Statyba

ISSN: 1392-1525 (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tcem19

AN ANALYSIS OF FACTORS FOR THE SELECTION OF A TECHNICAL SOLUTION VERSION IN THERMAL RENOVATION OF BUILDINGS

J. Parasonis & G. Ambrasas

To cite this article: J. Parasonis & G. Ambrasas (1995) AN ANALYSIS OF FACTORS FOR THE SELECTION OF A TECHNICAL SOLUTION VERSION IN THERMAL RENOVATION OF BUILDINGS, Statyba, 1:4, 67-74, DOI: 10.1080/13921525.1995.10531534

To link to this article: https://doi.org/10.1080/13921525.1995.10531534

Published online: 26 Jul 2012.

ISSN 1392-1525. STATYBA - BUILDING CONSTRUCTION - СТРОИТЕЛЬСТВО, 1995, Nr. 4(4)

AN ANALYSIS OF FACTORS FOR THE SELECTION OF A TECHNICAL SOLUTION VERSION IN THERMAL RENOVATION OF BUILDINGS

J.Parasonis, G.Ambrasas

1. Preface

Low fuel energy prices, ensuing low normative requirements for thermal characteristics of inclosure walls of buildings and inferior quality of production and construction predetermined the present situation when over 70 million square metres of dwelling floorespace in Lithuania has inclosure walls not meeting the requirements of RSN 143-92 "Thermal Technique of Buildings' Inclosure Walls" which newly came into force. The maintenance of such dwelling houses (flats) consumes a considerable part of owner's (tenant's) income. Constantly rising costs of maintenance call for efficient, simple and inexpensive solutions of thermal renovation.

2. Description of methodology

In this paper, we consider the thermal renovation as work upon the execution of which the heat conductivity of inclosure walls is reduced. Problems related to the reconstruction of technical installations of buildings (heating, ventilation, water and power supply systems) are not considered here.

Lithuania's experience in the field of thermal renovation is not very rich - solitary apartment houses for demonstration purposes (aid of other countries to Lithuania), scarce renovated one-family houses - that is only the beginning of great task. Scientific institutions closely related to the problems of thermal physics and interested in the perspective of thermal renovation, lacking purposeful and systematic support from Government and departments responsible for this section of economy, mostly work on their own risk.

The purpose of this paper is to discuss factors influencing the selection of versions for thermal renovation of buildings. The publication is aiming to describe a certain scheme of factor analysis when selecting a technical solution version for renovation.

When speaking about the versions of thermal renovation solutions, it is necessary to remark that all the solutions corresponding the requirements of RSN 143-92 and fit to use in Lithuania are not unique. Long-term experience of foreign countries in this field (where an interest to these problems arose a few decades ago) allows to adopt efficient solutions and, after insignificant alterations, to apply them in practice. Furthermore, we can rely on the experience of other countries because Lithuania produces no thermal insulation materials the application of which would require unique solutions.

Further on, when discussing about renovation versions of inclosure walls and floors, we shall speak about several most chracteristic versions of thermal renovation solutions intended for each type of wall or floor. Briefly about them. A basement floor can be heat-insulated by fastening the thermal insulation material to basement ceiling or under the flooring of the ground floor. When there is no basement, only the latter version is possible.

The walls can be heat-insulated either from the outside or from the inside. The thermal insulation material is fastened to the wall either by gluing or by means of special anchors on an additional wooden frame or special metal parts. The heat-insulating layer is protected from atmospheric effects by various sheeting's or by a thin layer of plaster on special netting's. The best

factory-like finishing is achieved by heat-insulation from the outside by using the so called "thermoblocks" manufactured by Danish firm "Rockwool" (the production of these blocks has been temporarily stopped). The thermoblocks have a layer protecting from atmospheric effects and need no additional protection. This allows to avoid seasonal restrictions of work.

Cavity brick walls with air gap can be heat-insulated by injecting the thermal insulation material into the existing cavity. For this purpose, holes are drilled in the outer brick wall and through them, using special equipment, the thermal insulation material is applied. It is necessary to note that quality control methods of this type of work technology are still problematic.

