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enviBUILD

BUILDINGS AND ENVIRONMENT 2014

PROCEEDINGS

18th – 19th September 2014

BRNO UNIVERSITY OF TECHNOLOGY

FACULTY OF CIVIL ENGINEERING

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Preface

Integrated building design tries to find new ways for an optimization of energy consumption and mitigation of environmental impacts of buildings with respect to quality of indoor environment. One of many factors contributing to this issue is application of new advanced materials and technologies.

The 9th International enviBUILD 2014 Conference held in Brno focused on specific issues related to buildings and environment especially in Central European Region. It provided an opportunity for discussion and publishing of most recent findings from scientific and academic community – current issues, technical aspects, recent progresses and future directions in the field of building physics, sustainability and healthy built environment.

This International Conference was organized by the Faculty of Civil Engineering of the Brno University of Technology in Brno, Czech Republic. The conference was held under the auspices of Prof. Ing. Rostislav Drochytka, CSc, MBA, dean of the Faculty of Civil Engineering of Brno University of Technology and supported by partners whose logos you can see in these proceedings.

In these digital proceedings you can find conference papers and abstracts of selected peer reviewed papers implemented in special issue of Advanced Materials Research Journal (full-texts available on http://www.scientific.net/AMR) corresponding with following conference topics:

- Building Materials and Components
- Energy Performance of Buildings
- Retrofitting and Revitalization of Buildings
- Sustainable Building and Environmental Assessments
- Hygrothermal Performance of Buildings
- Indoor Climate, Thermal Comfort and Ventilation
- Daylighting and Insolation
- Acoustics and Noise Protection

Before you start browsing the content of this proceeding, let us express many thanks to everyone who spent their time and contributed to the organization of the conference – members of the Scientific and Organizing Committees, authors, reviewers and editors. We highly appreciate the time and efforts you devoted to the creation of this Proceeding and value your assistance during all phases of the enviBUILD 2014 Conference.

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Construction Details from Secondary Raw Materials Used for Building Envelope

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Keywords: Low-energy, recycled materials, sustainable construction, building envelope, secondary raw materials.

Abstract. One of the important reasons for the choice of the article are increasing requirements from the persons interested in low-energy, passive or even houses with almost zero energy consumption. During decreasing of the energy demand is within the framework of the idea of sustainable construction not only required to decrease the total energy demand of the buildings, search and solve the critical spots in the building jacketing, but also to use the secondary raw materials as full-value substitutions for commonly used products from the primary raw materials. Recycled materials put into production represent possibilities how to decrease number of acquired virgin materials, need of primary energy and how to decrease risks connected to the waste disposal. Society is starting positively approaching to the products that are partially or fully produced from the secondary raw materials.

Introduction

Recycled materials put into production represent possibilities how to decrease number of acquired virgin materials, need of primary energy and how to decrease risks connected to the waste disposal. Society is starting positively approaching to the products that are partially or fully produced from the secondary raw materials. Nevertheless, before the products from the recycled materials enter the people´s consciousness, it is necessary to improve the procedure of waste storing, improve and make the assorting lines more effective, improve or stabilize the material characteristics and products properties, meet the hygienic criteria for usage in the residence houses´ interior and break many more milestones.

Phase is focused on the application of the products made from the secondary raw materials to the building envelope. The products are moulded according to the thermally – technical properties. Performed moulding approved that the products are fully functional and after reaching the required value of heat conductivity coefficient products eliminate imperfections of the solutions used at present. Strapping product for the threshold door joint is registered at Industrial Property Office of the Czech Republic and at European Patent Office at the same time.

Applicable laws, regulations, Czech Republic and EU membership require a reduction in energy consumption. This building is forced to a specific rapid development of new design elements and technology buildings. During the design and implementation of low-energy houses, passive houses and houses with almost zero energy, so there are many controversial aspects that need to be addressed in situ. Accepting already tested details and elements from other states is not suitable due to different climatic conditions in the Czech Republic. It is also necessary to address the issue of municipal and commercial waste. Contact with a view to allowing construction waste, secondary raw materials is not directly offer and has great potential. Municipal waste can be divided into unsorted and sorted (currently there are mainly two types of glass, plastic - usually ungraded, but in several cases closely - PET bottles and paper.

Secondary plastic raw materials in the construction industry represent an opportunity to effectively use waste material. Their workability allows you to create more complex design

elements and accuracy. Characteristics can be compared to some commonly used materials which are used in the construction details, but priority not designed for this purpose [2][4].

Description and Construction of the Threshold Coupling

The threshold coupling helps to remove existing unsuitable underlying layers of threshold of the door construction. It consists of at least two plates of recycled polymer and allows variable connection of waterproof membrane and also variable height setting for different heights of detail, based on various thicknesses of the existing floor and other local factors. The shape of plats is designed so that they fit together, or they are laid closely on each other and facilitate the technological process. Axonometric view of threshold coupling, including the basic dimensions is shown in Fig. 1. The standard width of the plats is 150 mm, which is based on prevailing dimensions of bearing structures, i.e. masonry of width from 250 - 300mm and thermal insulation. For existing buildings is this width useful due to narrowing of the jambs by one or more notches. In case of use in wider vertical bearing structures, it is possible to extend the basic plat set in production. Thickness of the base plat is 20 mm due to production requirements. They are easy to modify by cutting to achieve the exactly required dimension. The plats and their material characteristics are able to bear and pass to the ground the dynamic loads caused by normal operation. The plats are non-absorbent and diffusion closed.

Connecting and anchoring of the plats can be made using bonding, welding or screwing each other. Another possibility is to anchor the plats to each other throughout the entire thickness of the created threshold coupling into the substructure.

The problem with the termination of waterproofing membrane solves this system by pulling of waterproofing below the top plat and covering by the last plat. By connecting of plats to each other the strong and waterproof termination of waterproofing is created. Waterproofing can be variably pulled and anchored to any height and by means of special shaped plats is possible to pass smoothly from vertical to horizontal waterproofing and vice versa. Waterproofing can be variably pulled and anchored to any height and by means of special shaped plats it is possible to put waterproofing smoothly from vertical to horizontal position and vice versa. The problem is also not in material variations of waterproofing elements which are designed both for foil membrane and asphalt waterproofing and the builder is not limited either of existing waterproofing or of newly embedded type of waterproofing [1][3][4].

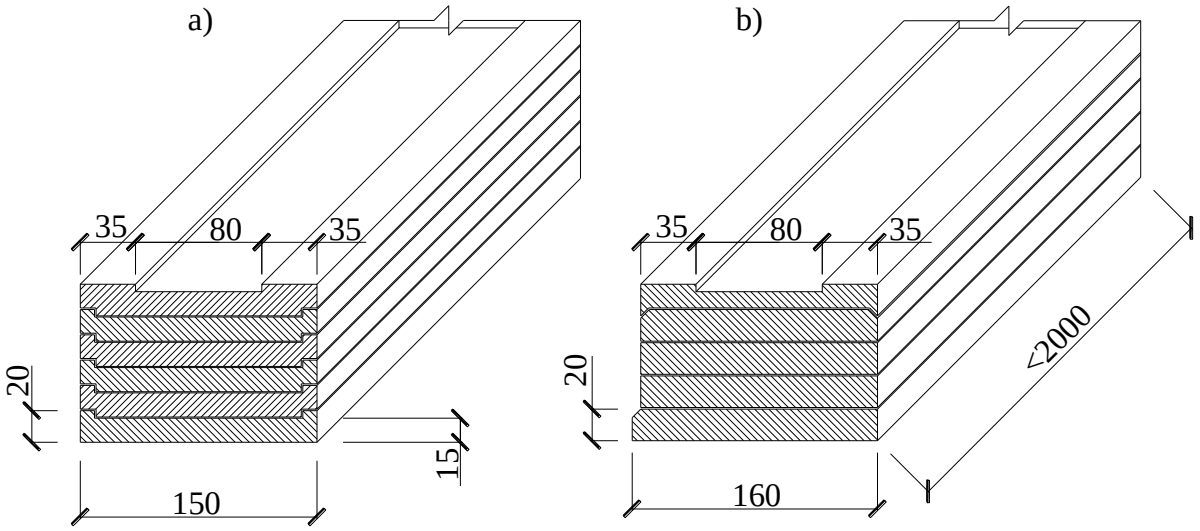

Fig. 1 Alternatives of the threshold coupling made of secondary raw materials - axonometric view

Other uses plates

Due to the constant size window and door construction, it is possible to use a single plate.

Perhaps a variant of the use is in not modular height setting window profile. In the event that the building is built piece of construction materials that can not be cut in the horizontal plane, while the architectural requirement to sill height in atypical height than the time standard or optional bricks can be used plats from secondary plastic raw materials needed to call a sill height (Fig. 2). The plates form a solid base under construction frame and can be re-connected to the support frame. This option is only suitable for full-frontal firm support for the window frame, it is not yet possible applications, including ventilated facades, single-or double-layer construction, which is a requirement for hanging the location of the building fills the hole.

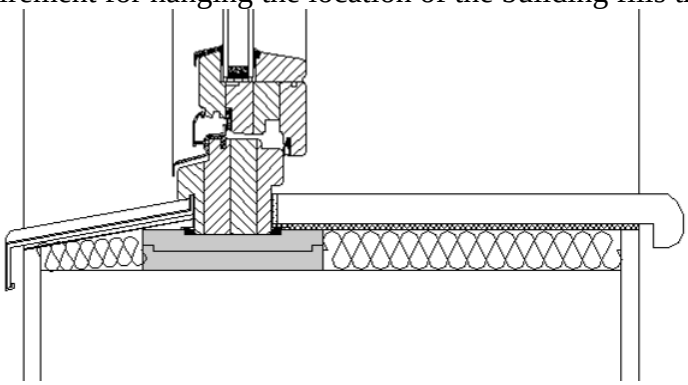

Fig. 2 The alternative use of panels at shoulder for windows - brick building

Anchoring the window, location, outdoor and indoor windowsill, using a special diffusion strips and other technologies incorporated fills the window opening retained.

Suspended facade panels

Facade panels in the base for ventilated facades are not necessary to solve priority in terms of thermal technology. Important criteria are compressive strength, weight, resistance to weathering and chemical and biological resistance. It seems appropriate plastic material with the necessary additives to achieve desired properties.

Skirting plates need to pull the cover waterproofing substructure and possible termination studded film from mechanical damage. Also important is the strength of the façade system to the influence of surrounding traffic was not necessary to constantly repair the surface (Fig. 3).

Plinth is made special foundation cover plate with teeth, which diverts water flowing from the upper part of the building envelope outside panels of the lower mantle. Inclined portion provides drainage plats before and during the winter months helps to prevent the capture and retention lasting snow cover on the plate. Additional internal aeration hole allows the connection of air gaps skirting a higher facade of the building.

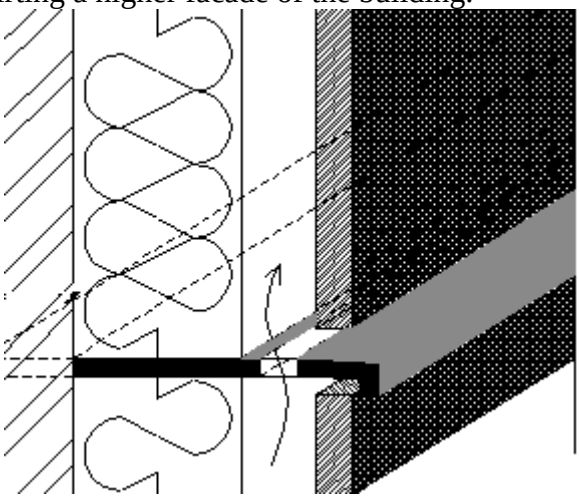

Fig. 3 Cover plate with a beveled edge and aeration hole

The motherboard is possible depending on the thickness of thermal insulation and air gap arbitrarily cut in the rear.

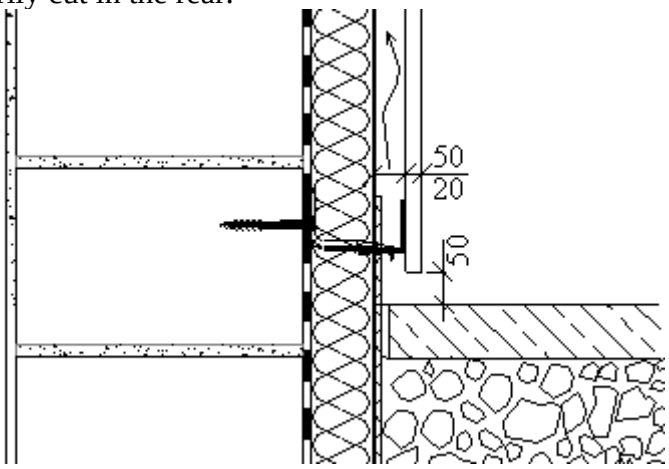

Fig. 4 Detail at the adjacent terrain

Waterproofing of buildings must be removed at least 300 mm above the ground level future. Thermal insulator at a height above the ground is good to protect the diffusion foil (Fig. 4)[4].

Summary

Materials from recycled polymers carry a high potential for use in a broader range of civil engineering. The thermo-technical, mechanical and chemical properties predispose to track where the use of traditional thermal insulation. Using products from secondary raw materials is achieved by a reduction in the thickness of the structure that is not to be used as additional waterproofing or other layers while remaining requirements of technical standards, regulations and laws. The indisputable advantage is the reduction of financial costs during construction.

References

[1] L. Matejka, R. Smolka, Brno University of Technology: Support structures for a doors threshold. EP 2159364 B1, patent. Munchen (2012).

[2] V. Duchacek, Polymers – production, properties, processing, applications, Institute of Chemical Technology in Prague (2006) p. 274.

[3] J. Pencik, L. Matejka, P. Zitt, Brno University of Technology: Material deformation testing stand for the long- term monitoring of deformation characteristics under constant pressure, EP 2078948, patent. Munchen (2009).

[4] CSN 73 0540-2 Thermal protection of buildings - Part 2: Requirements. Prague: Czech office for standards, metrology and testing, 10/2011

Financial Comparison of a Traditional and a Modern Method of a Passive House Foundation

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Keywords: Passive House, Financial Comparison, Granules of foamed glass.

Abstract. When designing a passive house, the emphasis is not only on passive measures consisting mainly of thermal protection and stability of the buildings, but also on the price demand of each of the proposed structures. The paper deals with the financial comparison of the traditional method based on the footings of plain concrete and a modern method of a passive house built of brick construction on the reinforced concrete slab foundation with a thermal insulating layer of compacted subsoil in the form of granules of foamed glass.

Introduction

Financial comparison is made on the family house with external dimensions of 10.5 x 8.75 m (including insulation) built in passive standard. This is a two-storey house with a pent roof slope of 5° is Perimeter walls are constructed of ceramic blocks with a thickness of 250 mm, internal bearing masonry thickness is 240 mm. Perimeter walls are insulated with thermal insulation thickness of grey polystyrene thickness is 250 mm (heat transfer coefficient U for the external walls is 0.09 $W \cdot m^{-2} \cdot K^{-1}$). The roof cladding is insulated with thermal insulation of mineral wool with a thickness of 400 mm, roof heat transfer coefficient U is 0.10 $W \cdot m^{-2} \cdot K^{-1}$). Types of flooring P1 is shown in Figure 2 (heat transfer coefficient U on the ground floor is 0.12 $W \cdot m^{-2} \cdot K^{-1}$). Window and balcony openings are plastic with triple glazing, the heat transfer coefficient of the window U_w is 0.80 $W \cdot m^{-2} \cdot K^{-1}$. The entrance door is also plastic with the heat transfer coefficient of entrance door U_d is 0.90 $W \cdot m^{-2} \cdot K^{-1}$ [1]. Building heating and primary hot water heating is provided by means of heat pumps ground-water. Partial needed of electrical power is provided by 12 pieces of polycrystalline panels with a total installed capacity of 3 kWp [2]. Photovoltaic power plant will mainly supply the photovoltaic heater for heating water using combined AC and DC power and also lighting and small appliances. The building is heated by a hot air regenerative unit.

Total energy reference floor area is 183.75 m^2, the total floor area 147.25 m^2. The total enclosed volume of the heated area is 662.42 m^3. Specific annual heat demand for heating a passive house is EA = 14 $kWh \cdot m^{-2} \cdot a^{-1}$. Construction of the building will begin in June 2014, the authors of the project of the family house are the authors of the paper.

Leading (indicative) prices of construction work are used for financial evaluation of each method of the building foundation. Calculation of the financial evaluation is processed in software BuildPower S from Brno company RTS, with the volume of construction work prices (data base) from the first half of 2012 (RTS 12/1). Retail prices of construction materials are also used (item No. A25-27th and B6.) from the price list of the largest building materials supplier in the Czech Republic [3]. All prices are in CZK excluding VAT.

