported structure, the formal and aesthetic possibilities may be attained by:

- following the formal elements of the basic structure,
- own formal possibilities.

Following the formal elements of the basic structure comprises bay windows and wall piers and other formal elements on the façade.

Application of own formal possibilities, as the façade facing is in question, comprises alterations in the casing thickness, as well as the different finish of the finishing layer (decorative render).

By altering the thickness of the casing (facing) – in the formal and aesthetic sense - the horizontal and vertical elements on the façade, and the individual parts of the wall mass are accentuated and the windows are articulated.

The accentuation of the horizontal and vertical elements on the façade is the common principle of composition and aesthetic formation, which is frequently applied in architectonic design. The accentuation of the horizontal lines on the façade is desirable at the higher structures, as may be seen in the Figure 3:

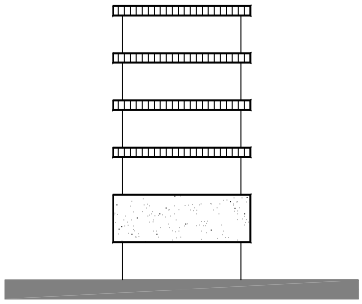

Fig. 3. Accentuation of the horizontal elements on the façade

The accentuation of the vertical elements on the façade is usually applied at low, ground level structures with considerable length, such as the industrial sheds, as may be seen in the Figure 4:

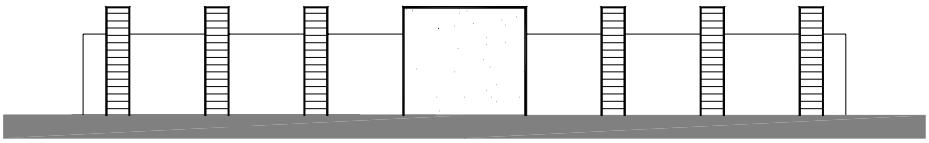

Fig. 4. Accentuation of the vertical elements on the facade

Variation in the casing thickness may be related to the reduction of the thermal bridges in the horizontal and vertical ring beams, which in aesthetic sense means discontinuing the façade plane along the vertical, that is, horizontal line. Thus, a certain rhythm as the composition element of the façade is introduced, and the contrast of the horizontal and vertical lines adds to the mobile character of the façade. An example of the increase of the thickness of the thermal insulation in the part of the horizontal ring beam, which provides the horizontal segmentation of the façade wall can be seen in the Figures 5 and 6:

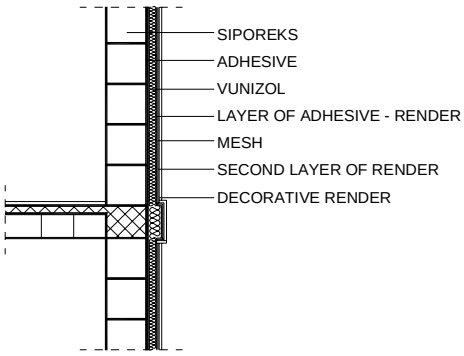

Fig. 5. Variation of the thermal insulation thickness at horizontal ring beam

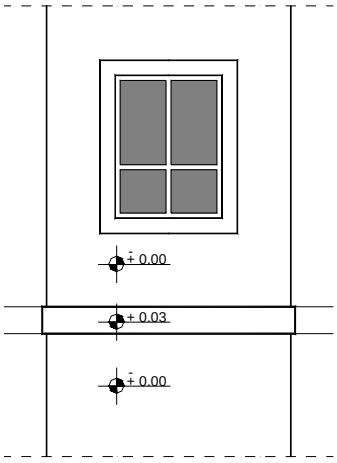

Fig. 6. Variation of the thermal insulation thickness at the horizontal ring beam

The similar effect of the accentuation of the horizontal lines on the façade, by the increase of the thermal insulation thickness in the part of the horizontal ring beam at the points of bay windows, may be seen in the Figure 7:

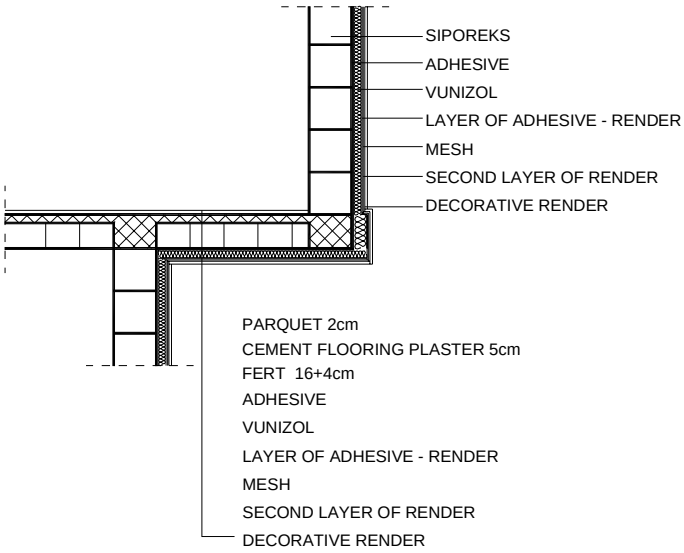

Fig. 7. Variation of the thermal insulation thickness at bay windows

The increase of the casing thickness may be required for the reasons of reduction of the thermal bridges, that is, linear heat losses at windows. In the aesthetic sense, the win-

dow obtains the frame, which provides a quality of massiveness and accentuates the window on the façade. An example of this formal possibility of Façade thermal insulation systems may be seen in Figure 8:

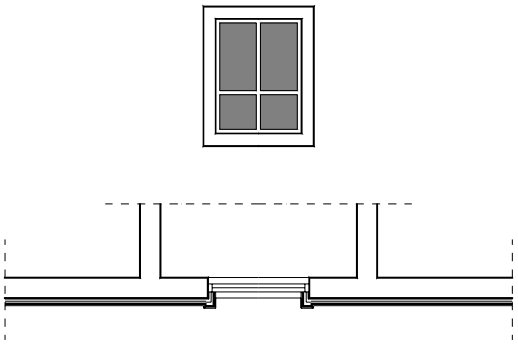

Fig. 8. Variation of the thickness of thermal insulation around windows

The increase of the casing thickness may be conditioned by the reduction of the heat losses of the individual partitions. In the aesthetic sense, the certain parts of the façade walls are accentuated, as well as the conflict of masses, and an effect of dynamical composition and the "dynamic movement of the façade" are achieved. An example of the accentuation of the central part of the faced wall may be seen in the Figure 9:

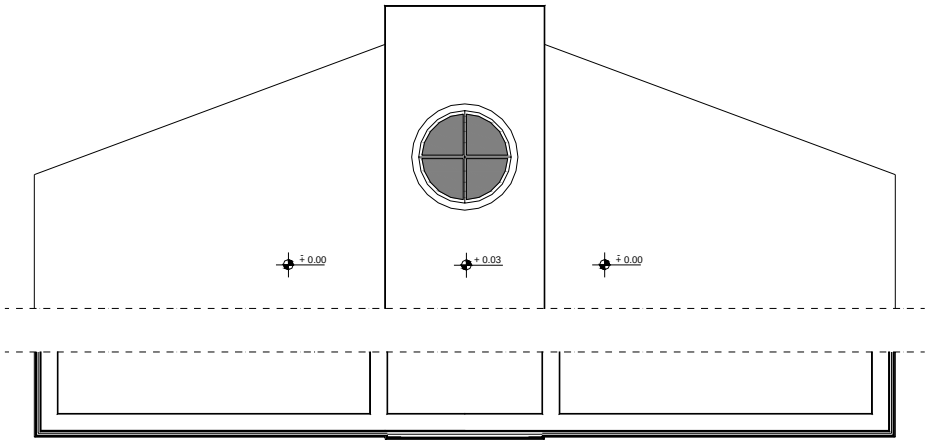

Fig. 9. Variation of the thermal insulation thickness for accentuation of the façade wall

An example of the articulation of the part of the façade plane may be seen in the Figure 10:

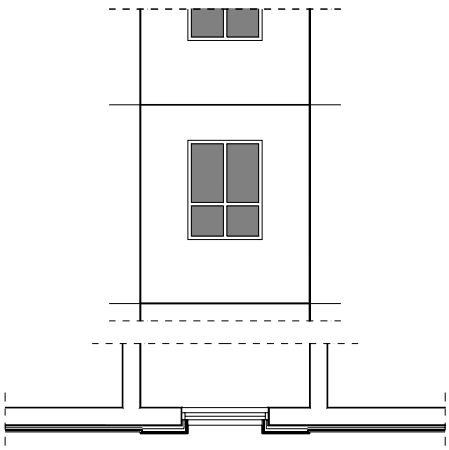

Fig. 10. Accentuation of the façade plane

Varied formation of the decorative render, as the finishing layer in this FTIS, combined with other façade liners (e.g. facing brick), affects the formation of the exterior appearance of the architectonic space forming of its ambient value. On the façade of the structure at Figure 11 the varied formation of the façade render was applied.

Fig. 11. Example of the varied formation of the façade render

4. CONCLUSION

In order to prevent the detrimental effects of the various actions on the façade thermal insulation system, it is necessary to conduct the adequate analysis of the structure and apply the optimal system.

The manner of formation of the façade participates in determination of the architectonic form of the structure, through the color, characteristics of the surface, and it also affects the overall impression the observer might have of an ambient. The façade materials are also significant for the formation of the impression of the geometrical and spatial characteristics of a structure, and participate in the creation of the ambient value and visual identity of the structure and the environment. The façade thermal insulation system applied as in the newly designed structures so as in the revitalization of the existing structures contributes to the energy efficiency of the architectural structures and improves them in the formal and aesthetic sense.

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ISTRAŽIVANJE STRUKTURE, OBLIKOVNIH I ESTETSKIH KARAKTERISTIKA FASADNIH TERMOIZOLACIONIH SISTEMA

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Elementi strukture fasadnih termoizolacionih sistema izloženi su raznovrsnim spoljnim uticajima i potrebno je projektovati i izvoditi ih tkao da je moguće izbeći štetne posledice uticaj a,kojima su izloženi. Fasadni termoizolacioni sistem, u zavisnosti od strukture, može se različito odražavati na estetske i oblikovne mogućnosti objekta, što utične na celokupnu predstavu o nekom prostoru i njegovu ambijentalnu vrednost. Ovaj rad je rađen u okviru naučno-istaživačkog projekta "Razvoj fasadnog termoizolacionog sistema" na Građevinsko–arhitekronskom fakultetu u Nišu, koga finansira Ministarstvo za nauku, tehnologiju i zaštitu životne sredine Vlade Republike Srbije.