Heat-insulation of a flat roof is possible either from the inside or from the outside. When insulating from the outside, the nailing of planks is not required in all cases (the thermal insulation material is laid directly on roofing structures), so when insulating from the inside, the thermal insulation material is often laid between nailed planks or glued to the ceiling.

There is a possible version of renovation when a flat roof is replaced by a gable roof with additional erection of usable mansard half storey.

There are also several possible versions of window renovation: the existing windows are made air-tight by means of various gaskets and sealing packings; a new window (with plastic or wooden frame, with triple glass packet) is fitted into the same or reduced window opening; an additional window frame is fitted into the existing window opening.

Performing thermal renovation of buildings, we are pursuing the following goals: efficient consumption and economy of fuel-energy resources (air-tight windows and low thermal

conductance of other inclosure walls considerably reduce heating expenses); environment protection (the less fuel burnt the less contamination of environment); comfortability (improvement of living and working conditions, cosy microclimate), aesthetics (new high-quality finishing of inclosure walls after renovation).

One of the indexes of economic maintenance of buildings is the consumption of fuel and energy resources. When normative thermal conductance of all inclosure walls is assured during the design of a future building, so automatically is attained (or should be attained if the norms are properly prepared) its integral thermal index, e.g. fuel consumption for 1 cbm of its volume. However, during the reconstruction of existing buildings, it is obviously not always the most economic way to strive for the attainment of normative thermal conductance of all their inclosure walls.

When reconstructing a building and performing its thermal renovation, various technical solutions are possible for thermal renovation of its different partitions (walls, windows, roofing, basement flooring, etc.) and various (imported, local) materials can be used for different and the same technical solutions, there can be various versions for the reconstruction of building's technical installations, various measuring and adjusting devices can be used, etc. The most economic thermal renovation version (from the standpoint of work execution costs, future maintenance costs, etc.) is then selected.

Naturally, a comparison of two versions the one of which foresees to use local materials and the other - the best imported ones shows that renovation costs of the latter version are considerably exceeding the costs of the first version. But the customers will not always choose the cheaper version. Besides, the ratio of maintenance costs can be quite the contrary.

Depending on possessed financial resources, a concrete house can be subjected either to a complex thermal renovation of all its inclosure elements or just to a partial renovation (windows, roof, walls, basement flooring). But in all cases efficient use of investments is impossible without a pre-project diagnosis of the building.

The purpose of the pre-project diagnosis is to evaluate physical state of a building on the whole so that a decision can be taken whether a thermal renovation of the building is worth while doing at all. After this, having arrived at a decision that the building should be refurbished, the state of all its inclosure elements is assessed and the values of their thermal conductance are determined. Simultaneously the, so called, energy certificate of the building is made up. This certificate shows the consumption of fuel and energy resources of the building prior to its thermal renovation.

The results received during the state analysis of the building form not just a database intended for the formation of thermal renovation versions. Simultaneously data is acquired on necessary replacements, reinforcements or improvements and limitations of building structures influencing the selection of thermal renovation version (wooden partitions and other elements, preserved

architectural details, state of inclosure elements, etc.). All of the named limitations can influence the formation of versions. Wooden structures, if the walls are heat-insulated from the inside, require special supports on external walls for wooden beams. The state of inclosure elements decides the choice to refurbish the worn-out structures or to replace them by new ones.

At present, no pre-project diagnosis is being carried out in Lithuania, and calculations in determining the layer of additional thermal insulation for a renovated inclosure element are based on project documentation without taking into account the quality of former construction works and possible changes during the use period.

In many cases the choice depends on financial resources. In order to realise a thermal renovation project for all inclosure elements, considerable capital investments are needed. Having in mind that at present there are no suggestions for cheap and efficient versions of technical solutions, the required resources are becoming the main obstacle.

Part of the solution limitations ensue from the pursued goal (heat-insulation of just a single flat or of the whole house, necessity of exterior finishing, replacement of roof structures, etc.).