Method of foundation of the family house on foundation strips

For financial comparison, the structure of the house foundation was proposed on the foundation strips with the same heat transfer coefficient on the field as the founding of the family house on the foundation slab. To eliminate thermal bridges at the foot of the wall, the masonry is based on the foam glass plate with a height of 115 mm. Exterior footings are based in frost-free depth and with

an extension of 150 mm on the inner side of the foundation, see Fig. 1. Internal strip foundation under the load-bearing walls is size 0.55 x 0.6 m. Due to the greater thickness of the floor the overall height of floors of the first above-ground floor was increased. The increased amounts of materials to the second variant are included in items No. A13 to A20.

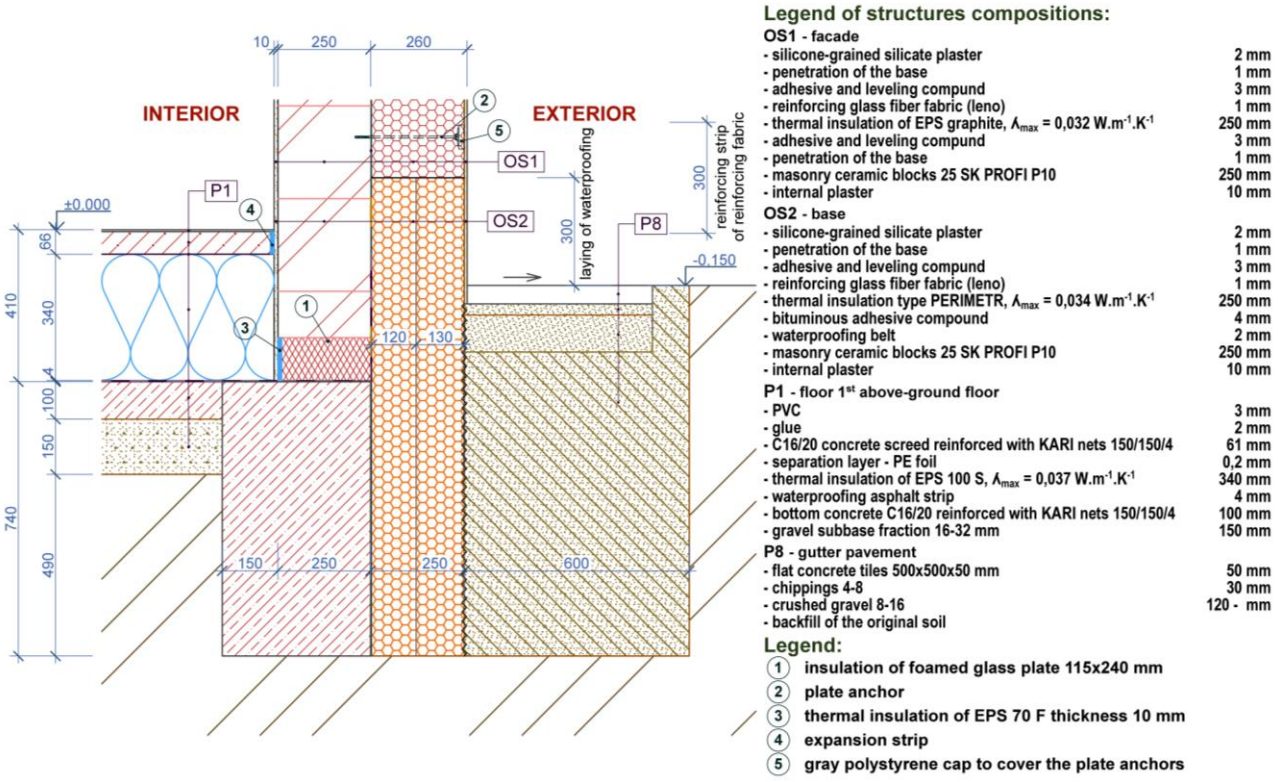

Figure 1. Detail of the family house foundation on foundation strips.

The following Table 1 shows costs of building materials and labor including the amount when founding the family house on foundation strips.

Table 1. Costs of building materials and work when founding the family house on foundation strips.

Serial No.	Description	UM	Amount	Cost/UM CZK	Cost CZK
A1.	Removal of topsoil	m^3	59.287	46.00	2727.23
A2.	Excavation of foundation pits without sheeting	m^3	24.538	270.72	6642.97
A3.	Trenching to a width of 60 cm	m^3	2.984	657.37	1961.59
A4.	Trenching to a width of 200 cm	m^3	33.815	410.87	13893.93
A5.	Horizontal transfer of excavated material within 1000 m	m^3	79.770	80.70	6437.47
A6.	Backfill of pits. trenches with compaction	m^3	30.729	61.20	1880.65
A7.	Gravel sand fraction 0 - 32 B	t	15.11	317.50	4799.74
A8.	Reinforced concrete of foundation slabs C 16/20	m^3	6.108	2555.62	15609.73
A9.	Reinforcement of foundation slabs with welded mesh	t	0.123	24981.71	3083.24
A10.	Plain concrete of foundation strips C 16/20	m^3	14.806	43564.29	37853.89
A11.	Wall formwork of foundation strips - installation	m^2	45.550	376.57	17152.76
A12.	Wall formwork of foundation strips - removal	m^2	45.550	76.47	3483.21
A13.	Installation of geotextile	m^2	36.575	15.96	583.74
A14.	Geotextile 150 $g \cdot m^{-2}$ width 200cm 100% PP	m^2	39.501	15.40	608.32
A15.	Ceramic blocks 17.5 Profi P10, width 175 mm	m^2	0.876	538.90	472.21
A16.	Ceramic blocks 24 Profi P10, width 240 mm	m^2	0.892	672.11	599.86
A17.	Ceramic blocks 25 SK Profi P10, width 250 mm	m^2	4.437	989.63	4391.48
A18.	Partitions 11.5 Profi, width 115 mm	m^2	0.738	409.36	302.11
A19.	Plaster of interior walls, lime-cement mortar	m^2	15.508	190.50	2954.27
A20.	Insulation system EPS graphite width 250 mm	m^2	1.540	1278.48	1968.86
A21.	Thermal insulation of floors dry - installation	m^2	70.020	29.12	2038.98
A22.	EPS board 100 S width 200 mm - delivery	m^2	71.42	452.00	32282.02

A23.	Thermal insulation bonding - installation	m^2	39.660	86.29	3422.30
A24.	Board EPS PERIMETR 120 + 130 mm - delivery	m^2	27.489	679.90	17354.79
A25.	Plate glass insulating foam 450 x115x240 mm - delivery	Pcs	87.000	451.24	39273.54
A26.	Plate glass insulating foam 450x115x175 mm - delivery	Pcs	17.000	388.41	6602.97
A27.	Plate glass insulating foam 450x115x115 mm - delivery	pcs	15.000	296.47	4475.05
A28.	Material transfer	t	70.482	211.46	14904.20
Total cost ex VAT		Rounded to CZK			**249659.00**

Method of founding a family house on the foundation slab

In the process of establishing a building on the foundation slab with a sub-base of the foam glass granulate with a thickness of 400 mm it is necessary to make a drainage layer of sandy gravel fraction 0 - 32 mm with a slope to a drainage pipe below it. In case of a change of the direction of drainage piping drainage well must be designed. According to the statistic calculation there is designed reinforced concrete slab of reinforced concrete C20/25 reinforcing grids 100 x 100 x 8 mm at the upper and lower surface. Reinforcement of reinforced concrete slabs comes to 100 $kg \cdot m^{-3}$ of concrete. Types of flooring including basic dimensions are shown in Fig. 2.

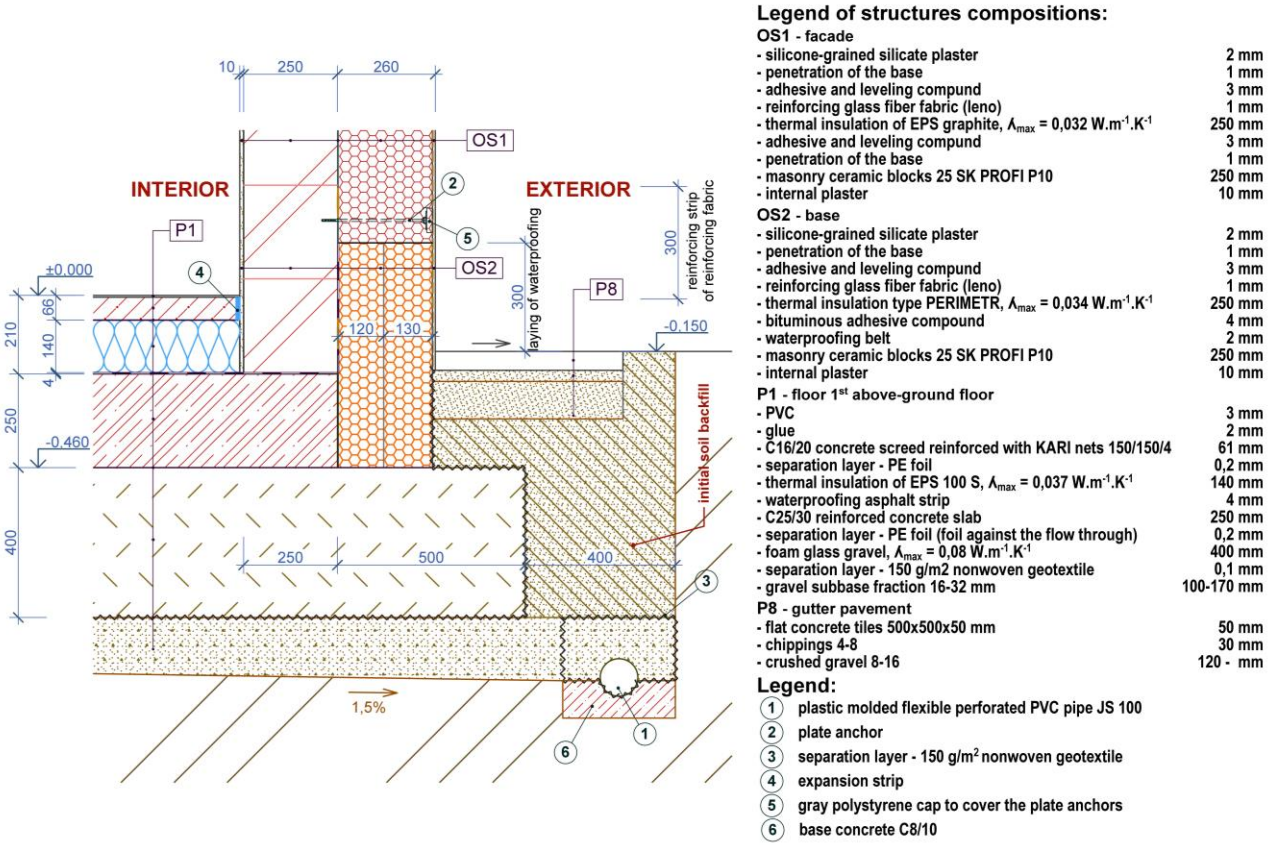

Figure 2. Detail of the method of founding a family house on the foundation slab.

The following Table 2 shows the prices of construction materials and labor, including the amount when establishing the family house on the foundation slab.

Table 2. Prices of building materials and labor when founding the family house on foundation slab.

Serial No.	Description	UM	Amount	Price/UM CZK	Price CZK
B1.	Removal of topsoil	m^3	59.287	46.00	2727.23
B2.	Excavation of foundation pits without sheeting	m^3	68.440	260.50	17828.75
B3.	Horizontal transfer of excavated material within 1000 m	m^3	96.312	80.70	7772.39
B4.	Backfill of pits, trenches with compaction	m^3	75.094	61.20	4575.79
B5.	Gravel sand fraction 0 - 32 B	t	33.264	317.50	10561.48

B6.	Granular foam glass insulation, particle size 30-60mm	m^3	52.910	1497.85	79251.24
B7.	Reinforced concrete foundation slabs C 20/25	m^3	23.125	2640.00	61050.00
B8.	Wall formwork of foundation slabs - installation	m^2	11.550	517.00	5971.35
B9.	Wall formwork of foundation slabs - removal	m^2	11.550	78.10	902.06
B10.	Reinforcement of foundation slabs	t	2.312	25730.00	59500.63
B11.	Installation of geotextile	m^2	210.840	15.96	3365.01
B12.	Geotextile 150 $g \cdot m^{-2}$ width 200 cm 100% PP	m^2	227.707	15.40	3506.69
B13.	Drainage bed of plain concrete	m^3	1.275	2388.02	3044.73
B14.	Drainage from drainage pipes DN 10 cm without bed, PVC	m	50.000	39.30	1956.00
B15.	Normal drainage shaft from PE	ks	4.000	2406.93	9627.72
B16.	Fixing manholes	kg	8.000	47.46	379.68
B17.	Cover to the shaft tube 315 mm / 1.5T PP	ks	4.000	381.00	1524.00
B18.	Laying the insulating film, including PE film delivery	m^2	91.875	27.42	2519.21
B19.	Transfer of materials	t	104.584	211.46	22115.42
Total cost ex VAT		Rounded to CZK			**298208.00**

Conclusion

In the final financial evaluation of both variants the cheaper one is the variant of founding the building on foundation strips with the price of 249659 CZK without VAT, while only the board from foam glass comes to approximately 50000 CZK without VAT. Variant of founding the building on the foundation slab with a sub-base of the foam glass granulate comes to 298208 CZK without VAT, which is 20 % more than the first variant. From the perspective of the total price of the family house (3.0 million CZK without VAT) price increases by only 1.6 % more than the first variant. However, the variant of founding the building in the passive standard shows the positives in the elimination of thermal bridges (the establishment of a continuous thermal insulating envelope of the building without thermal bridges), followed by the perspective of time (time savings when realizing substructures) and technology (effort).

The aim of the authors of the paper is to investigate the course of the temperature field using temperature sensors in the soil under the floor of a passive brick house based on a reinforced concrete foundation and compared with theoretical calculations of the temperature field.

Acknowledgement

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References

[1] P. Oravec. *Windows in Buildings - Diagnostics of Selected Properties after Time of Using*. Advanced Materials Research. 2014, vol. 899, pp. 184-187. DOI: 10.4028/www.scientific.net.

[2] J. Labudek and P. Oravec. *Energy Solar Wall in Low-Energy Apartment House*. Advanced Materials Research. 2013, vol. 649, pp. 155-158. DOI: 10.4028/www.scientific.net/AMR.649.155.

[3] M. Jašek, Finanční porovnání tradiční a novodobé metody pro zesilování zděných sloupů (Financial comparison of traditional and modern methods for strengthening of masonry Columns [in Czech]). *Sborník vědeckých prací Vysoké školy báňské – Technické univerzity Ostrava, řada stavební, řada stavební,* 2012, roč. 12, č. 1, s. 81-86. ISSN 1213-1962.

Architectural Concrete: Aesthetical and Constructional Considerations of Design

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Keywords: Construction, Material, Architectural Concrete

Abstract. With an ever-accelerating technological progress, the question of the use of advanced materials solutions in architecture acquires new dimensions. The use of architectural concrete is particularly interesting in terms of architectural design for its indisputable aesthetic qualities, but it is a challenge in terms of technical solution difficulty. Requirements for the energy efficiency of buildings are constantly growing. Sandwich structures gradually replaced unsatisfactory single-layer structure used in the first half of the 20th century. The new millennium has brought the trend of single-layer monolithic thermal-insulating concrete. A further increase in requirements for thermal protection of buildings however caused that the solutions which have been used only recently are today substandard. Looking ahead, the combined systems using active thermal insulation and multiple layers with different thermo-physical properties are therefore particularly promising.

Introduction

At first concrete found its use in the building industry as a high-strength material that is also non-flammable, non-toxic and able to withstand natural disasters (such as earthquakes). The appearance of its surface was, however, in its infancy aesthetically unsatisfactory. Aesthetic potential of concrete became the centre of attention in early 19th century, when the period of search for the expression and form corresponding with the nature of the new material has begun. But real revolution in its use as a mass-faced material extends from the mid-20th century. Concrete acquired specific characteristics based on various factors (aesthetic, statics, physical, environmental, economic), which it responded to in its development. Flexibility concrete allowed this material to transform into substance denying its primary essence - the essence of liquid stone. However, most of the presentation and method of use claims affecting architectural aesthetic and physical (Thermal), which caused the most pronounced changes in structures of architectural concrete.

The method of its presentation and use influenced the architectural, aesthetical and physical (thermal) demands that caused the most notable changes in development of architectural concrete.

Subject of research

Subject of research is the analysis of parallel evolution of design and aesthetic characteristics of architectural concrete and determination of the main factors of their development.

Concrete Surface: The Aesthetics of Visual Area. Appearance of the visual area depends mainly on: formwork, reinforcement and concrete mixtures, release agents and quality of construction.

