RATIONAL DESIGN OF THERMAL REHABILITATION OF RESIDENTIAL BUILDINGS

Savitsky N.V., Batasheva K.V., Nikiforova T.D., Yurchenko E.L.
Prydniprovs'ka State Academy of Civil Engineering and Architecture,
Dnipropetrovs'k, Ukraine

Abstract

An important part of expenses for the operation and maintenance of buildings are expenses for energy used for suitable living and working conditions. Expenses for the maintenance of residential and public buildings are in the large scale charging the local communities and the state budget. The expenses for energy are one of the largest that can be supervised and lowered by implementation of the energy efficiency measures. The biggest number of buildings, which operation is based on the municipal budget are the primary schools and existing residential buildings. Systematic financing of the energy restoration of existing buildings offers possibility to decrease energy consumption and expenses and, with the means saved, to create a fund for investing into more intensive actions of the energetic refurbishment or into modernization of the activity.

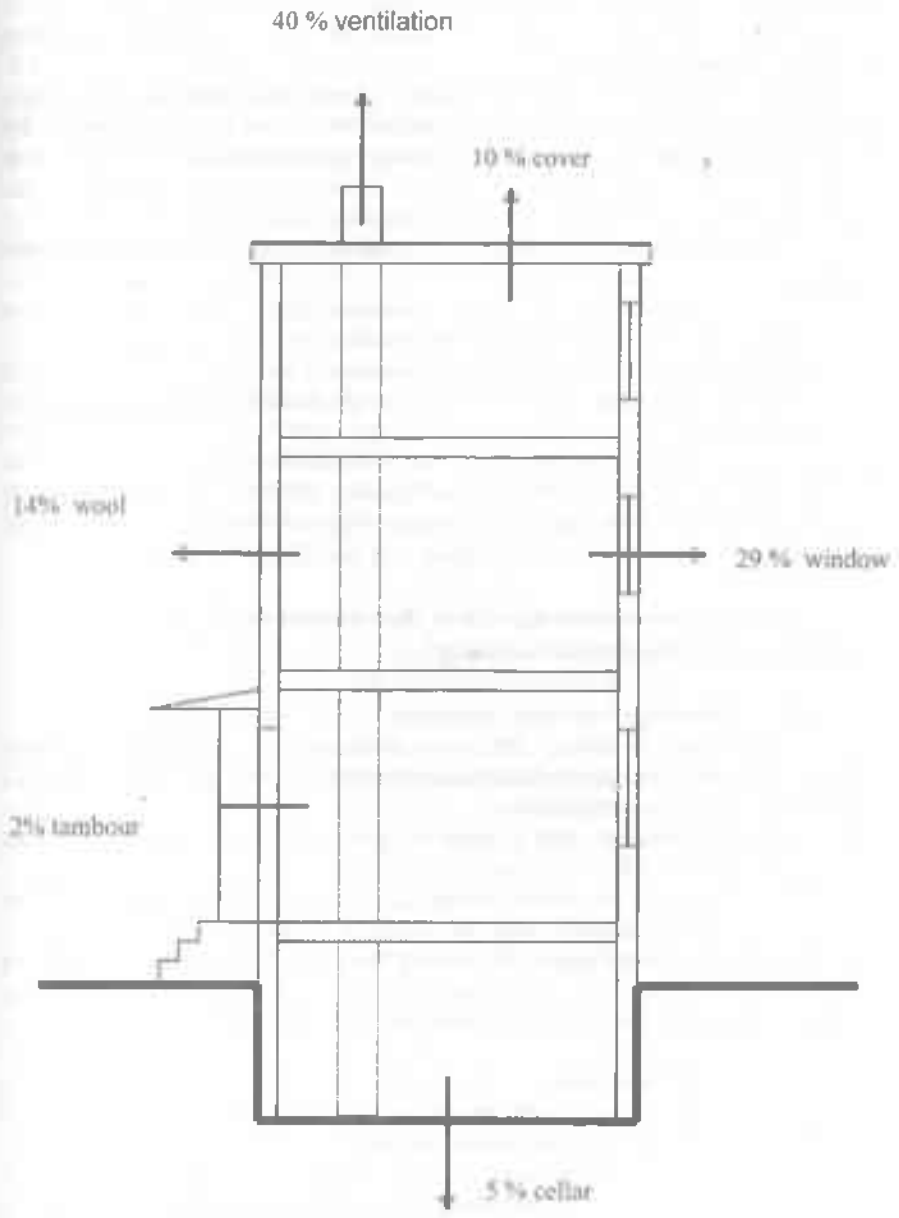
1. Introduction

At present in the existing residential buildings of old design do not answer the new norms of energy consumption, and their protecting structures don't answer the new norms of resistance to a heat transfer (tab. 1). For the introduction of measures on energy conservation it is necessary to make the exact analysis of the thermal costs by elements of a building (fig. 1), and to require clarification of the methods of account the heat losses [1,2]. The economic analysis of measures on introduction of new technologies bases on a methodology «of the indicated costs», that does not answer the new economic conditions. Therefore the basic scientific and technical idea for the realization the thermal rehabilitation projects is the development of scientific bases energy conservation in residential buildings of old design with the purpose of reduction the energy consumption in municipal services sector of Ukraine [3].