Besides, the solution can be influenced by architectural or historical value of a building (external insulation in such a case is not acceptable), seasons of the year ("wet" operations should be avoided in winter), planned time of use after thermal renovation of the building (life time of the used insulating and covering materials should not exceed the life time of inclosure elements themselves) and changes in engineering communications required to be done in order to realise one or another version (new heating system, heat meters, ventilation installations, etc.).

Selection of materials to be used is also an important stage. Efficient, but expensive imported materials require considerable financial resources and, therefore, unaccessible for wide user. Local materials, although not distinguished for high quality, are used more frequently because they are cheaper. This especially can be said about thermal insulation materials. However, local industry produces none of cheap sheet materials for exterior finishing work.

Having investigated the state of a building and possible limitations of solutions, follows the selection of optimum renovation version for each structure (roof, walls, basement floor and walls, windows, etc.). The versions may differ not only by design solution, but also by technological realisation. Here also, the constantly changing subjective factors (customer's needs and his financial capability, aesthetic side of the solution, comfortability of premises after thermal renovation of the building and so forth) should be taken into account.

Almost all of the factors mentioned above exert their influence in the stage of formation of versions and selection of optimum version. For instance, striving for comfortability and aestheticism, we shall have to reject the versions foreseeing the use of cheap and therefore poor finishing materials. Having decided to do all the work on our own, we shall have to choose a

version more simple in technological aspect. When everything is decided by rational longevity, we must give up simpler solutions and cheaper materials.

However, other kind of factors is also beginning to be active in the stage of formation of versions and selection of optimum version. In formation of versions, importance is acquired by the peculiarities of building's structures, of their state and of possible thermal renovation versions. Namely in this stage principal development of further events is decided (decision is made to perform the heat insulation from the inside or from the outside, the problem of replacement or refurbishment of structures is being co-ordinated, etc.). The accepted renovation versions for different structures must be mutually co-ordinated.

Prior to the assessment of versions, it is necessary to make some comments on the sequence in which a thermal renovation version is accepted (see Fig.).