Evolution of Opinions on Aesthetics of the Visual Area of the Concrete Structure

1st half of 20th century. Architectural Concrete as artificial stone. Surface treatment was determined by effort to mimic the look of natural stone and avoid the negative connotations that the use of concrete as a facade material in this period evoked. The visual area is treated in the hardened

state using the techniques of stone masonry, thereby eliminating traces of formwork and exposing aggregate [1,2].

cca. 1950. Le béton brut. The movement that became later known as brutalism appeared in the architecture in sixties. The concrete surface was left in its original state after removal of the formwork. The traces of formwork (texture of formwork which was usually made from wooden boards was imprinted in the form of negative to the surface) and all defects which ocurred during concreting were acknowledged.

cca. 1960. Over time it became clear that architectural concrete realized without corresponding adjustments was rapidly losing its aesthetic qualities due to pollution caused by rainfall. Attempt to solve this problem consisted in changing the shape of surface of the concrete structure (for example, vertical ribbing or creating ledges at the level of the ceiling).

cca. 1970. Economic factors have necessitated the development of cheaper and faster formwork systems. The use of plywood formwork panels of large dimensions allowed the realization of smooth surfaces, which remains the peak of quality in the production of architectural concrete until now.

From this analysis it is clear that the dominant influence in the appearance of architectural concrete surfaces is aesthetical and ideological factors that change over time. Another factor is the effort to avoid the negative effects of pollution caused by rainfall [3].

Concrete Surface: New Trends.

Architectural Concrete with a Smooth Surface. At present, it is probably the most widely used, but particularly difficult process for quality of construction. Formwork panels coated with plastic, treated with special release oils and spatially rigid structure of formwork, create vast flat and silky smooth surface of low basis porosity. Colouring depends on the cement used.

Translucent Concrete. Glass or plastic fibres are placed into fine-grained concrete, which allow the light to pass through this material. The alternative is to use translucent fabric deposited layer by layer into fine-grained concrete instead of acrylic and optical fibre. Dematerialisation of building substance allows to perceive concrete in the new context and distorts preconceived notions about the nature of the material. During prefabrication plastic foil, onto which is by means of concrete retarder applied raster pattern, is deposited at the bottom of the mould into which concrete is then poured.

Coloured Concrete. Colour pigment is added in the concrete mix in liquid or powder form. Colour of the surface formed this way is therefore regarded from the ideological point of view for an authentic expression of the concrete materiality. The main reason for using colored concrete is aesthetics: the replacement of normal colour of cement which literally became synonymous with the gray reality of mass housing.

Construction design

In terms of evolution of architectural concrete in exterior, we can observe changes since the period when concrete was used as a single monolithic system, whose task was to ensure the static requirements [4]. Since 1900 its high strength (compressive strength, also in interaction with steel as reinforced concrete tensile strength) exceeded its negative thermo technical properties - high thermal conductivity ($\lambda = 1.3$ $W \cdot m^{-1} \cdot K^{-1}$) and thermal bridges that are causing decrease in internal surface temperature. However, this changed during the oil crisis in 1973, which on the basis of environmental considerations forced architects to develop different constructional system to eliminate heat transfer. Four basic design concepts have been developed - insulation of concrete from the interior, sandwich systems, monolithic construction of lightweight and architectural concrete used as prefabricated cladding panels.

Basic design solutions developed for building envelopes with an outer layer of exposed concrete are characterized by a combination of these basic factors:

- General characteristics include the number of layers of construction and position of insulation in the composition of wall.
- Thermo technical criteria determine the maximum value of heat transfer coefficient U_N [$W \cdot m^{-2} \cdot K^{-1}$]. Hygiene criterion determines the minimal internal surface temperature of building structures.
- Other characteristics (technological criteria, static criteria, etc.).

Single-layer construction systems.

Single-layer building envelopes consist of only one concrete layer. Nowadays, the lightweight concrete (λ = ca. 0.32 $W \cdot m^{-1} \cdot K^{-1}$, $\rho \leq 1200$ $kg \cdot m^{-3}$) [5,6] is used for these structures. Such solutions excel because of aesthetic properties of monolithic concrete. The latest trend in the design of single-layer building envelopes systems are thermally activated walls with capillaries integrated in the structure. The water obtained by heat pumps circulates through these capillaries. What of course requires a suitable source of thermal energy in the proximity of the building.

Single-layer systems respond to the tightening of thermal requirements with difficulties. The reason is the relatively high thermal conductivity of lightweight concrete, which currently allows to insure a maximum value of the heat transfer coefficient only at the cost of substantial increase in the thickness of building, optionally by using ultra light concrete (λ = 0.181 $W \cdot m^{-1} \cdot K^{-1}$, $\rho \leq 800$ $kg \cdot m^{-3}$) [7]. Critical points where there is a high risk of thermal bridges occurrence, additionally insulated in their vicinity. Another problematic factor is the steel reinforcement that can however be replaced, for example by reinforced fibreglass.

In the implementation of single-layer building envelopes plastering, plumbing work and complex formwork is eliminated. However this system demands the high-grade technology of construction. For lightweight concrete are also unfavourable strength properties when compared to conventional concrete. Due to the limited ability to respond to thermo technical requirements, in the future usefulness of monolithic thermal insulated concrete in construction will be apparently limited if there is no change in the knowledge of composition, technology or production of this material.

Multi-layer constructions.

Sandwich Systems. The principle of these systems is the embedding of insulation between two layers of concrete. The thickness of such structures is about 600 mm and more. Architectural Concrete can be presented also in interior.

The advantage is the ability to customize the thickness of the thermal insulation according to requirements, but at the same time it increases the overall thickness of the peripheral wall. However, there is the risk of thermal bridges occurrence in critical construction detail.

Sandwich systems are labour intensive during construction and therefore more costly. Regulation of the insulation thickness is an advantage, but it could also pose a problem with daylight illumination of interior.

System of Thermal Insulation from the Interior. Nowadays the most common method how to present exposed concrete is to locate thermal insulation from the inner side of building envelope. Although the difficulty and cost of construction is relatively low, architectural concrete is not presented in the interior.

Construction can be adapted to the requirements by adjusting the thickness of thermal insulation, but to insulate building from interior may cause the possibility that thermal bridges occurrence at the joint of the ceiling structure and building envelope. In addition, if there is no added layer with a high diffusion resistance there could occur condensation of water vapour inside the insulation.

Architectural Concrete as Prefabricated Cladding Panels. Supporting structure with thermal insulation is separated from cladding by a layer of air. Cladding elements are anchored to supporting structure of the building. There could occur problems with condensation of water vapour inside the insulation if there is no added layer with a high diffusion resistance.

This system allows to easily control the thickness of thermal insulation and to prevent the occurrence of thermal bridges due to disconnection of external exposed layer from supporting structure. This seems to be the best solution for design of architectural concrete from the point of thermal technique.

Higher weight of concrete cladding panels results in high demands on the quality of anchoring to the supporting wall and complex assembly.

Plaster: Imitations of Architectural Concrete. Concrete plaster is essentially an imitation of architectural concrete applied as a surface layer on existing conventional structural systems. Their arrangement from interior to exterior should be as follows: non-permeable vapour layer (plaster), the support layer (supporting wall) thermal insulation layer, the exposed layer.

Thermo technical requirements are insured the same way as the existing conventional multilayer systems (each layer provides an individual function). The composition of building envelope of several layers makes easier to exclude water vapour condensation in construction.

Concrete plaster seeks to balance the aesthetic quality of the material (it is debatable to what extent) with the simplicity of conventional systems of peripheral walls, but this solution is already standing on the edge that defines the truth in the architecture and lacks haptic quality of monolitic concrete.

Conclusion

The choice of architectural concrete surface treatment depends on aesthetic and ideological factors that it is now possible to provide with a wide range of different solutions. Although these solutions are not mutually specific, future potential in the plane of architectural concrete surface aesthetics lies in their combination, which remains virtually inexhaustible. In terms of construction design, a major challenge is to ensure thermotechnical requirements. Progressive solutions in this area focus on combining lightweight and thermal insulating concrete passive, active isolation.

References

[1] A. Forty, Concrete and culture: a material history. Londýn, Reaction books, 2012. 336 p.

[2] L. Marko, Architektonický betón. Bratislava, Alfa. 1989. 312 p.

[3] P. Collins, Concrete: the vision of a new architecture. Montreál, McGill-Queen's University Press. 2003. 472 p.

[4] F. Kind-Barkouskas, B. Kauhsen, S. Polonyi, J. Brandt, Concrete Construction Manual. Berlin, Birkhäuser, 2002. 296 p.

[5] Information on http://www.zement.at/Service/literatur/fileupl/04_10efh_chur.pdf

[6] Information on http://www.liapor.cz/liapor_tisk/2009/zdivo/Materialy-pro-stavbu-4.pdf

[7] https://www.google.sk/search?client=opera&q=hauschlaich+filetype:pdf&sourceid=opera&ie=UTF-8&oe=UTF-8&gws_rd=cr&ei=fg-XU6L_J8Wd7gaa9IHYCA#q=haus+schlaich+filetype:pdf

Analysis of the Building Materials in the Energy Efficient Buildings

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Keywords: Energy Performance, Energy Efficient Buildings, Building Materials, Sustainable Development, Thermal Insulation

Abstract. According to the Energy Performance of Buildings Directive (EPBD II) an important role in current construction of buildings plays a constant effort to reduce energy performance, reduce the consumption of non-renewable resources and reduce the production of greenhouse gases. The emphasis is placed on the use of attested and quality building materials with good thermal properties. The aim of the paper is analysis of the building materials in the current energy efficient buildings.

Theoretical Calculation of Heat Losses of Heat Exchangers to Vicinity

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Keywords: Heat Exchanger; Heat Losses; Heat Insulation; Own Simplified Calculation

Abstract: This contribution is focused on heat exchangers and their heat losses dispersed into vicinity. In the introduction of the contribution this loss heat flow of heat exchangers is analysed into basic physical processes and with applying simplifying assumptions it is described by a computational equation suitable for technical practice. The result of the study is the confirmation of the general fact that the quotient of losses heat into vicinity with regard to the transferred heat flows in the heat exchanger is insignificant.

Hydraulic Diameter of Compact Design Tubes with Small Diameter

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Keywords: Hydraulic Pipe Diameter, Smooth Pipe, Compact Design Tubes

Abstract: The contribution is aimed on hydraulic diameter of Compact Design Tubes with the small diameter. First part of contribution is focused on calculation of the hydraulic pipe diameter by contemporary way for technical use. Second part of contribution is aimed on Compact Design Tubes with the small diameter and compared with typical smooth pipes. Results of this study confirm general fact, that the inner/outer hydraulic diameter of Compact Design Tubes is different from the hydraulic diameter of typical smooth pipe.

Analysis of the Degradation of External Plasters in the Buildings with ETICS

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Keywords: Biotic Attack, Degradation, Plasters, ETICS, Algae, Fungi, Facade

Abstract. The external plaster are currently the most common finish coat of buildings. The characteristic technological and chemical properties of plasters protect supporting structure against weather and temperature extremes. Quality of plaster is determined by its durability, which depends primarily on the quality of raw materials, the quality and porosity of the substrate, the temperature during application, concentration of carbon dioxide and humidity of the ambient air. The paper deals with the analysis of the causes of degradation and the possibilities of remediation of biotic attack of plasters buildings with External Thermal Insulation Composite System (ETICS).

Technological Analysis of the Orientation of the Pitched Icelandic Turf Roof to the Cardinal Points and their Effect on the Stability of the Vegetative Layers

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Keywords: Pitched Green Roof, Turf, Cardinal Point, Suction, Turf Strip, Cramp

Abstract. This article is focused on the assessment of the pitched turf green roof to the cardinal points, its permanent sustainable functional condition and investigation of a possible damage caused by local climate. The solution of these problems is the crucial factor in next development, use and expansion of this type of roofing in European broader range. This study of the roof construction that was made in Iceland offers conclusion based on quick changes of the local climate conditions and demanding extreme weather impacts. The main aim of this research is proposed the right possible solution and design of this construction including dealing with the details, select the convenient orientation to the cardinal points and surroundings to provide long-term stability of this construction.

Test of Adhesion and Cohesion of Silicone Sealants on Facade Cladding Materials within Extreme Weather Conditions

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Keywords: Sealant Classification, Surface Finish, Refrigerated Enclosure, Conditioning, Compression, Maintained Extension.

Abstract. This research was carried out as part of project MPO FR - TI4/332 – New Technologies of Bonded Facade Cladding with Anchor Elements with Increased Resistance to Corrosion.

This contribution concerns tests carried out to investigate the tensile properties of silicone sealants for use with facade cladding materials. The experimental part of the research is aimed at ascertaining the technical properties of sealants via the cyclic alternation of extension and compression of test specimens in test moulds. For the tests, industrially manufactured neutral and universal silicones were chosen from three different manufacturers. The aim of the research was to discover any differences that might appear in their resistance against alternating maintained extension and compression of the specimens under extreme temperature conditions, i.e. a high temperature of (70 ± 2) °C and a temperature simulating freezing, i.e. (- 20 ± 2) °C. The cladding material used was fibre-cement composite boards (known as Cembonit), ceramic and glass cement facade claddings.

The result of the measurements taken is a summary in which effective and unsuitable combinations of sealants and test substrates are outlined. The main conclusion is the fact that it is not possible to responsibly choose a suitable material without taking appropriate measurements or having previous experience. A secondary conclusion to this article is the fact that there are significant differences between individual sealants in the results they provide in combination with specific cladding material.

Study of the Mechanical Behavior against Horizontal Forces of Self-supporting Facades

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Keywords: Brick, Wall, Self-Supporting, Wind

Abstract. The brick facades are one of the most used facades in the current architecture. This typology is used during centuries, but still relevant today. The conventional way to build a brick facade is supporting the outer sheet on the slabs of the building. In buildings with these conventional facades have appeared stability, insulation and sealing problems.

The self-supporting facade appears to solve these problems easily. This type of facade can solve more easily thermal bridges in buildings, which is an optimization of energy consumption. To resist horizontal forces facades need anchors between the two sheets or between the outer sheet and the

structure. The current standards in Spain do not define the arrangement of the anchorages between the exterior sheet and the inner sheet of the enclosure. This paper studies the influence of the inner sheet in self-supporting facades. The transmission of horizontal forces between the two sheets of the facade is analyzed in detail, in order to check whether the inner sheet assists in the stability of the outer sheet. Different models of facade have been simulated to compare their results using the finite element method.

Numerical Study of the Influence of Insect Grille on Airflow in Ventilated Facade Constructions

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Keywords: Ventilated façade, convection CFD simulation, insect grille, CFX

Abstract. This article discusses a numerical model to evaluate the influence of inlet/outlet insect grilles in naturally ventilated facades. Two models were created for this comparison. The difference between these models is in inlet and outlet openings. One model is fitted with insect grilles and the other one without insect grilles. Both models are three dimensional vertical ventilated cavity. Boundary conditions fit to summer season. In particular, the influence of insect grilles on airflow velocity and air temperature in the cavity are evaluated. The main goal of this work is to show the effect of openings size and geometry to functionality of natural ventilated constructions.

Optimization of Lubricant Return in Refrigeration Systems

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Keywords: Refrigeration Equipment, Oil, Refrigerant.

Abstract. Oil is necessary for most of the heat pumps, cooling and freezing equipment, for proper operation of the compressor and other moving parts. Speed of the refrigerant vapor in the critical section, which is suction piping, is strongly dependent on the evaporating temperature, but also on the actual device performance. Well-designed piping is essential to the proper function of the cooling devices or heat pumps and affects the efficiency of the device. The aim of this paper is to describe problems of returning of oil in refrigerant devices and investigate the exact solution of design of refrigerant speed for carrying the lubricating oil in all segments of refrigerant pipes. Paper is based on facts obtained during developing of new refrigeration equipment. The resulting proposal of the device was numerically verified.

Experimental Determination of Thermal Properties of Highly Viscous Liquids

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Keywords: Experimental Measurement, Density, Specific Heat Capacity, Thermal Conductivity.

Abstract: This contribution deals with experimental determination of thermal properties needed for transient heat transfer calculation by conduction in highly viscous fluids; which are the density, thermal conductivity and specific heat capacity. Density was determined by direct method, heat capacity was measured with mixing calorimeter and thermal conductivity was studied with two different measuring equipments. Experimental set up for determination of thermal conductivity was designed and constructed by the authors. Results were corrected by numerical simulations in CalA software. All measurement quantities were compared with calculations based on the chemical composition of the substance. The determined thermal properties can be used for calculation of energy performance of heating and cooling of highly viscous fluids.

Assessment of the Load Capacity of Multilayer Glasses Depending on Their Total Thickness

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Keywords: Double-layer Glass, Safety Glass, Bending Tests, Load-bearing Capacity, Correlation, Descriptive Statistic.

Abstract. Nowadays, glass is a very popular building material, in various forms (fill openings, insulation, and composites [1]) even if it is primarily regarded as a filler material in the Czech Republic and widely used in residential developments [2]. There is an effort to extend the applicability of glass in the building industry. The article deals with the experimental bending tests of multilayer glasses. The bending tests were performed for the determination of the maximum load capacity at destroying the integrity of the samples. The results of the performed tests were statistically evaluated. The aim was to find dependence between the thickness of the multilayer glass and its load capacity.

