УДК 692.23:699.866

ANALYSIS OFEXISTINGINSULATIONFAÇADE SYSTEMS. TESTING OF THERMAL INSULATING PLASTER

Postgraduate studentK. S. Sobinova, PhDO. A. Ozhyshchenko,
Doctor of Technical Sciences, ProfessorM. V. Savytskiy
Prydniprovsk State Academy of Civil Engineering and Architecture,
Dnipropetrovsk

Formulation of the problem. Oneof the acute issuesof construction in Ukraine is the question ofbuilding thermal insulation.Exterior wallsare always under the influence of wind, thermaland mechanical loads, atmospheric precipitation, ultraviolet radiation which form corrosion offacade surfaces and reduce its thermalparameters.

The main part of apartment buildings in Ukraine was constructed in 1960-80s years. Nowadays thethermo-physical parameters of such constructions are farbelow thestandards andit requiresan additional protectionandthermal insulation. In view ofimpossibility andeconomicalirrationality ofthe housebreaking thermal insulation is becoming increasingly important. The high-qualitythermal insulation of the wall isprotectingstructuresfrom the influence ofdestructive factorsandprovides more than 50 percent of energy saving.In addition a variety of materials andarchitectural formsof facade systemsensureseach houses itspersonality andgives a city anewexpressivelook.

Analysis of the publications. Theoretical analysis ofthe literatureand publications about thermalinsulation systems[1 -5] allowed identifying the mostpopular methods of the externalthermal wall insulation.

The objective of the article is analysis of the existinginsulationfaçade systems,identifying the main advantages and disadvantages of each system and choosing the most effective method of building warming.

Materials and methods. Thermal insulation provides maximum saving and comfort in buildings. It can be made both on the internal and the external sides of the construction. But it should be noted that in case ofinternal insulation"thermal bridges" are formedatjoints between thefloor slab and the wall because of impossibility of setting the heat-insulating material there. “Thermal bridges” create the significant amount of loss in the energy we spend for heating our houses. Another majordisadvantage of theinternal insulation is formation of condensationon the inside ofthe wall and theinsulation layerwhich leads tothe creation of mold, fungus and high humidity in the room.

Thereforeexternal insulation is much more effectiveforkeeping normaltemperature and humidity conditions.

There are three main design solutions of the external thermal insulation:

1. System with the ventilated air gap;
2. System of the "bonded" thermal insulation;
3. Plastering façade surfaces with the insulatingmortars.

Systems with the ventilated air gap. Theair gap in “ventilated” facades is situated between the heater and the facing layerand ensures insiccation of heat-

insulating material and wall in case of moistening. It helps to save high heat-shielding index of the system and it works as a protective rainscreen [3].Mineral wool and glass-wool are used as a heating material in this system. It is fixed to the wall surface with the metal dowels and anchors and forms a ventilated air gap. Forventilationand penetrationthe outside air to the gap in the wall there are vents in the lower rowof the masonry and in the cornice[3].

The main advantages of this façade system are a possibility of all-season construction work, low requirements forthe wall surface and a partial maintainability.For the facing layer we can use such materials as brick, different panels and siding, granite or marble tiles and blocks, etc.The main requirementfor the facing layeris highfrost-resistance.

The disadvantagesof the system:1)the expensiveness;2) difficulties during installation of the system elements;3)risk of thestructural andcladdingdeformations;4)disability ofthe façadealignmentin case of monolithic frame deflection from thedesign mark;5)possibility of waterlogginganddurability reducingof facades because of errorsin design and construction.

As practice shows using “ventilated” façade systems with the brick facing leads to accidents concerned with crack formations, brick cladding fracture andcollapse, etc. [2]. Consequently requirements for such constructions are not fulfilled.

System of the "bonded" thermal insulation. The principle of the second system is the creation of monolithic multilayer building envelope working as a unit which ensures durability and reliability. This method is the most traditional and widely used in construction andeffective for allconstruction schemes.