Table 1: Present situation in protecting structures R value (m^2K)/W in Ukrainian existing residential buildings (the most widespread series 1.464-D)

Protecting structures	Resistance to a heat transfer, R (m^2K)/W		%
	account values	normative	
wool panels	0,677	2,1	67,8 %
windows	0,377	0,42	10,2 %
cover	0,895	2,5	64,2 %
cellar	0,762	2,4	68,3 %

Figure 1 Analysis of the thermal costs by elements of a existing building



The thermal rehabilitation projects are aimed at further development of calculation and rational design method for thermal rehabilitation projects of large panel residential buildings for the purpose of selecting the most efficient project.
The research is concerned with the development of energy saving scientific bases in existing residential buildings.
The project should include general methods of residential buildings heat losses assessment, and the heat losses evaluation method through the building elements. For the purpose of expediency evaluation of energy saving activities it is planned to develop the methods of cost-benefit analysis of existing residential buildings thermal rehabilitation projects based upon the world experience in investment sector.
Various options of operating residential buildings thermal rehabilitation have been studied:

- application of external and internal insulation layers: (tab. 2: the optimum thickness of a heat-insulating, for requirements of Dnepropetrovsk);
- modernising of windows and doors, insulation of window and door apertures around their perimeter, their efficiency for all climatic zones of Ukraine has been estimated.

An engineering method of building heat loss calculation has been advanced in the part of heat losses through linear heat-conducting intrusions (joints of building envelop elements). For the purposes of engineering heat loss calculations through elongated joints of building envelop a linear heat transfer coefficient is utilised.

2. Technical and economic aspects of the rational design of thermal rehabilitation of residential buildings

2.1. Technical aspects of the work comprise:
- the methodology of energy efficiency evaluation of operating residential buildings by means of improved assessment of climate conditions and by offering a methodology of heat loss estimation;
- the quantitative measure and ranking of structural elements regarding their contribution to the total heat loss have been obtained;
- technical requirements for external insulation and finish systems which will allow further development of domestic external insulation systems have been formulated;
- the potential for energy saving in existing large panel residential buildings in physical and cost values for I - IV of climatic zones of Ukraine is established under execution of complex measures on thermal protection of buildings.

2.2. Economic aspects include:
- the methodology of cost-benefit analysis of thermal rehabilitation projects of operating residential buildings has been developed;
- the evaluation of economic efficiency and estimation of payback period of thermal rehabilitation of residential buildings have been carried out;
- the proposals on the issues of economic, administrative and legal conditions of energy conservation in Ukraine have been offered.

The proposed method of operating residential buildings thermal rehabilitation design is used for determining the optimum values of heat losses for existing buildings accounting for climatic, micro- and macroeconomic conditions in Ukraine.

2.3. Economic appeal of development to progress on the market, introduction and realisation, parameters, cost

The application of research development which has overweight above existing methods of the accounts energy consumption by buildings and modern methods of an estimation of the investment projects is provided at the development of scientific bases energy conservation in residential buildings of old design.

The results of the project which is being developed will allow to determine the actual consumption of thermal energy and fuel by buildings. The obtained values of actual energy consumption will make it possible to assess the benefits of the proposed means of energy saving and select the most efficient.

The cost-benefit analysis methodology will also serve to determine the payback period of the selected projects.

The cost thermal rehabilitation $1 m^2$ of a facade of a building, which makes $10, at the interest rate on the capital 10 % and $15 at the interest-free credit at cost of a thermal energy - 13,6 $/Gcal., and payback time about 10 years is determined on a preliminary economic estimation.

3. Existing results

The energy inspection residential large panel walls of a building of a series 1.464-D (the most widespread series) [4], buildings of public purpose (schools, hospital, building of institutes, building of a hostel) [3] is conducted with the help of a elaboration methodology

The developed methods give the opportunity to determine, the optimum thickness of a heat-insulating, for requirements of Dnepropetrovsk for the thermal rehabilitation projects of residentinal buildings.

Table 2: The optimum thickness of a heat-insulating, for requirements of Dnepropetrovsk [4]

The interest rate on the capital, %	Cost of a heat-insulating material, $/m^3				
	30	35	40	45	50
5	124 163	112 150	103 139	94 130	87 121
10	89 123	79 111	71 101	65 93	59 86
15	67 96	59 86	53 77	47 71	43 65
20	53 78	46 69	41 62	37 56	33 51

The developed methods give the opportunity to determine, the expense of increase of thermal resistance of buildings up to modern norms of the common building thermal losses can be reduced on 31,7 % in comparison with the existing energy consumption level [4].

Conclusion

Results of development can be realised the in different spheres. Rational design of thermal rehabilitation can be efficiently used in the Municipal services sector of Ukraine (for determination of actual energy consumption by buildings and for a choice priority of measures on reduction energy consumption by residential buildings of old design).
Area of management of the thermal rehabilitation projects (at acceptance of the investment decisions, concerning expediency of fulfilment thermal rehabilitation of residential and public buildings in regions of Ukraine).
The results of scientific research work can be used such organisations as:
- State Committee of Ukraine on energy conservation;
- State building committee of Ukraine;
- Regional state administrations.

The results of this work can be also used:
- For the introductions in the normative technical documents;
- At the reconstruction of old residential buildings;
- In the educational process of graduation works.

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