Application of Multi-Criteria Optimization for Selection of Building Materials for New Buildings

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Keywords: Multi-Criteria Decision Making, Partitions, Interior Construction.

Abstract. The issue of optimizing the selection of a suitable building material for new buildings in the Czech Republic is a frequent topic. The paper reviews the methodology of multi-criteria evaluation of partitions for the selected criteria.

Comparison of Low-Energy Houses Selected Parameters Made by Traditional and Modern Methods of Construction

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Keywords: Low-Energy Houses, Cost, Building Volume

Abstract. Currently, in the building industry is emphasizes the sustainability of construction. Sustainable buildings have low costs for energy consumption and operations, they are environmentally friendly, able to save natural resources and they are comfortable and healthy for their users. One of the factors contributing to this requirement is also application of more or less known materials and components through modern methods and technologies. Modern Methods of Construction (MMC) can be the way, how to achieve buildings, that can minimise the negative impacts of building life cycle on the environment. MMC can, in addition to increasing the efficiency of the construction, ensure the requirements resulting from Agenda 20-20-20 in energy consumption. The paper is focused on the research and comparison of two low-energy houses groups from technical and quality indicators point of view and especially from the perspective of relationship between construction cost and building volume. One of the groups is low-energy houses made of bricks by Traditional Methods (TM) and the second group representative of modern methods of construction are low-energy houses made of ceramic panels.

Settlement of Crushed Straw

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Keywords: Settlement, Crushed Straw, Blown Insulation, Bulk Density

Abstract. This article is focused on an experimental measurement of settlement of blown insulation from crushed straw. Straw has appeared like building material in recent years. It is ecological and cheap building material which is required for sustainable construction. Straw is usually used in form of bales. These are generally used like thermal insulation filling the supporting structure. An alternative to straw bales can be crushed straw. Crushed straw is not used in building industry currently. Its thermal insulating properties and structure are appropriate to use it like blown or loose thermal insulation. The experimental measurement was necessary to verify application of crushed straw by blowing or bulk and to find out values of settlement. Results of this measurement are described in this article.

Non-Traditional Thermal-Insulating and Rehabilitation Materials and their Hygrothermal Behaviour

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Keywords: Thermal Insulating Plasters, Thermal Conductivity, Moisture, Relative Humidity, Hygrothermal Behaviour, Rehabilitation of Building Structures, Non-Traditional Binders

Abstract The development of non-traditional, thermal insulation plaster leads to the development of new eco-efficient materials suitable for insulation and rehabilitation of both existing and new building structures. Optimal function of these materials is then to reduce the energy consumption of buildings. This is beneficial from an environmental perspective. In addition, the development of new, promising, thermal insulation plaster was used innovative, environmentally friendly binders, such as substitution for energy intensive binder - cement. The paper presents the results of development of thermal insulation plaster and research in their hygrothermal behaviour.

Comparison of Measuring Instruments and Methods for Determining the Moisture Content of Wood

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Keywords: Moisture Content, Moisture Meter, Softwood, Calibration Curve.

Abstract. The monitoring of moisture in building structures is a long solved problem accompanied by a difficult data collection with more complex interpretations. Moisture of structures is very difficult to monitor and evaluate due to its changing not only in the local distribution but especially in relation to time and material properties. The paper is focused on the comparison of measuring instruments designed for immediate detection of moisture in material due to its parameters. For comparison the samples of softwood were selected, which have undergone specific exposing of wet in accordance with terms and conditions of Czech technical standards.

Studying of the Behavior of Thermal Insulation Materials Based on Natural Fibers for Incorporation into the Building Structure

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Keywords: Thermal Insulating Materials, Thermal Conductivity, Moisture, Technical Hemp, Mechanical Properties

Abstract. Thermal insulation materials based on natural fibres exhibit after incorporation into the construction of higher moisture sensitivity, while high humidity may just be the reason for the degradation of their thermal insulation properties and in extreme cases can lead to a reduction in their lifetime. The paper describes the results of research focused on the study of hygrothermal behavior of thermal insulating materials on the basis of bast fibers and their behavior after incorporation into the building structure.

Single-layer mechanical fastening waterproofing systems

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Keywords: Flat roof, single-layer waterproofing, bitumen sheet, mechanical fastening system.

Abstract. Single-layer mechanical fastening waterproofing systems are often used within the compositions of flat roofs. Although in case of plastic based systems it is a common solution, for

bitumen sheets it handles about a relatively new approach, since the application of asphalt has a long history in the building industry.
There are some key factors which all of the one-layer mechanically fastening systems should meet, especially water-resistance and resistance against the suction of wind. The application of dynamic loads on the joints may damage the bonds, which may lead to leakage of water. In particular the most delicate locations are the anchoring points at places where the waterproofing sheets are not connected mutually and the wind is captured.
Research was focused on the extent at which the strength of the resulting mechanically fastened joints is affected by the placement of fastenings elements within the strip overlap, including the possibilities when the distances from the edge.

Usage of Hydrophilic Mineral Wool Panels in Green Roof Systems in Passive Houses

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Keywords: Green Roof, Hydrophilic Mineral Wool, Lambda Design Value, Passive House

Abstract. Hydrophilic mineral wool panels can be used in extensive vegetation green roof systems as a soil replacement. They are lightweight (also with full water saturation), have certified thermal insulation properties in wet conditions and beyond all, they have laboratory approval of vertical and horizontal drainage ability, similar as a special drainage NEP composites.

Low weight of panels is further more advantageous in the intensive green roof systems and passive houses– static demands on roof and wall constructions can be dramatically decreased. Special water-accumulation panels can be used in retention roofs. Multiple-layered panels can help with thermal properties of building envelope of passive houses.

New Structures for Transparent Roofs

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Keywords: Transparency, Glazed Barrel Vault, Steel Rectangular Net Structure, Static Model, Displacement's Shape.

Abstract. Transparency of glazed roofs does not depend on glass as material, which enables an admission of daylight to the interior, but it depends on the share of the glazed part of the canopy and their structural part. Spaces of glazed atria and courtyards of historical buildings are covered with very difficult shape of glazed canopies, which are supported by various types of load-bearing structures. In contemporary architecture glazed atria are used for the reason of saving energy and lighting up the inner spaces. New types of structures and using glass in load-bearing function in glass canopies are important thanks to their structural subtlety, where the structure covers slight part of

glazed canopy. The result of clever ideas and modern technology are lightweight structures of bold forms and spans. In this context transparency became a new expression element of architecture.

Hempcrete – an environmentally friendly material?

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Keywords: Hempcrete, Building Material, Lime, Hemp, New Zealand, Czech Republic.

Abstract. In the last decade, society has been looking at sustainability of construction. The pressure for improved construction methods also leads to the search for new materials. One possible material with suitable technical properties based on renewable resources is hemp fibre concrete – hempcrete.

Hempcrete is a construction material made from hemp fibres, lime and water. This composite breathes, as well as having good thermal and acoustic-insulation properties. The paper provides an overview of international literature and its relevance to New Zealand (where hempcrete has already been used) and the Czech Republic (where the first hempcrete house is under construction).

A life cycle analysis of hempcrete will be used to examine its ecological footprint, especially in reducing carbon dioxide emissions. The construction in 2014 of a New Zealand house provides data which can be used to model performance in both countries. The preliminary results suggest that hempcrete offers both environmental and construction opportunities which can help to deliver sustainable housing solutions.

The Future of the Polystyrene as Thermal Insulation in Buildings

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Keywords: Polystyrene Insulations in Construction, Development of Properties, Flame Retardants, Construction Waste, Demolition Waste, Recycling, Energy Use, Liquidation.

Abstract. The future of expanded polystyrene (EPS) and extruded polystyrene (XPS) as thermal insulation in the construction industry is divided into two trends. The first one contains polystyrene boards and shaped elements already built-in in the buildings, respectively problems of their liquidation as construction or demolition waste generated during reconstructions and demolition of the buildings. The second trend is focused on the future production of polystyrene foam as the material for thermal insulations. Its target in particular is the change of technological processes and finding new methods to reduce energy consumption during production, improve the thermal insulation properties and replace the existing flame retardant other, environmentally acceptable.

Hygro-thermal Behaviour of Timber Frame Straw Bale Construction as an Energy Efficient Building Technology

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Keywords: Straw Bales Construction, Energy Efficiency

Abstract. Due to an increasing request for ecological building constructions, in particular straw bale buildings, a research in this regard has been performed at the Vienna University of Technology. Straw bale construction is a new rediscovered building technology, which is an alternative to conventional construction technologies. The aim of this study is caring out of hygro-thermal simulation of a straw bale wall construction to design as efficiently as possible straw bale house. The choose of other construction elements for a thermal analysis (appropriate wall, roof and a base plate construction), was based on an extensive literature researche. For the examination of the building a timber frame construction has been selected. The straw bales in this construction were plastered inside with clay plaster and externally with a combination of lime and clay plaster. The roof structure was designed as a green roof and insulated with straw bales. The base plate was also insulated with straw bales.

To check the thermal behavior of the structures described above were thermal bridges calculated using a FEM program. The hygrothermal behavior was calculated with HAM4D building physic software, developed on the department for Buildings Physics and Sound Protection on Vienna University of Technology. Ecological and economic evaluation of straw bale construction was carried out with reference to the data from the literature.

The performed thermal (with COMSOL) and the first hygrothermal calculations (with HAM4D Software) have demonstrated a very favorable performance of the proposed building components. The achieved low U-values of the components allow the construction of passive houses. The use of self-build-service in the construction process can reduce construction costs significantly. The use of ecological materials such as: straw, clay and wood allows a low cost recycling of building materials.

Measurement of Physical Properties in Waste-Based Particle-Reinforced Polymer Composites (WPPC)

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Keywords: Particle Polymer Composite, Recycled Material, Thermal Insulation, Coefficient of Thermal Conductivity.

Abstract. Recently, a unique Waste-based Particle Polymer Composite (WPPC) made from recycled foam glass and polypropylene has been developed at Brno University of Technology. WPPC was designed so as to provide both good thermal and mechanical properties in order to become a material of choice for thermally insulating construction details. However, before WPPC can be reliably used

by construction designers, physical properties of WPPC must be accurately identified. Therefore, we studied thermal, mechanical, and moisture absorptivity of WPPC. In this work, we firstly present material structures of WPPC and difficulties related with experimental determination of WPPC´s physical properties. Secondly, we present measurements of coefficient of thermal conductivity using several experimental methods in order to show discrepancies among those methods. Thirdly, we show and discuss compressive properties of WPPC including Young´s modulus, strength and yield stress and their dependencies on testing temperature. Fourthly, we present measurement of moisture absorption. Finally, we compared experimentally identified physical parameters of WPPC with those of other common construction material in order to clearly show the application potential of WPPC. To sum up, we present an experimental study providing not only valuable data on physical properties of WPPC but also difficulties and discrepancies related to these experiments and we assess the potential of WPPC as a construction material.

The Modular Construction - Energy Balance and Airtightness

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Keywords: Modular Construction, Airtightness, Blower Door Test, Building Envelope, Energy Balance.

Abstract. When designing building is practically always assumed the high quality of realized works. Based on this assumption is also calculated heat requirement for the operation of the building. In practice leaks frequently occurs in building envelope, which may result in increased heat loss of the object, disturbed microclimate inside the building, but also adversely affecting the lives of individual structural units. The article deals with the energy balance of modular construction (residential container). The airtightness of the building envelope was verified by a Blower Door test and the result has been involved in computational states.

Introduction

The heating required for building operation is calculated based on the assumption of standard (normative) the quality of the realized work. In practice, we often encounter the sloppy realization of the works, leading to leaks of the building envelope. The measured object building envelope tightness was determined by Blower Door test. It is a detection method that makes possible to determine the airtightness of the building, which has an impact on its energy performance. Due to the fact that when the defects of airtightness windows, walls and roofs leads to significant losses of heat and thus higher demands on heating, these measurements are very important.

Description of the Measurement Object

The measured modular construction is structurally designed as a frame container with the main construction parts consists of a steel frame. The basic casing of the peripheral wall of the outside constitute is a sheet metal. The supporting wall structure is a steel frame, reinforced by wooden pillars between which it is an insulating layer of mineral wool, thickness 160 mm. This insulating layer is protected against the ingress of atmospheric moisture from the interior side using a foil vapour barrier. For wiring installation is on the inside before vapour barrier created advanced wall with air gap of thickness 50 mm, sheathed with drywall.

The roof structure is designed in a similar way, when the insulation thickness 220 mm is fitted in a wooden grate of supporting steel frame. Wooden grate does not pass through the entire height of the thermal insulation and thus thermal bridges in the structure are limited. From the inside under the insulation layer it is fitted foil vapour barrier protected by drywall. In this case, the modular building is roofed with a flat roof with metal roofing.

The floor is formed by a frame, which in this case is reinforced by I-profiles and additional upper wooden grate. Into these parts mineral insulation with a total thickness 160 mm is inserted. Again, here is fitted foil vapour barrier above which is the surface layer. The lower layer of the I-profile is protected by a layer of a smooth sheet. Residential container must always be installed so it ensures the ventilated air space under the building.

Airtightness Diagnostics

The way the building is used has no influence on measuring the permeability of its insulation. The object is to reach the most optimal level of air-tightness. A badly insulated construction contributes to undesired permeability through cracks and leads to increased heat loss and ineffective ventilation. [1]

Methods for measuring permeability are based on the principle of creating pressure fluctuations and measuring the current amount of air necessary to create a fluctuation. The result is the value of intensity of exchanged air n_{50} [h^{-1}] at a pressure fluctuation of 50 Pa. For the actual diagnosis it was used Blower Door device, which is described in [2, 3].

If it is between the interior and exterior sufficient temperature difference (> 20 K), then leaks can be found by using infrared thermocamera.

Measured modular building is located in the production hall with a constant air temperature 10 °C, for the purposes of measuring container was heat to 35 °C, by the following was achieved by a temperature gradient of 25 °C.

Leak Detection

During underpressure test at a differential pressure of 50 Pa leaks in joints of horizontal and vertical structures were detected (Figures 1, 2, 3). Thermovision imaging was performed from the interior. During pressure test at a differential pressure of 50 Pa leaks at the connection of opening filling were detected (Fig. 4, 5, 6). Thermovision imaging was performed from the exterior.

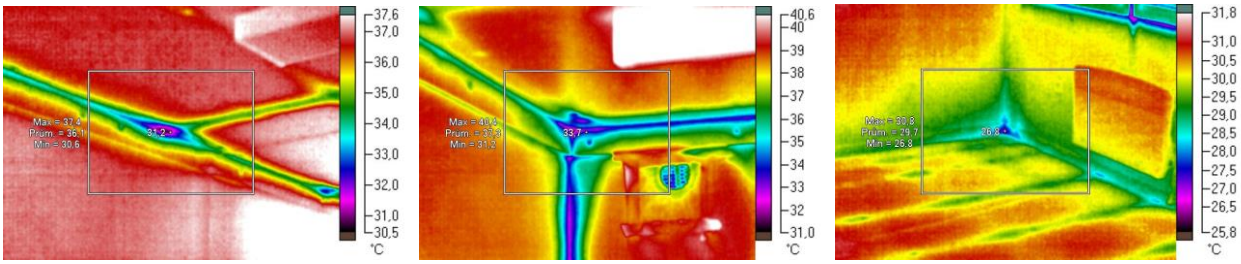

Figure 1, 2, 3. Thermovision images connection of horizontal and vertical structures (ceiling and wall construction, upper corner, lower corner), imaging from the interior. Source: Output of infrared thermocamera FLUKE software.

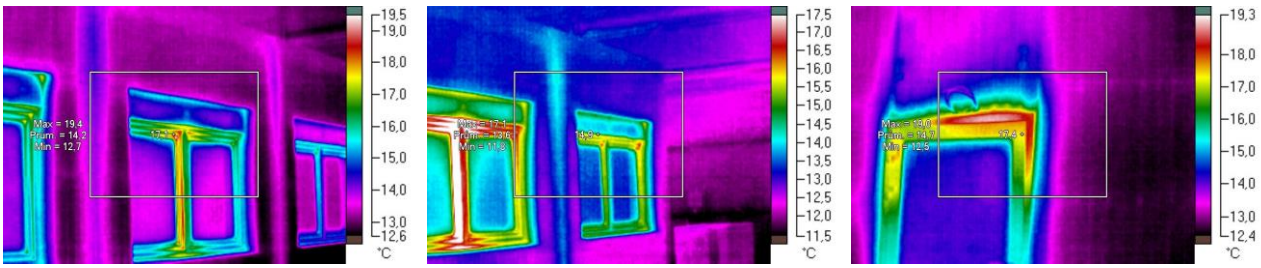

Figure 4, 5, 6. Thermovision images of connection of opening filling (window, window, entrance door), imaging from the exterior. Source: Output of infrared thermocamera FLUKE software.