The insulation material (as a rule it’s expanded polystyrene) is fixed to the wall with anchors, dowels or adhesives[3]. The surface of heating material is plastered on the reinforcing grid.There are some special requirements forplasteringlayer: highadhesion,frost-resistance,water vapor permeability, goodheat insulation.The quality ofplastering determinesreliability and durabilityof the system.

System advantages:1) low costin comparisonwith ventilatedfacades;2) high speed of installation;3)providingdifferent architecturalfacadesolutions;4)low weight;5)maintainability.

Disadvantagesof the system:1)work seasonality;2)high demands for wall surface.

The low price of the"bonded insulation" systems provides its high popularity among consumers.The most often used heating materials for thermal insulation are mineral wool and expanded polystyrene which have a very low thermal conductivity ratebut it also has great disadvantages such as combustibility and environmental threat.

Plastering façade surfaces with insulatingmortars.Moderninsulation(“warm”)plasterscombine the properties of insulation and facing materials. It has low thermalconductivity rate andhigh water vapour transmission rate.Plastering gives the building an aesthetic appearance and protects the walls from the influence of unfavourable factors.

Thermal insulationplastersbased on cementand (or) lime, lightporous fine aggregates and special admixtures likewaterproofing agents, plasticizers, air-entrainingadmixtures and etc. Thermal insulation materialsfor“warm” plasterscan be divided intotwo types:mineral aggregates (perlite, granulatedfoam glass) andorganic aggregates (granulatedexpanded polystyrene).

Thermal plastering has following advantages:1) it creates the monolithic and homogeneous layer that protects from “thermal bridges” formation;2) maintainabilityin the caseof mechanical damage;3) high adhesionto suchwall materialsas brick, concrete, stone, some speciescan be appliedevenfor ceramic tiles, glass, and metal;4) high speed ofinstallation;5) does notabsorb water, vapor permeability;6) safe to use, personalprotection is notrequired;7) “warm”plasters with mineral aggregates arefireproof and non-flammable; with organicaggregates are not sustaining the combustion.

Strength properties,flammability and plaster cost depend of aggregate type andits amount in themixture (table 1). Ukrainehas a strongresource baseand production of perliteso its use for drymixturesis relevant andappropriate.

Table 1

Comparison table ofthe characteristics ofthermal insulation mixtures

Parameter	Mainaggregate				
	perlite		granulatedfoam glass		granulated expanded polystyrene
1	2	3	4	5	6
Name	Перлитка ШТ4	Thermo Putz	UMKA UB-21	Thermover	IsoputzExtra
Manufacturer	"Ecothemo perlit" (Ukraine)	"Baumit" (Austria)	'Ecothermo grup" (Ukraine)	"SayThermo Plast" (Turkey)	"Knauf" (Germany)
Astringent	cement	cement, lime	cement, lime	cement	cement
Thermal conductivity, W/ m·K	0,07	0,13	0,065	0, 05	0,09
Adhesion, MPa	0,65	>0,6	>0,2	0, 51	> 0,05
Compression strength, MPa	0, 5	> 1,5	>1,0	1,6	> 0,5
Water vapour transmission, mg/(m·h·Pa)	0,1	8 (EN 998-1)	> 0,34	-	10 (EN 998-1)
Frost-resistance, cycles	50	-	> 35	-	-

Table 1 (continuance)

1	2	3	4	5	6
Combustibility	incombustible				combustible
Package, kg	25	18	7	7	22,5
Price for package, UAH	150	111	135	165	172,52
Amount of materialwith layer thickness 10 mm, kg/m^2	3,2	5	4	3,5	4,5
Price for 1 m^2 layer with thickness 10 mm, UAH	19,2	30,83	77,14	82,5	34,5

In cooperation with "Caparol Ukraine" Company there were made some experimental models of new drymixture forbuilding thermal insulationplastering for detailed examination of its properties. The material was provided by "Caparol Ukraine" andits composition is presented at the table 2.