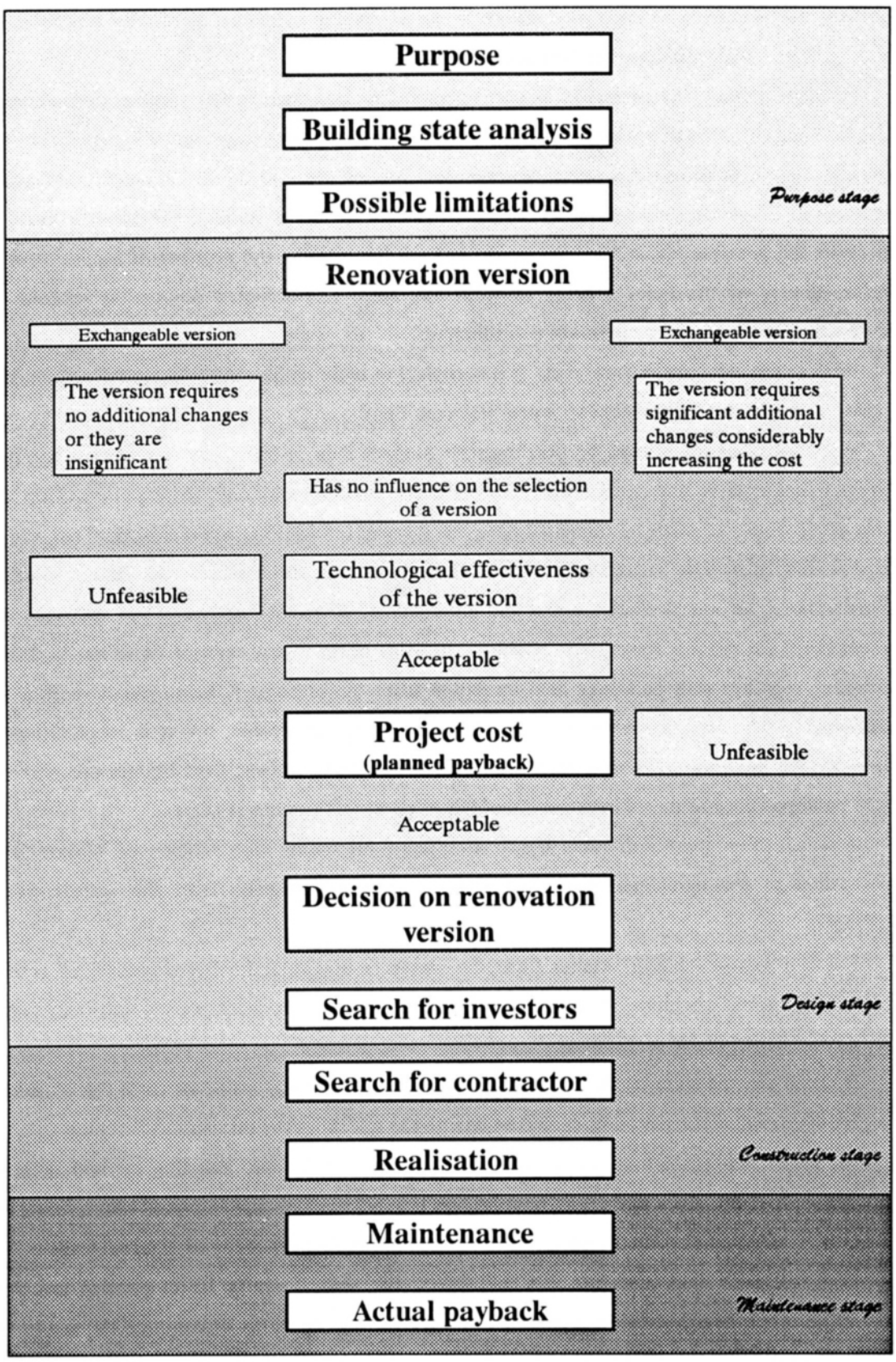
A specialist, basing himself on building state analysis data or construction project (when pre-project diagnosis is not carried out), recommends possible solutions. Basing oneself on the commendations and other accumulated data, the thermal renovation project is worked out and its cost is calculated. The customer here can have influence on the aesthetic side of the solution. Furthermore, he has to decide about the allotment of financial resources. The specialist can recommend (in order to save funds, when the building needs a new exterior finishing) to do the finishing together with building's heat-insulation from the outside. A heat-insulation from the outside can be more expensive than heat-insulation from the inside, but it is more effective. Besides, the building gets a new protection from atmospheric effects, frost bridges are removed (the building keeps nice cool in summer and longer preserves warmth in winter).

A tenant of an apartment house has to co-ordinate his actions with neighbours. Without such co-ordination and agreement on collective financing heat-insulation from the outside is not possible.

When a heat-insulation version from the inside is accepted, further sequence of actions remains the same (recommendations of a specialist, thermal renovation project and cost, search for a contractor, project realisation).

Because the selection of thermal renovation of walls from the inside or from the outside is widely discussed, a few sentences should be devoted to tell about the principal differences.

An inside heat-insulation can be cheaper than an outside one. But this method of heat-insulation does not allow to exclude heat bridges around windows and in places where floors are supported on external walls. Besides, a part of heat-preserving capability of external walls is lost. A room with such heat-insulation gets cold faster (but, also, it can be faster warmed up). And again, an inside heat-insulation in most cases requires to temporarily discontinue the use of the building and to move out the tenants. Although a possibility to do the job independently of neighbours' wishes and capabilities is rather attractive.



Acceptance Sequence of a Thermal Renovation Version

Among the disadvantages of heat-insulation from the outside can be mentioned: higher cost (expensive finishing materials), more complicated work execution technology.

A version of thermal renovation solution, regardless of its constructional advantages, should also be simple in execution. As a rule, such solutions do not require neither expensive powerful mechanisms nor complicated equipment, and construction site for such work is also of minimum size (the work can be normally performed also in narrow old-town streets). Normally, thermal insulation from the outside requires only site-assembled scuffold and, sometimes, special equipment.