Simulation of Computational Conditions

To calculate the heat loss SVOBODA software was used, specifically software ENERGIE 2013 in which there were simulated different computational states. Boundary conditions for calculation and parameters of the building were in all computational status unchanged (Table 1).

Table 1. The boundary conditions involved in the calculation.

Floor area	**54.34 m^2**
The exposed perimeter of the floor	30.1 m
Building volume	182.0 m^3
The design outdoor temperature in winter	- 15.0 °C
The average annual temperature of outdoor air	8.3 °C
Design internal temperature	20 °C
Coefficient of wind exposure	0.05

The calculation in the software Energie 2013 was carried out according to EN ISO 13790, which ventilation heat loss evaluate in accordance with EN ISO 13789. According to this procedure, the infiltration by leaks in natural ventilation has no effect since it is included in a volume of naturally ventilated air, i.e. how much more will be the infiltration by leaks, the less it is possible to ventilate by windows. However the hygienic minimum must be met.

Infiltration - value of n_{50} will apply only in controlled ventilation, when also coefficients of wind exposure enter into the calculation.

Calculated values of specific heat flow by ventilation at different values of n_{50} during controlled ventilation are shown in the graph in Figure 7. Object under consideration is taken to be unprotected and the wind acts on the all walls of the building.

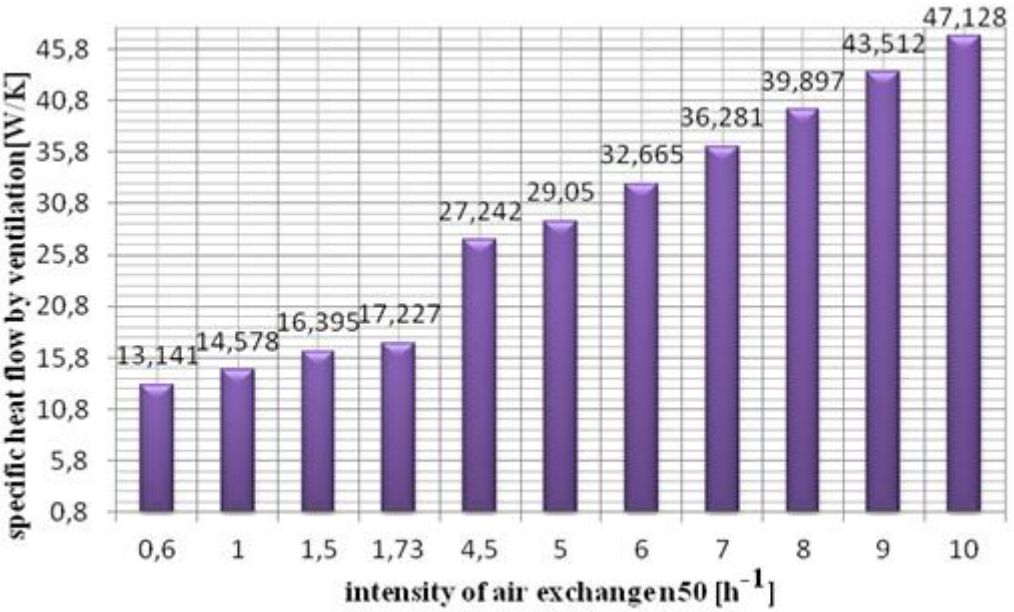

Figure 7. Graph of the intensity of air exchange on the specific thermal flow by ventilation

The result of the experiment

As it is shown in Figure 7, the specific heat flow by ventilation (buildings with controlled ventilation) is directly dependent on the intensity of air exchange n_{50}. The lower the value n_{50}, the lower the value of specific heat flow by ventilation, consequently value of the total specific heat flow - and thus also the cost of operation of the buildings will be lower.

The fundamental leaks were detected in the area of openings fillings, namely: the area between the frame of openings fillings and a building structure, i.e. mounting joint (Fig. 4, 5, 6), and the area between the window leaf and the frame of openings fillings, i.e. between openable and unopenable parts - so-called functional joint.

After studying the material on this subject, namely [4, 5, 6], using data taken by infrared thermocamera and airflow measurement, the following alterations (leading to correct the problem) were defined:

Improving of the tightness is only possible by additional adjustment of the window leaf of opening fillings. Adjustments can be made on the hinges and in the adductor areas. Effective sealing of mounting joints requires the disclosure of details on the connection of opening filling from the interior, which is not possible without removing plaster around windows and doors and removing the parapet. After revealing the jambs, head and parapet will be needed a thorough re-sealing of detail of the inner seal. It is necessary to carefully (airtight and vapour) provide connection details of the frame of opening filling and peripheral structures (reinforced concrete panel), for example, using a vapour barrier tape and butyl sealant.

Conclusion

Standards and regulations requirements on the quality of indoor environment dictate that the envelope and its components should be absolutely airtight. [7]. Experience from the air permeability measurements shows that the most common leaks in building envelopes are in the area of fitting of openings fillings. Already during the implementation it is necessary to carefully select the material and design of fillings openings and oversee the proper fitting. In the case of detection of leaks in existing buildings is possible with the help of technical measures shown in the "result of an experiment" to improvement of tightness.

Acknowledgment

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References

[1] M. Kraus, M. Černá, B. Hrubá, B. Součková, D. Kubečková, Influence of Building Materials on Building Airtightness, Applied Mechanics and Materials, 2013; vol. 372, pp. 195-198

[2] J. Teslík, N. Zdražilová, M. Vodičková, Air-Tightness and Acoustic Properties of SuperAdobe System, Advanced Materials Research, 2014; vol. 899, pp. 365-368

[3] D. Katunský, M. Němec, M. Kamenský, Airtightness of Buildings in Slovakia, Advanced Materials Research, 2013; vol. 649, pp. 3-6

[4] P. Oravec, Windows in Buildings - Diagnostics of Selected Properties after Time of Using, Advanced Materials Research, 2014, vol. 899, s. 184-187

[5] E. Bas, Indoor air quality guide for facility managers. 2nd ed. Lilburn, Ga: Fairmont Press, 2004

[6] T. Woolley, Low impact building housing using renewable materials, Online-Ausg. Chichester, West Sussex, UK: John Wiley, 2013

[7] J. Štefko, D. Bebej, J. Bednár, Envelope Structures of Low Energy Wooden Houses Considering Indoor Climate, Advanced Materials Research, 2013, vol. 649, pp. 69-72

Different Options for Foundations of Buildings in Thermal and Financial Context

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Keywords: Linear Thermal Transmittance, Wall Footing, Steady State, Thermal Bridge, Economy

Abstract. Great emphasis is placed nowadays not only on the quality of the building envelope, but also the financial costs associated with this solution. One of the places that have an impact on the quality design of the building envelope is the connection of the building to the foundation structure. There are many variants that can be used in addressing this structural detail. This article describes the most common variants used for building facilities based on the foundation strips. These variants are supplemented with their financial evaluation. The study was conducted on an idealized facility with ground plant dimensions of 10.9 m x 10.2 m. The masonry was considered to be built to a height of 1 m above the base concrete slab. Individual variants are mutually compared in thermal and technical terms using the linear thermal transmittance coefficient determined in accordance with CSN EN ISO 10 211 [1] a CSN EN ISO 13 370 [2], but also from the economic point of view.

Defining the Model

The study was conducted on four variants of the perimeter masonry foundation on foundation strips with the floor on the ground. The perimeter wall is in all variants built of ceramic blocks HELUZ STI 44 th. 440 mm. In the variant V1 and V3, in which the wall is not equipped with wall contact system we considered the thermal transmittance through the wall $U_w = 0.21$ W·m^{-2}·K^{-1}. In the remaining two variants (V2 and V4), the perimeter wall was insulated with external thermal insulation (ETICS) with a thickness of 100 mm. For these variants we considered the thermal transmittance through the wall $U_w = 0.136$ W·m^{-2}·K^{-1}. In variants V3 and V4 we concurrently used in the first course of masonry the blocks of foamglass with a thickness of 115 mm. The composition of wall and floors for individual variants is shown graphically in Fig. 2. The geometry of the individual layers and their thermal and technical parameters are given in Tab. 1.

Thermal-technical calculation was performed for stabilized thermal state using the calculation application ANSYS 14.0. The interior calculation temperature considered was + 21 °C according to CSN 73 0540 [3] with the heat transfer coefficient for the wall $h_i = 7.7$ W·m^{-2}·K^{-1}. The exterior temperature was determined according to CSN 73 0540 [3] to -15 °C with the heat transfer coefficient $h_e = 25$ W·m^{-2}·K^{-1}.

Itemized budget was created using the software KROS plus by ÚRS Praha. This application calculates the indicative prices. Price Database was valid for the month of January 2014.

The itemized budget of the considered variants changed only in terms of the method of insulation of the selected building facility Fig. 1 with regard to the elimination of thermal bridge, which occurs primarily in the first course of masonry between the foundation strip and the first layer of the bricks. Itemized budgets were created for the selected building facility (Fig. 1) to a height of 1 m of masonry taking into consideration the interior and exterior plasters.

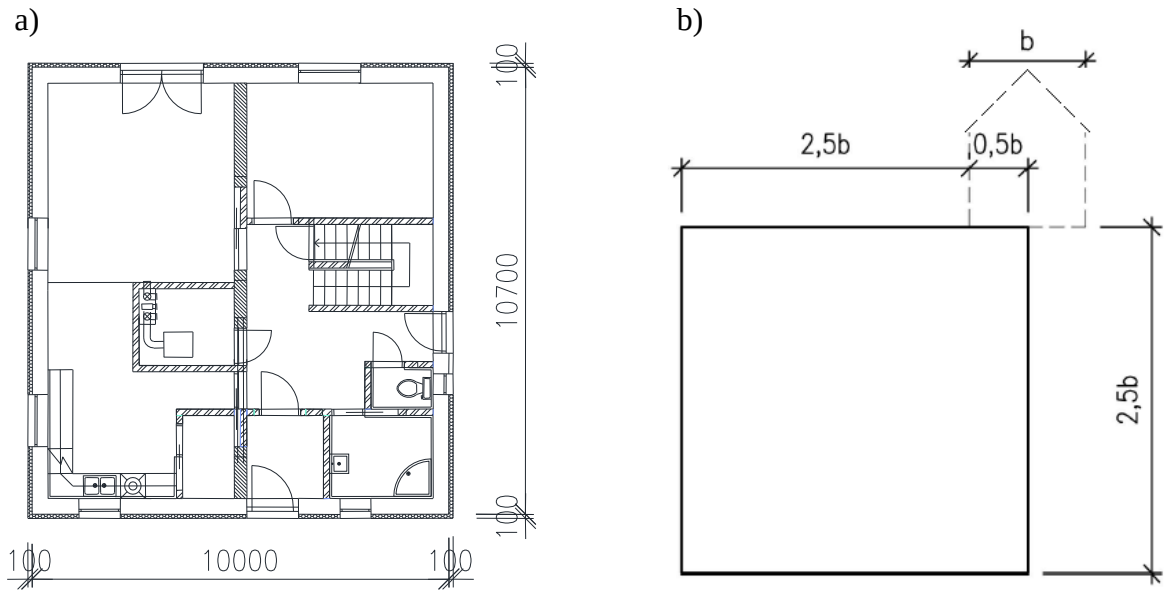
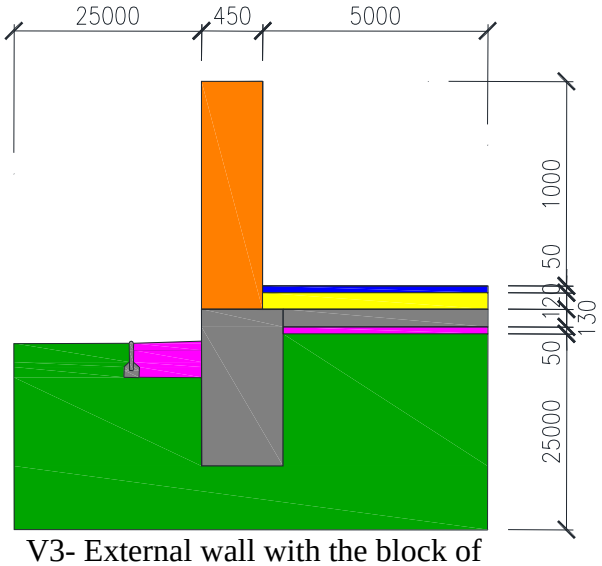
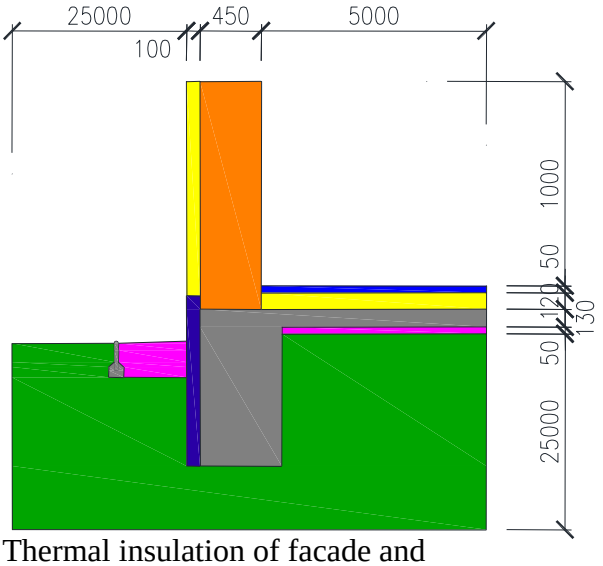


Figure 1. a) Ground plan of the simulated building facility b) Indication of the size of the soil block under the building facility for calculating linear thermal transmittance coefficient.

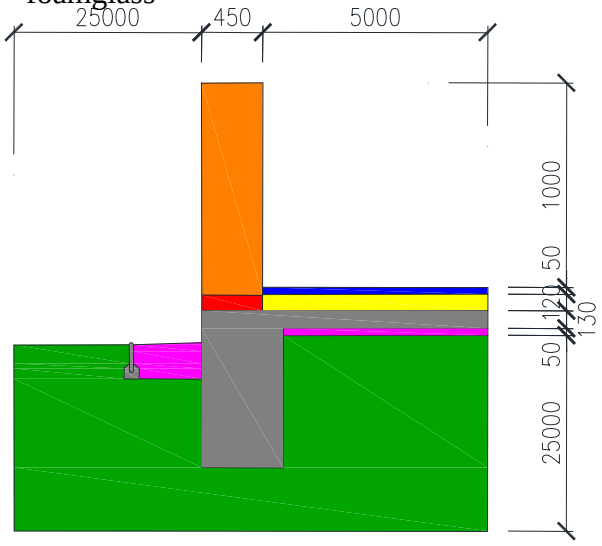
V1- Purely external wall



V2- Thermal insulation of facade and external wall



V3- External wall with the block of foamglass



V4- Thermal insulation of facade and external wall with the block of foamglass

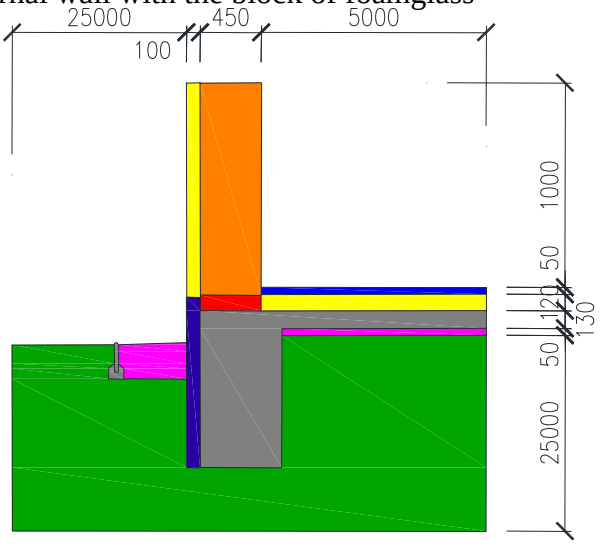


Figure 2. Geometry of individual variants.

Table 1. Thermal conductivity coefficient of the used materials (TI - thermal insulation). [4, 5, 6]

Material	Color in fig.2	Thickness [m]	Thermal conductivity coefficient λ [W·m^{-1}·K^{-1}]
Facade polystyrene EPS 100 F (TI)		0,1	0,039
XPS polystyrene (TI)		0,1	0,034
HELUZ 44 STI		0,44	0,097(→); 0,670(↑)
Anhydrite (poured flooring)		0,05	1,23
EPS 200 S (TI)		0,12	0,034
Concrete		0,13	1,23
Gravel with sand		0,05	2
FOAM-GLASS (TI)		0,115	0,05
Soil			2,3

Procedure of Calculation of Linear Thermal Transmittance Ψ [W·m^{-1}·K^{-1}]

In the case when the investigated detail is subject to multiple marginal conditions, the calculation procedure is more complex and is specified in ČSN EN ISO 10 211 [1] a ČSN EN ISO 13 370 [2]. Linear thermal transmittance Ψ is determined by equation (1) presented in [1,2]

$$\Psi = L_{2Di} - \Sigma U_w \cdot l_w - L_g \quad (1)$$

Where L_{2Di} is the thermal transmittance through the entire detail [W·m^{-1}·K^{-1}], U_w heat transfer coefficient of the wall [W·m^{-2}·K^{-1}], l_w height of the wall from the outside [m], L_g thermal transmittance through floor including the influence of soil [W·m^{-1}·K^{-1}].