Table 2

The composition ofdry thermalinsulation mixture

№	Material	Manufacturer
1	Portland cement ПЦІ 500	“Podilskiy cement”, Ukraine
2	Ground limestone (0 – 0,63 mm)	“Gipsovik”, Ukraine
3	Perlite (0-0,125 mm)	"Budperlit", Ukraine
4	Pit sand (0 – 0,8 mm)	-
5	Hydrated lime	"CARMEUS", Romania
6	Methylcellulose Walocel MKW 15000 PP30	“Wolff Cellulosics”, Germany
7	PorophoreHostapur OSB	“Clariant”, Germany
8	Stiffener Solvitoset 112	“Bang&Bonsomer”, Finland, Netherlands
9	Waterproofing agentLigaphob NF	“Peter Greven”, Germany

The optimalwater-mixture ratio (0.3) was defined during the experiment. For studying the new materialproperties and determining area ofits use there has beenmade 27 experimental models for testing strength of material adhesion (9 pcs.), compressive strength and tensile strengthin bending (3 pcs.), rate of water absorption (3 pcs.), crack-resistance (3 pcs.), frost-resistance (6 pcs.),thermal conductivity rate and water vapor transmission rate (3 pcs.)in accordance with standard [5].

The required quantity of mixture and water was mixed by the drill. Metal moldswithout pallets(sizes: 70.7 x70.7x70.7mm, 40x40x160 mm, 150x150x20 mm)

were cleaned,oiled with the mold-parting agent and placed on the wrappedinto moistened newspapersbricks [5].

Molds for thesamples for testingthe strength ofadhesionand crack-resistancewere placed on concretebeams(concrete classB20) preparedin accordance with [5]. Forms werefilledwith the mixtureand left for plaster slurry thickening at T=(20±5)°C and RH=(95±5)%. After 48 hours forms were takedown and experimental models left for thickening in the following conditions T=(25±10)°C, relative humidity according to [5]. Experimental samples for testing the strength of material adhesion after alternate cycles of freezing and defrosting will be transferred to the water bath (T=(20 ± 2) °C) at age of 7 days and nights.

The samples will be testing after thickening for 28 days and nights in accordance with [5]. The results will be published in the next article.

Conclusions

Analysis of various façade systems has shown that method of thermal insulation must create a monolithic multilayer building envelope and providethe most comfortable living conditions. Nowadays the private builder worries about ecological compatibility and reliability of the thermal insulation system. Taking into account the technological parameters, architectural and aesthetic possibilities, economic indicator and thermal properties of insulating plasters this methodsatisfies all the mentioned criteria ofwarming systems.

In developed countries insulating plasters based on a fine aggregate with a porous structure provides high thermal insulation properties of construction. Such mixtures can be produced in our country due to the natural mineral resources and active manufacturing of cementitious materials in Ukraine.

REFERENCES

1. Системы фасадной отделки [Электронный ресурс] / Е. А. Жукова, А. В. Чугунков, В. А. Рудницкая // Научно-практический Интернет-журнал «Наука. Строительство. Образование». – 2011. - №1. - Режим доступа к статье: http://www.nso-journal.ru/images/stories/NSO/2011/01_15.pdf
2. Гагарин В. Г. Теплофизические проблемы современных стеновых ограждающих конструкций многоэтажных зданий / Гагарин Владимир Геннадьевич // Academia. Архитектура и строительство. – 2009. - № 5. – С. 297 – 305.
3. Утепление существующих ограждающих конструкций [Электронный ресурс] / А. Матвиевский, Н. Умнякова – Режим доступа к статье: http://www.maxmir.com/publish/p_tech1.html
4. Теплоизоляционные материалы и конструкции / Бобров Ю. Л., Овчаренко Е. Г., Шойхет Б. М., Петухова Е. Ю. – М.: ИНФРА-М, 2010. – 266 с.
5. ДСТУ Б В.2.7-126:2011 Будівельні матеріали. Суміші будівельні сухі модифіковані. Загальні технічні умови