Having assessed all the aspects mentioned above and selected an optimum version of thermal renovation, we shall have in our possession all initial data necessary for project-payback analysis. This factor, acting as a feedback information, can also have influence on the selection of a version (if capital investments in a given time cannot be covered by the planned economy of fuel and energy resources, the version should be changed).

A realised version of thermal renovation has also influence on further maintenance of a building. Besides a number of positive changes (they were discussed while speaking of thermal renovation purposes), negative aspects are also possible (if they were not taken care of in the beginning). Well heat-insulated inclosure walls of a building reduce heat losses several times and if no regulated heating system is installed (or surface area of radiators reduced), the rooms will be to hot. Air-tight windows reduce natural air circulation and if the system of ventilation is not changed (a forced ventilation system could be installed), it is hard to speak about the efficiency of renovation because the warmed up rooms will have to be aired more often, and open windows will cause additional heat losses. Knowing what we are aiming at, ways of realisation and how much it will cost, we can look around for financing sources. If a customer personally has enough means, the problem is solved. In all other cases, financial means (or part of it) can be received as a loan from a bank, allotted by special funds or the Government. But this will be feasible only then when the loan granting and repayment (part-repayment) mechanism will be clear and based on favourable conditions. Today's conditions (high interest rate, short repayment time, etc.) in Lithuania do not stimulate investments into thermal renovation.

Having found a financing source and evaluated expenses related with it (bank interest, duration, inflation and so forth) and being in possession of the thermal renovation project, we can choose a contractor. At this stage, it is already possible to make a more exact calculation of the project realisation cost and to correct the calculations of planned payback.

In maintenance stage, are practically confirmed the rightness and efficiency of the chosen solution and the costs of building maintenance can be calculated with greater precision. The received figures allow to check the actual payback of the thermal renovation solution.

3. Conclusion

Especially now, in initial stage of thermal renovation, it is very important to accumulate and systematise the data on each renovated building. It is necessary, by means of corresponding equipment, to carry out observations during maintenance. This would allow to select in proper time versions more efficient for the conditions prevailing in the Republic of Lithuania.

We have discussed in this article the technical problems of thermal renovation of inclosure elements and just mentioned that for this purpose financial resources are necessary. But we also would like to emphasise that thermal renovation in the Republic of Lithuania cannot attain a wide character, first of all, because of the lack of financial resources and absence of credits for broad sections of the population. These problems are very complicated and very important. If they were solved, wide possibilities would open for the realisation of ideas suggested in the article.

ŠILUMINĖS RENOVACIJOS TECHNINIO SPRENDIMO VARIANTO PASIRINKIMO VEIKSNIŲ ANALIZĖ

J. Parasonis, G. Ambrasas

Santrauka

Susistemintai nagrinėjamas šiluminės renovacijos techninio sprendimo varianto parinkimas. Renovacijos procesas analizuojamas keturiose stadijose: tikslų-projektavimo-statybos-eksploatacijos. Šiluminės renovacijos varianto pasirinkimą įtakoja daugelis veiksnių. Straipsnyje nagrinėjama veiksnių įtaka tiek atskirai stadijai, tiek visam renovacijos procesui. Atkreipiamas dėmesys į priešprojektinės diagnostikos svarbą teisingai įvertinant pastato būklę, galimus sprendimų apribojimus ir formuojant renovacijos techninio sprendimo alternatyvius variantus. Kalbama apie skirtingų konstruktyvinių sprendimų privalumus ir trūkumus, įtakojančius pasirinkimą. Atkreipiamas dėmesys į tai, kad, atlikus šiluminę renovaciją, gali tekti tvarkyti inžinerinę pastato įrangą. Pažymima kokybinių rodiklių, pvz., estetiškumo ir komfortabilumo, siekimo įtaka parenkant variantą. Aptariamas susistemintas požiūris į techninio sprendimo varianto pasirinkimą pateikiamas algoritmine forma. Pasirinkta metodika, kuomet investicinis procesas nagrinėjamas nuosekliai pagal tikslų-projektavimo-statybos-eksploatacijos stadijas, leidžia daryti prielaidą, jog tokiu būdu pavyksta įvertinti daugelį sprendimo priėmimą įtakojančių veiksnių.