The thermal transmittance L_{2D} from equation (1) is intended for the entire detail, and marginal conditions were defined on all surfaces that were in contact with the exterior and interior. The margins of the detail for calculating thermal transmittance L_{2D} and L_g was according to [1] and [2] determined in a way to exclude the influence of missing marginal condition in the soil. This was achieved using a large block of soil below the rated detail, as shown in Fig. 1 b).

a) Thermal transmittance L_{2D} for used variants b) Thermal transmittance through soil L_g

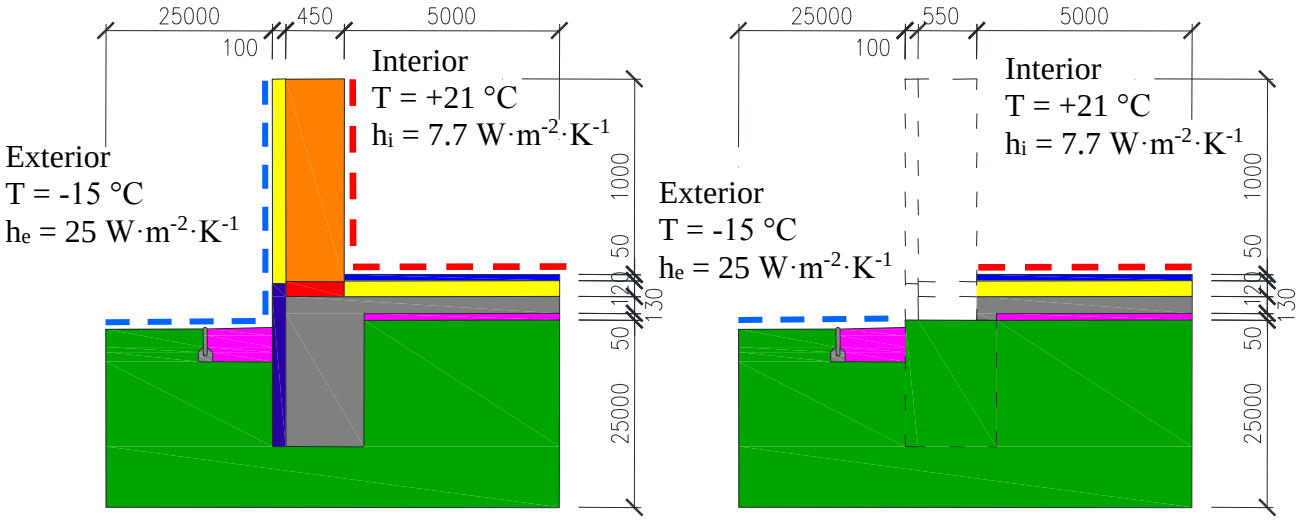


Figure 3: Steady state limit conditions

When calculating the thermal transmittance of soil L_g, according to the methodology of CSN EN ISO 10 211 [1] and CSN EN ISO 13 370 [2] we alternatively replace all the materials below the ground with soil, but retain all the insulation materials along the floor slab, and remove the wall downwards to the level of the external terrain Fig. 3b. The problem arises in the case when thermal

insulation is pulled under the ground. In this case it is necessary to leave free space next to the floor to prevent heat flow between the edge of the floor and the soil as shown in [1, 2]. The boundary conditions in this case are defined only on the inner surface of the floor and the inner surface of the original soil, see Fig. 3b.

Conclusion

Table 2. Thermal transmittance and financial evaluation of each variants.

Option	U_{wall} [$W \cdot m^{-2} \cdot K^{-1}$]	L_g [$W \cdot m^{-1} \cdot K^{-1}$]	L_i [$W \cdot m^{-1} \cdot K^{-1}$]	Ψ [$W \cdot m^{-1} \cdot K^{-1}$]	Price without VAT	%	Costs of thermal insulation	
							Perimetral walls	Foamglass Block
V1	0.2100	0.7675	1.2728	0.1545	521 352	100.0		
V2	0.1360	0.7632	1.0506	0.0736	601 939	115.5	80 587	
V3	0.2100	0.7675	1,1635	0,0567	604 126	115.9		82 774
V4	0.1360	0.7632	0,9801	-0,0066	688 034	132.0	83 908	82 774

The results of thermo-technical calculation show that if the building facility is made up of only Therm-type ceramic blocks, i.e. variant V1, the heat transfer coefficient through wall U_{wall} = 0.21 $W \cdot m^{-2} \cdot K^{-1}$, this variant is susceptible to a more significant thermal bridge at the foot of walls, which in this variant corresponds to the magnitude Ψ= 0.1545 $W \cdot m^{-1} \cdot K^{-1}$. According to the standard values it is supposed to be lower than Ψ_N = 0.2 $W \cdot m^{-1} \cdot K^{-1}$ and according to the recommended values Ψ_{rec} = 0.1 $W \cdot m^{-1} \cdot K^{-1}$. With regard to the evaluation the variant V1 was considered as a variant of reference, i.e. the price of building a building facility to a height of 1 m of masonry was 100%. Other variants were related to the variant V1.

As shown in Tab. 2, alternative variants, i.e. V2, V3 and V4, using the structure of external walls with thermal insulation are more expensive, but already significantly eliminating thermal bridge at the foot of the wall. The variant V4 leads to negative values of the thermal bridge at the foot of the wall. This means that the heat loss of the room by transmittance is already included in the heat loss through the surface structures. Option V4 is the most expensive of all the variants. Comparison with the variant V1, it is by 32 % more expensive, but the thermal bridge originating at the foot of the wall is completely eliminated in this variant.

The Variant V2 - considering a wall with a contact system and V3- using foamglass blocks under the first layer of masonry, has a significant impact on reducing the thermal bridge at the foot of the wall. The price calculation implies that these variants V2 and V3 are equally costly. This, however, is not the case. It should be noted that in V3, the first layer of masonry is made using a very expensive foam glass and the wall structure reaches transmittance coefficient U_{wall} = 0.21 $W \cdot m^{-2} \cdot K^{-1}$. To reduce the costs it would also be possible to replace the foam glass alternative materials such as polymer-based composite materials [8,9,10]. In variant V2, which uses contact insulation system with thermal insulation of the foundation, the thermal bridge corresponds to the magnitude Ψ= 0.0736 $W \cdot m^{-1} \cdot K^{-1}$ and compared to variant V3 it has a a higher thermal bridge value Ψ= 0.0567 $W \cdot m^{-1} \cdot K^{-1}$, but the coefficient of heat transfer through the wall is U_{wall} = 0.136 $W \cdot m^{-2} \cdot K^{-1}$ compared with variant V2, where the coefficient of heat transfer through the wall is U_{wall} = 0,21 $W \cdot m^{-2} \cdot K^{-1}$. It is also important to realize that an itemized budget is made only to a height of masonry of 1 m. If you select this solution, the contact insulation system would be made on the entire height of the building, which significantly increases the initial investment in the real estate property. These investments, however, will return in time in reduced heat loss of the building and thus reduced the demands for heating of the building facility.

Acknowledgement

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References

[1] CSN EN ISO 10211 Tepelné mosty ve stavebních konstrukcích – Tepelné toky a povrchové teploty – Podrobné výpočty (Thermal bridges in civil structures – Thermal flows and surface temperatures – Detailed calculations). Prague, Czech Republic: ÚNM. 2009.

[2] CSN EN ISO 13370 Tepelné chování budov – Přenos tepla zeminou – Výpočtové metody (Thermal performance of buildings – Heat transfer via the ground – Calculation method). Prague, Czech Republic: ÚNM. 2009.

[3] CSN 73 0540-2 Tepelná ochrana budov - Část 2: Požadavky (Thermal protection of buildings). Prague: Czech Standardizing Institute 2011. 56 p.

[4] Foamglas [online], [q. 20. May]. World Wide Web: < http://www.foamglas.cz/ >

[5] Software Stavební fyzika, program Teplo 2009 (software Building physics, program Heat 2009), Svoboda Software 2008

[6] HELUZ - Cihly, stropy, komíny, stavební materiál (HELUZ - Bricks, ceilings, chimneys, building material) [online]. HELUZ cihlářský průmysl v.o.s.– [q. 20. May 2011]. World Wide Web: < http://www.heluz.cz/>

[7] ANSYS 11.0 Software Manual USA, 2007

[8] Brno University of Technology, “Thermal insulation composite polymer”, CZ Patent 302851, Dec. 14, 2011

[9] Pěnčík, Jan; Matějka, Libor; Kalužová, Alena; Matějka, Libor; Dostálová, Darina; Pospíšil, Tomáš. Production of thermal insulation composite material based on polymers. Advanced Materials Research : Applied Mechanics and Materials, 2012, Vol. 535-537, ISSN 1022-6680

[10] Pospíšil, Tomáš; Pěnčík, Jan; Matějka, Libor; Kalužová, Alena; Matějka, Libor; Dostálová, Darina. Elimination of thermal bridge by thermal insulation composite material. Advanced Materials Research : Applied Mechanics and Materials, 2012, Vol. 482-484, ISSN 1022-6680

Comparison of Selected Energy Simulation Tools

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Keywords: Energy-efficient house, Energy Simulation Tools, Comparison, Heat Demand.

Abstract. Energy performance of buildings is the essential parameter for their classification and optimization. If everything is placed in the design process of the project, it is possible to achieve economies of scale as the design of the present object so in case of any further use.

Our paper focuses on the analysis of different simulation tools. By comparison enter both commonly used programs, such as 3D drawing program using BIM (Building Information Model). From the group of instruments using quasi-stationary method was chosen one of the most used software for calculating energy performance in the Czech construction practice "Energie 2013", and internationally well-known tool "PHPP" specially designed for calculations of passive houses. The representative of the dynamic simulation programs was chosen "TRNSYS" and from CAD systems, which provide simulation of energy behavior, was chosen software “Archicad 17”.

Introduction

At present, the building became one of the largest consumers of energy, and therefore is a constant endeavor of the European institutions reduce their energy consumption. Directive 2010/31/EU [1] adopted by the European Parliament and the Council of the EU on May 19, 2010, told us, by the end of 2020 to be in the EU, all newly constructed buildings designed like buildings with almost zero energy consumption.

The design of these buildings is complicated in order to achieve the required parameters, therefore it must be early in the use of various simulation and calculation software for the assumption of object behavior.

Therefore, this article gives a brief description of simpler and more accessible tools PHPP and energy, more elaborate and sophisticated software TRNSYS and ECODESIGNER, which is integrated into the ArchiCAD 17th Finally are compared the results of selected simulation tools.

Material and Methods

Assessment Building. We choosed detached family house for the simulation. The building is located in Rapotice (Czech Republic) (49°11'13.788"N, 16°15'18.031"E).

Figure 1. View of the building.

Table 1. Technical data of the building. [2]

Geometric data	
Built in volume (V)	635.4 m^3
Area of peripheral structures (A)	458.91 m^2
Ratio A/V	0.72
Area of floors	139.27 m^2
Thermal conductivity of the envelope	
External walls	U = 0.097 $W \cdot m^{-2} \cdot K^{-1}$
Floors on the terrain	U = 0.12 $W \cdot m^{-2} \cdot K^{-1}$
Roof	U = 0.11 $W \cdot m^{-2} \cdot K^{-1}$
Fittings of openings (windows)	U_W = 0.76 - 0.93 $W \cdot m^{-2} \cdot K^{-1}$
Characteristics of systems	
Heating	Infra panels Sun Waves SW 500 W-K - power 500 W
Air conditioning unit	Nilan Comfort 300 – efficiency of recuperation 88 % (at 200 $m^3 \cdot h^{-1}$)
Earth heat exchanger	Length 36 m, depth 3 m, diameter DN250, PE, Rehau SN 100

Assessment Methods.

PHPP (Passive House Plannig Package) [3]**.** PHPP is a Europe wide recognized planning tool. It is developed by Passive House Institute in Darmstadt and is widely used for the design of passive houses. It was first introduced in 1998. Since then it is continuously updated and developed. The tool is based on the calculation methodology for the determination of energy balances of complex dynamic simulations, although it is relatively easy to operate because of simplifications, even while entering data. It works inside of a spreadsheet of MS Office Excel or OpenOffice.org Calc. The foundations of its usage do lie in sheets for the calculation of specific heat demand for heating, heat production and distribution, the need for electricity and primary energy demand. Gradually these were then complemented with newly added design modules (blades), such as the calculation of parameters of windows, shading and heat load and summer time.

TRNSYS (TRaNsient SYstem Simulation Tool) [4]**.** TRNSYS is an advanced simulation tool, developed since the 70's of the 20th century by Madison University (USA). The software allows simulations to be done in the fields of solar thermal technology, alternative energy sources (including wind power, co-generation and fuel cells and related areas of heating) and last but not least ventilation and air-conditioning. It takes into account the geometry and properties of structures, glazed surfaces, latent heat storage of inner surfaces, internal heat gains, etc. The dynamic model in interaction with the defined profiles of zones and climatic conditions valid for the exterior balances the heat flow in all of the areas of a building in an hour based step. The definition of zones is individual (utilization, occupancy, lighting, heating and ventilation control, management solar gains). The result is a detailed and reliable calculation of heat demand, although it is time consuming to build the model of the building. TRNSYS requires a detailed knowledge of simulations of given physical issues as much as the software itself.

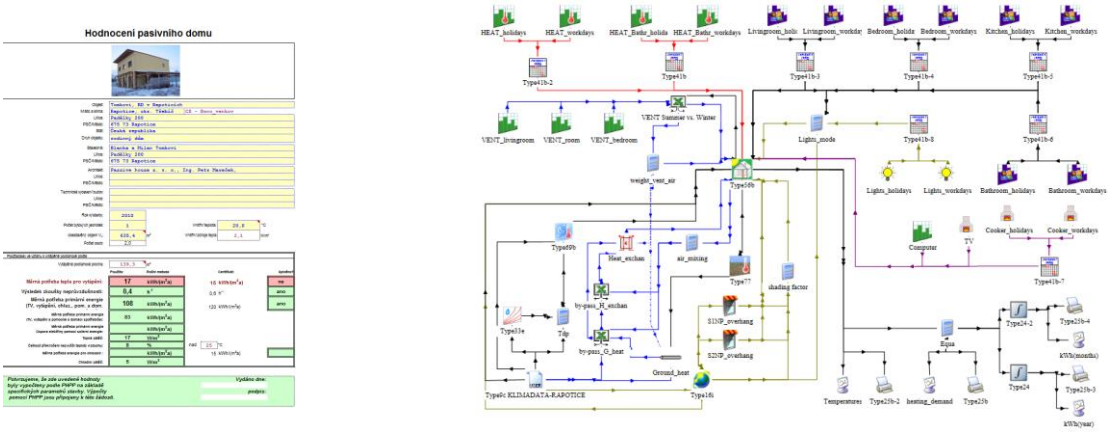

Figure 2. Left – PHPP 2007: user interface,
Right – Simulation Studio in TRNSYS 16: user interface.

ENERGIE [5]**.** Software „Energie" is very widespread and popular especially for its ease of use and quality technical support. It is primarily designed for comprehensive assessment of the energy performance of buildings. This software enables the calculation of the average heat transfer coefficient of the building, specific heat flows rate, demand for heating, partial delivered energy (heating, cooling, forced ventilation, humidity adjustment, domestic hot water, lighting), and more.
Heating and cooling demand can be determined according to EN ISO 13790 [6] by two ways: detailed calculation for individual months or a simple calculation over the heating season (seasonal calculation) [7]. Other tools that use similar principles in the Czech Republic as follows: software package "Protech", national calculation tool "NKN" and more recently by "Energetika" by DEK. The results of each tools is slightly different, although the fact that the tools use the same normative rules and climatic data.

ArchiCAD [8]**.** Graphisoft adds integrated tool "EcoDesigner" to software ArchiCAD. This tool performs energy analysis since the early stages of project development based on the information of a virtual building. The design issues of the energy-efficient buildings are greatly simplified if the designers are able to analyze the energy performance of their projects during the study.
The advantage of this program is the ability to interface with other software, eg, "EnergyPlus", "Riuska", "ArchiPHYSIK", "Ecotect", "Green Building Studio", etc.

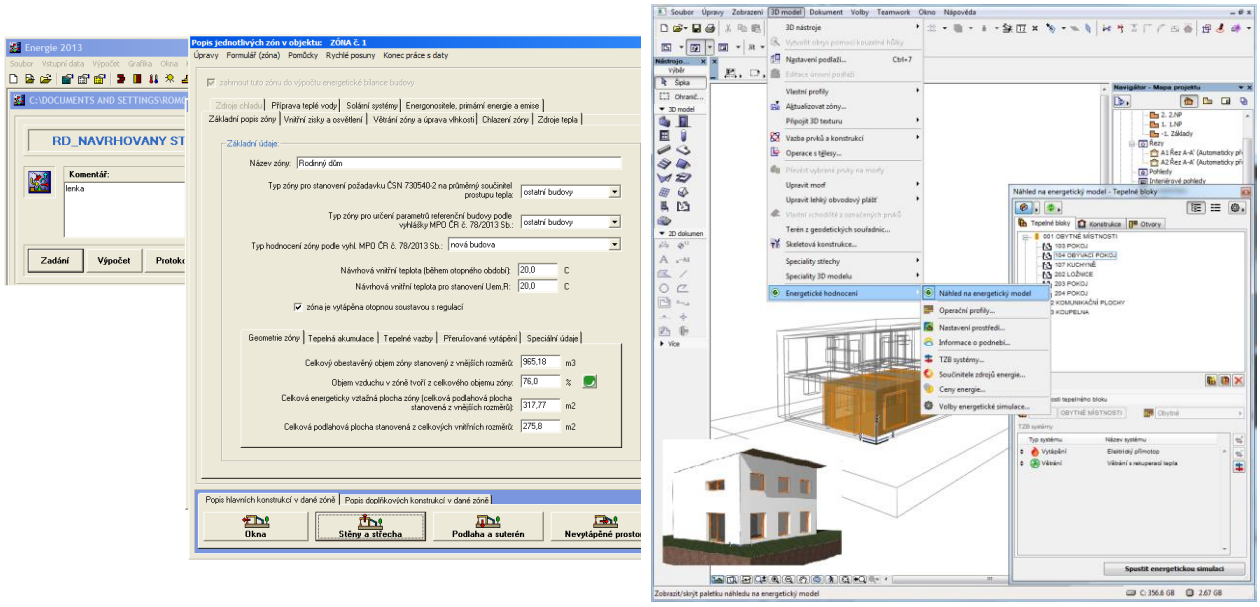

Figure 3. Left – Energie: user interface, Right – ArchiCAD: user interface.

Results and Discussion

Summarized results of individual tools are presented in Table 2.. Because the total energy reference area of individual tools is different, conversion to the same value is shown at the end of the table. Values of specific heat for heating can be compared after conversion. Results of the tools are comparable in case of correct modeling and using the same boundary conditions, similar internal gains.

Table 2. The Results of simulations

Tool	Average U-value U_{em} [$W \cdot m^{-2} \cdot K^{-1}$]	Floor area according to the methodology of tool [m^2]	Specific heat demand according to the methodology of tool [$kWh \cdot m^{-2} \cdot a^{-1}$]	Total heat demand [$kWh \cdot m^{-2} \cdot a^{-1}$]	Heat demand relative to the floor area pursuant to Act No. 406/2000 Coll. * [$kWh \cdot m^{-2} \cdot a^{-1}$]
Energie	0.15	195.5	12.7	2484	12.7
PHPP	0.16	139.3	16.9	2354	12.0
TRNSYS	-	195.5	12.6	2468	12.6

* in the Act No. 406/2000 Coll. The energy management [9] is an energy reference area provided from the external dimensions of building, which in this case is 195.5 m^2.

Conclusion

The purpose of the article was to introduce the common users with programs that are readily available and deal with the calculation of the energy performance of buildings. From the above results, it is clear that with proper process and sufficient user proficiency can be results comparable. The question is how much the possible values are different from actual results and measurement. The article has also introduced the concept of 3D building program that uses Archicad. Since this is relatively new software, we do not intentionally obtained results. Modeling in this program is a little different and uses different terminology than we're used from other programs. Therefore, the interpretation of the results will require more testing and comparing a deeper understanding of this extended program.

Acknowledgement

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References

[1] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings, 2010.

[2] L. Šteffek, P. Jelínek, M. Ostrý, Energy Assessment and Monitoring of Energy-Efficient House. *Portugal SB13*. 2013.

[3] PHPP, Passive House Planning Package 2007, Passivehaus Institut Darmstadt, 2007.

[4] TRNSYS 16, Transient System Simulation Tool, Solar Energy Laboratory, University of Wisconsin, Madison, USA, 2006.

[5] Z. Svoboda : Výpočtový program Energie 2013, Svoboda software, 2013.

[6] EN ISO 13790. *Energy performance of buildings - Calculation of energy use for space heating and cooling* , 2008.

[7] Stavební fyzika: Energie. *Kcad* [online]. 2014 [cit. 2014-06-09]. Available from: http://kcad.cz/cz/stavebni-fyzika/tepelna-technika/energie/

[8] ArchiCAD17. *Cegra* [online]. 2014 [cit. 2014-06-09]. Available: http://www.cegra.cz/200-produkty-software-archicad-17-vypocet-energeticke-narocnosti.aspx

[9] Zákon č. 406/2000 Sb.: *o hospodaření energií*, ve znění pozdějších předpisů, Česká republika. (Energy managment)

Preparation and Measurement Procedure Rate of Aggregates Compaction in Relation to the Long-term Accumulation of Heat

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Keywords: Long Term Accumulation, Aggregate, Grading Curve, Bulk Density

Abstract. Long-term accumulation of heat is one of the ways to reduce the energy consumption of buildings, to which we are pushed by the European Union. Currently water is the most often used as a heat transfer medium, but this can be very problematic in many ways. Very interesting option is the accumulation storage, which is formed by sprinkled material, whose advantage is the heat capacity and low price. The most important parameter is the structure of matter. This structure is derived primarily from the void age of aggregates, which significantly affects the ability of accumulation of heat. The paper presents the elementary parameters, which will determine the subsequent measurement of rate of aggregates compaction of a minimum of two different humidity. In the design of grading curve will focus on finding the optimal ratio of aggregate and air the effort to create the most homogeneous structure, which is necessary for heat conduction, as well as for its long-term accumulation.

Introduction

Nearly all the energy on the Earth comes from the sun, respectively all energy sources are generated by converting solar energy of the sun. In our latitudes is the quantities variable. In summer period achieves the power up to 1200 $W \cdot m^{-2}$, while in winter period it is almost a half [1]. Power from the Sun is quite a contrast to the energy requirements of modern living. While the need for energy of the hot water is practically constant, the energy for heating are fundamentally different during the year. Needs reaches up to zero values, what is precisely opposed by solar power in the summer.

According to the energy requirements of the European Union, this is summarized in the Directive of the European Parliament and of the Council 2010/31/EU [2] on the energy performance of buildings, would every building have to produce every energy to cover needs associated with a typical using of the building in future, especially using renewable sources. The most simple solution is to get solar energy directly through the solar collectors, which are practically can assure hot water throughout the year, in the full amount. Need for heating would be able to cover only with uneconomical increasing of effective area. It is generally designed so that at least a in good solar month could produce the amount of energy, which is needed to heat hot water and this relatively small area formed solar surpluses too, in summer period. The solution is long term accumulation [3]. In principle, it is preserve the amount of energy surpluses, mainly surplus of heat. Then is this energy stored in a storage, which consists of a mass of material with maximize heat capacity. The basic problem is thus to find the most suitable material.

Storage for Accumulation

Storage, which is developing on Faculty of Civil Engineering by VŠB-Technical University of Ostrava is designed as a sprinkled tray. The whole concept is based on the premise a perfectly homogeneous accumulating material. By sprinkled aggregate proposal is closely linked to the proposal aggregate in concrete.

The basic criterion itself is grain of aggregates, which should be complied the effort to preserve highest possible homogeneity. The ideal would be to take the whole rock mass of the desired size and move it to the destination. But it would be in practice very expensive and especially impractical. Maximum of homogeneity can be attained by using primarily coarse aggregate supplemented by other sizes. Coarse aggregate is, when $D > 11.2$ mm and $D / d > 2$, or $D < 11.2$ mm, and $D / d > 4$ [4]. To calculate the grading curve is necessary to know the maximum size of aggregate. The Czech Republic is commercially available as crushed and broken aggregate with D_{max} 63 mm. It cannot therefore apply equation for the line grain size by EMP, which is intended to aggregate into D_{max} 32 mm. Therefore calculations based on the equation by Fuller [5,6].

$$y = 100\sqrt{\frac{d}{D}} \tag{1}$$

Where: y is passing, the overall sieve through d [%],

d/D is particle size fraction [-].

The grading curve according to that this formula is shown in Figure 1 and corresponds to good granularity area 3 [3,7].

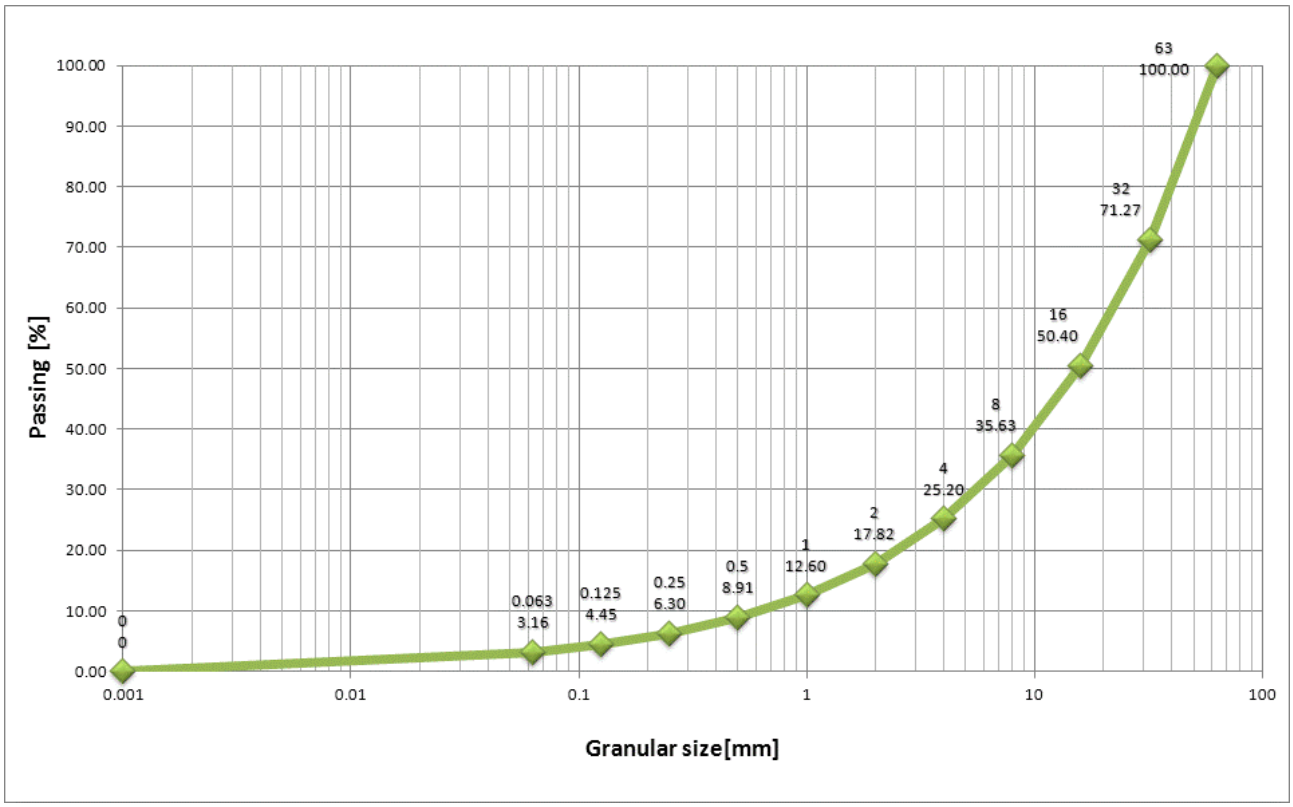

Figure 1. Grading curve.

Continuous grading curve is done to perfect filling of the spaces between the grains of the aggregate. The proportion of gaps, voidage, can be calculated from equation:

$$M = 1 - \frac{\rho_s}{\rho_k} \tag{2}$$

Where: M is voidage [%],

ρ_s is bulk density of compaction aggregate [kg·m^{-3}],

ρ_k is bulk density [kg·m^{-3}].

The bulk density of compaction aggregate according to the type aggregate is between 1400 and 2000 kg·m^{-3}, therefore, the standard voidage is 16 to 24 %. For aggregate for concrete, it is a free space for the cement, but in the heat accumulation is a completely undesirable. This space is full of air, which have very small thermal capacity. Higher porosity induces a lower storage capacity. Therefore it would be appropriate to fill the gaps with fine dust particles. It can be assumed the higher bulk density of compaction aggregate and therefore lower voidage (Figure 2), assuming the same moisture content of the aggregate.

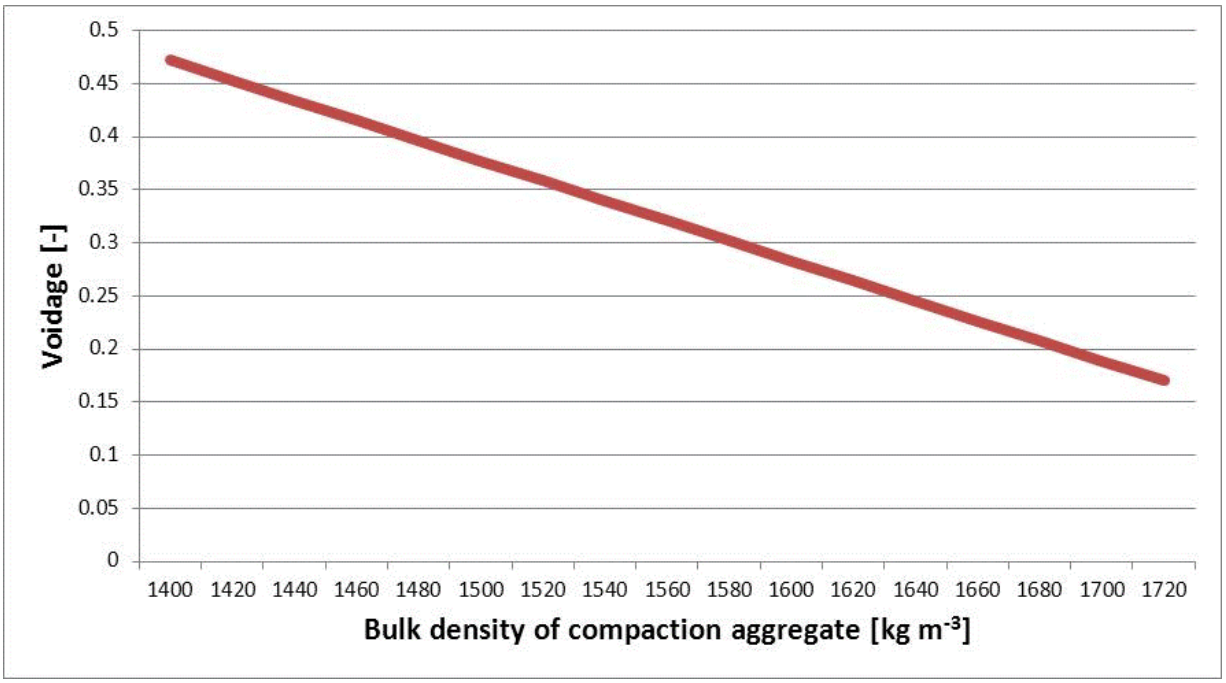

Figure 2. Voidage of aggregate with same moisture.

Bulk Density of Compaction Aggregate- Measurement Procedure

In relation to the voids of aggregate is the only modifiable parameter of bulk density of compaction aggregate. This is determined on the dried sample at 110 ± 5 °C. For the sample is already known density, grading curve and other standardized parameters [6]. Aggregates are placed into the measuring container and shake off and compacted to the maximum possible degree. Then the whole container with the sample is weighed and calculates the bulk density (formula 3[8].). To measure bulk density of compacted aggregate will be used vibrating table or immerse vibrator. Selecting the vibrating device will be based on the highest achieved weight aggregate in the container.

$$\rho_s = \frac{m_2 - m_1}{V} \cdot 100 \quad (3)$$

Where: ρ_s is bulk density of compaction aggregate [kg·m^{-3}],

m_1 is weight of measuring container [kg],

m_2 is weight of measuring container with compacted aggregate [kg],

V is volume of measuring container [m^3].

Conclusion

The accumulation storage represents a very simple and economical solution for requirements of the European Union on the power of renewable energy sources. It is more than suitable solution for buildings that are not possible to reduce the energy consumption for example by external insulation, for example, whether from an aesthetic or economic aspects. Another question is diagnostic method by using selected aggregate by the grading curve, which will be the subject of further research.

Acknowledgments

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References

[1] J. Labudek, L. Michnová, L. Martiník, M. Černíková, Microclimate depending on solar radiation, GRANT journal Vol. 01, No. 01

[2] Directive 2010/31/EU of the European parliament and of the council of 19 May 2011 on the energy performance of buildings

[3] V. Šípková, J. Labudek, O. Galas, Low energy source synthetic thermal energy storage (STES). In: Envibuild Buildings and Environment 2013. Durnten-Zurich: Trans Tech, 2014, pp 143-146

[4] PYTLÍK, P., Technologie betonu. 2/Technologies of concrete 2. vyd. Brno: VUTIUM, 2000, 390 p

[5] A. I. Nakorchevskii, Dynamics of discharging of a heat accumulator in an infinite grand massif. Journal of Engineering Physics and Thermophysics.2005, Vol.78, No. 6, Abailable at: http://www.springerlink.com/index/10.1007/s10891-006-0042-0

[6] ČSN EN 933-1 (721183): Zkoušení geometrických vlastností kameniva / Tests for geometrical properties of aggregates

[7] L. Svoboda, O mísení frakcí kameniva / About aggregate mix design, Beton: Technologie, konstrukce, sanace. Praha: Česká betonářská společnost. ISBN 1213-3116.

[8] ČSN EN 1097-3 (721194): Zkoušení mechanických a fyzikálních vlastností kameniva, Část 3: Stanovení sypné hmotnosti a mezerovitosti volně sypaného kameniva / Tests for mechanical and physical properties of aggregates- Part 3: Determination of loose bulk density and voids

Windows Energy Labelling in Slovakia

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Keywords: Window, Energy Need, Heating, Thermal Balance, Window Label.

Abstract. Energy labelling of windows has been introduced in some Member States - for example Denmark, Finland, Slovakia and the UK. The UK BFRC scheme on window energy labelling has proved very efficient in communicating to the general public about the energy saving properties of high performance products thus contributing to their faster uptake. Slovak labelling system was introduced in 2008. The paper deals with main principles of energy rating system used in Slovenergookno. National system for rating the energy efficiency of windows and is recognised within the Building Regulations as a method to show compliance for your replacement windows installation.

Possible Solutions for Ground Slabs of Energy Efficient Buildings

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Keywords: building envelope, ground floor, thermal insulation, buildings on the terrain

Abstract: The building envelope is a barrier that separates the internal environment from the effects of weather. This barrier ought to facilitate the optimal comfort of the interior environment in winter as well as summer. It has been shown in practice that most building defects occur within the building envelope. This includes external walls, roofs and floors too, and is impartial to new or renovated buildings. Heat losses of buildings through external constructions – roof, external walls, ground slabs are not negligible. It is therefore important to pay more attention to these construction elements. Basementless buildings situated on the ground are in direct contact with the subgrade and its thermal state. An amount of heat primarily destined for the creation of thermal comfort in the interior escapes from the baseplate to the cooler subgrade. The outgoing heat represents heat losses, which unfavourably affect the overall energy efficiency of the building. The heat losses represent approximately 15 to 20 % of the overall heat losses of the building. This number is a clear antecedent for the need to isolate and minimalize heat flow from the building to the subgrade.

Modelling of a Small Solar Collector Array and Comparison with Meteorological Data Using TRNSYS Energy Simulation Software

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Keywords: Solar Collector, Energy Simulation Software, TRNSYS, Meteorological Data.

Abstract. This article deals with the modelling of a small domestic solar collector array using Transient System Simulation Tool. The model was developed using meteorological data included as part of the Transient System Simulation Tool , mean regional data and actual meteorological data collected near the site of the solar array during testing. The main aim of this study was to compare the results of model simulations using the different types of meteorological data. The most accurate simulation was that prepared using meteorological data collected near the site of the solar array. Even here, however, differences were observed due to the equipment used to monitor heat gain, that is earlier insolation of the meteorological station.

Determination of Linear Thermal Transmittance for Corners with Acute Angle

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Keywords: Linear Thermal Transmittance, Corners, Acute Angle, Energy-Saving Architecture, Thermal Bridge.

Abstract. This paper deals with the determination of linear thermal transmittance for buildings with acute angle shapes. Calculation of linear thermal transmittance is a standard problem in determining the influence of thermal bridges on the overall energy performance of buildings. Computational methods are known for ordinary rectangular buildings and the values of typical detail are listed in databases. Current architecture of designs buildings uses acute angle shapes quite frequently. It corresponds with new trends in architecture. In such cases the value of linear thermal transmittance is not accurate for using databases. This paper presents an analysis of the influence of the change of angle of the walls in corner to linear thermal transmittance. It provides information applicable for buildings assessment in engineering practice.

Behavior of Point Thermal Bridges from Mechanical Anchoring of Flat Roofs

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Keywords: Flat Roof, Thermal Bridges, Metal Anchors

Abstract. Building of structures with high energy performance is topical. To achieve this, it is necessary to have processed besides other thing a detailed design. Thermal bridges have to be eliminated in the design period. Thermal bridges occur as point, linear and 3-dimmensional ones [1]. Mechanical anchoring creates point thermal bridges too. In this paper will be described only the mechanical anchoring to stabilize a flat roof. In the space with anchoring elements there is increased the thermal flux. This flux depends on the composition of the flat roof and kind of anchoring elements. It could lead to the condensation of water vapour in these locations upon attainment of the critical value of surface temperature in the room. This issue has another not-less interesting side. It is behaviour in summer season, when the anchoring conducts heat to the interior of objects. These thermal bridges caused by the anchoring elements described in this article will be modelled with the Ansys software tool.

The Issue of Including the Influence of Thermal Bonds in the Passive House

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Keywords: Passive House, Granules of Foamed Glass, Thermal Bonds.

Abstract. Influence of thermal bonds when evaluating the energy performance of buildings can be included in the calculation approximately by means of a surcharge on the effect of thermal bonds or precisely by using specific linear heat transmission coefficient for thermal bonds between structures. The article presents a comparison of the two options in the energy performance of a particular building, the specific amount of heat for heating the building of a brick passive house based on the foam glass.

Long-Term Monitoring of the Effectiveness of a Ground Source Heat Pump Borehole

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Keywords: Borehole eat Pump, Thermal Performance, Substrate Cooling, Primary and Secondary Side of the Heat Pump

Abstract

In this study, we evaluate the qualitative thermal performance of a groundwater borehole by monitoring the temperature at the primary (borehole) and secondary (heat pump) sides of a domestic heat pump over three heating seasons between 2010 and 2013. Based on early results, the borehole was extended during the monitoring period in order to increase performance. Our results suggest that the temperature parameters of a borehole do not remain constant and that a borehole's properties can change significantly over time if the borehole substrate temperature is not given time to regenerate.

Climate Data Processing For Needs of Energy Analysis

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Keywords: Climatic Data, Measurement, Energy Analysis, Weather Station

Abstract. This article describes a part of experimental measurement with assistance of independent weather station. Later on, after the data processing from chosen period of time (1 week in March 2014) measurements are described, graphic processed, interpreted and compared to the results of real meteorological station from Slovak Hydrometeorological Institute (SHMÚ). Convenient climatic units are elaborated. The influence of differences in measured data on results of calculations for thermal-technical parameters of covering constructions is analysed.

Identification of a Percentage of Engagement of the Bivalent Source of the Earth–Water Type Heat Pump in Heating of the School Using the DDFPM Method

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Keywords: Bivalent Source, Earth–Water Type Heat Pump, DDFPM Calculation Method.

Abstract. The calculation based on the DDFPM method will enable us to identify the percentage engagement of the bivalent source in heating of the facilities in the period under consideration and at the location under consideration and we will be able to verify an optimum design for covering the heat loss by the bivalent source of the heat pump.

Heat Supply Optimization

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Keywords: Heat Supply Optimization, Interrupted Heating Regime, Building Accumulation, Operational Regime Saving

Abstract. Due to the energetic evaluation of buildings, the solutions for optimal heat supply are a problem of current interest. The topicality of this problem is underlined by the European Union requirements for reducing the energetic demands of buildings by the year 2020.

From the operational point of view, most of the heating systems seem to be optimal; however, with the use of the results of this detailed analysis it is possible to make even further improvement. The objective is not to supply more heat energy than necessary in order to achieve energy saving. This reduction of heat supply can be achieved by the use of the heat accumulation potential of the building by means of appropriately chosen heating mode. By operation modes are meant a mode with constant heating and a mode with interrupted heating.

In this sample case of non-stationary simulation during the interrupted heating regime it is possible to demonstrate the potential saving achieved by the chosen interrupted heating mode. The case study is conducted on a secondary school building. In this project, supported by the specific investigation project on the Faculty of Civil Engineering, I carried out an experiment of an interrupted mode, which was also supported by a theoretical part, in which a non-stationary calculation was used.

This contribution suggests the possibility to save energy by optimization of the heat supply. It also presents the difference between a stationary and non-stationary solution to this problem.

Analysis and Quantification of the Influence of Thermal Properties of Building Envelope on the Energy Balance

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Keywords: Energy-Efficient House; Energy Simulation; Energy Balance; PHPP.

Abstract. Unfortunately, buildings are in practice rarely created as expected during the design process. This may be due to changes in the project during the construction, or to poor implementation. Energy consumption of the real building can be significantly different from that theoretically calculated. User behavior and the physical characteristics of buildings and their systems are the main influences for these deviations.
This paper deals with a computer simulation quantifying the influence of changes the thermal parameters of a building's envelope demands of the future energy. Furthermore, it compares the costs and returns of each alternative solution.

Evaluation of the Thermal Resistance of Structure with Reflective Insulation: Measurement under Non-Stationary Boundary Conditions

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Keywords: Reflective Insulation, Radiation Heat Flow Rate, Emissivity, In-situ Measurement; Thermal Resistance.

Abstract. Some manufacturers of reflective insulation products claim that their relatively thin products have the same thermal insulation properties as common insulation with much times higher thickness. This paper deals with experimental measurements of the thermal insulation properties of real structures with reflective insulation. Several experimental sequences were conducted to determine the thermal resistance of the structure. The evaluation was conducted according to the procedures specified in the international standard (ISO 9869 - 1994). Effect of products (based on the reflection of thermal radiation) on the thermal insulation properties of the structure will be determined by evaluation. This effect will be compared with the effects of common insulation (with the intention of reduce of the heat transfer by the conduction).

The Comparison of the Probabilistic Calculation of Course of Temperatures in Peripheral Construction with Actual Measured Data

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Keywords: Probabilistic Calculation, DOProC Method, ProbCalc Software, Peripheral Wall, Wooden Passive House, Temperature Inside the Structure.

Abstract. This article deals with probabilistic calculation of the behavior of the peripheral wall of the wooden passive house in terms of the temperatures inside the structure in the winter. The probabilistic calculation was made for the actual boundary conditions, ie. actually measured exterior and interior temperature. The results of the probabilistic calculation are ultimately compared with the results of experimental measurements of temperature inside the structure, ie. the actual behavior of the structure.

Comparison of Polysun Simulation with Direct Measurements of Solar Thermal System in Rapotice

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Keywords: Solar Thermal System, Passive House, Comparison, Polysun, Simulation, Measurement In-Situ.

Abstract. Design of small solar thermal systems used in family houses is currently commonly based only on experience of designers who rely on a few basic rules. But these sophisticated systems' design should be tailor-made according to the needs and habits of the users, because their behavior has great impact on the systems' efficiency. This is why we should use computer simulations – to design the most appropriate option that would fulfill the needs of the users. In this paper we compare computer simulation (using Polysun - Designer software) of a small solar thermal system installed on a passive house in Rapotice with in-situ measurements. From this comparison we make conclusions applicable for design of similar systems.

Integration of Small Wind Energy Source for Optimization of Energy Efficiency in Residential Building

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Keywords: Thermal Losses, Renewable Energy Sources, Wind Turbine, Wind Energy

Abstract. According to current European strategy and effort, an integration of renewable energy sources (RES) applying of new technologies should have of crucial importance, especially with contribution to the energy efficiency optimizing in buildings. Concurrently, energy performance and energy consumption of the all housing stock is one of the key indicators that represent the adequate utility value of those efforts. The paper focuses on the proposal concept integration of renewable energy for residential house in relation to assessment of the building thermal and energy performance. The proposed concept applying of wind turbines is presented for residential building in terms of standardized target periods. Finally, payback period calculation demonstrates a certain potential of applying small wind turbine as a renewable energy source in residential building of recently given target periods of current technical regulation.

Advanced Thermal Performance Analysis of Thermal Break Element Applied in Balcony Slab

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Keywords: Thermal Bridges, Thermal Losses, Thermal Conductivity, Balcony Slab, Isokorb

Abstract. Thermal performance of any building component is the result not only of its thermophysical properties but also of a way of final installation and connections altogether of their all elements. In addition, thermal leakage and bridging in buildings can eventually contribute to a multitude of problems. The thermal bridge is the place in the building envelope through which heat transfer has a multi-dimensional nature. That is why in recent studies, the issue of heat transfer phenomena in the building components is considered as a multi-dimensional more frequently. One of the specific details that create thermal leakage is located in balcony slabs. This paper is focused on detailed analysis of thermal performance of thermal break element applied in balcony slab with relation to the thermal aspects of wall building envelope. Particular cases of commonly used balcony systems in buildings are observed related to multi-dimensional and parametric approach of modeling. As result of analyzed thermal aspects, such as importance of building envelope type and its thermal performance, variations of thermal properties, are presented as study findings that affected thermal bridges magnitude and resultant thermal performance of balcony slab detail.

Modeling of Details for Single-Layer Wall in a Passive House: The Case of Balcony Slab

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Keywords: Balcony Board; External Eall; Thermal Analysis; Linear Thermal Transmittance; The Thermal Factor.

Abstract. The balcony is one of the main reasons of the increased heat loss. The presence of thermal bridge in constructions of balcony envelopes influences the energy consumption, durability of the building envelopes, and also the thermal comfort of occupants. If the balcony construction is performed of a metal back slab it would be hardly possible to avoid the formation of a powerful thermal bridge that will go along the whole balcony length. This problem could be solved by using of thermal insulating element for connecting cantilevered steel components to wall. An investigation into the various performance criteria concerning the effectiveness of steel balcony connections to reinforced concrete wall has been carried out in our article.

Influence of Window on Solar Gains and Daylight Level

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Keywords: Window, Solar Gain, Daylighting, Solar Factor, Light Transmittance, Heat Loss Coefficient.

Abstract. Energy savings led to design requirements for buildings with thermally insulated envelopes. Window glazing with better thermal insulation properties have in many cases reduced transmittance of solar radiation. They decrease solar thermal gains and daylight level in buildings. A study of influence of selected windows on solar gains and daylighting in a reference room is presented in the paper.

Economic Assessment of Increase Energy Efficiency of the Residential Building by the Envelope Renewal

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Keywords: Thermal Insulation, Envelope Renewal, Residential Building, Budget, Cost, Unit Price

Abstract. The currently, much frequent revitalization of residential buildings should provide for the increase of energy efficiency, by the investor. The increased energy efficiency leads to a reduction of noxious emissions of CO_2 and a prolongation of the life cycle of building, simultaneously. Those requirements are derived from the principles of sustainable buildings. The subject of this article is cost calculation and economic assessment of the revitalization of the residential building. Cost calculation is presented in a particular example of the residential building, where are analyzed the economic relationships between revenues, costs, production volume and profit, which leading to the calculation of unit price. The investor selects the next contractor, on the basis of determining the unit price. This contractor is to ensure the successful revitalization of the residential building.

Introduction

The present issue is highly topical since, according to expert estimates, is still almost ¾ of the housing stock without insulation. Specifically, according to the Association for thermal insulation of buildings are only 31.9 % insulated residential buildings in the segment of residential buildings for the last eighteen years. Increasing energy efficiency can be in several levels. Selecting this level depends on approval of finance package, tenants of the apartment building, which are prepared to invest in the revitalization of the apartment building. The selecting this level depends on approval of finance package, by tenants of a residential building, which are prepared to invest in the revitalization of the residential building. Renewal should be as comprehensive as possible. The fact remains: comprehensive restoration brings greater cost of construction work, but thus increased monthly energy savings with the use of flats. Initial information is to prevent the heat losses in the individual constructions. Heat losses are identified as follows: by the roof structure heat losses are 6 - 20 %, by the foundation structures 5 – 15 %, by window panes 25 – 40 % and 30 – 50 % by external walls (fig.1) [1]. This initial information more or less decided that complex reconstruction will be narrowed down to those structures which are most heat escapes, thus the exchange of window constructions and the insulation envelope of the residential building. After the selection, the next step is the choice of contractor for the future reconstruction. It is necessary to consider choosing a contractor very well. Between the criteria for selection of the contractor include: price for construction work, references, license to insulation work, guarantee and delivery conditions, technical and human capacities of the contractor, payment, fulfilment of obligations towards public institutions and the like. The request should state the requirements to fill all these criteria. In no case should be decisive only price. It is good to identify the reference building and personally go see the materials and technology. Energy efficiency is also described in the publications [2], [3].

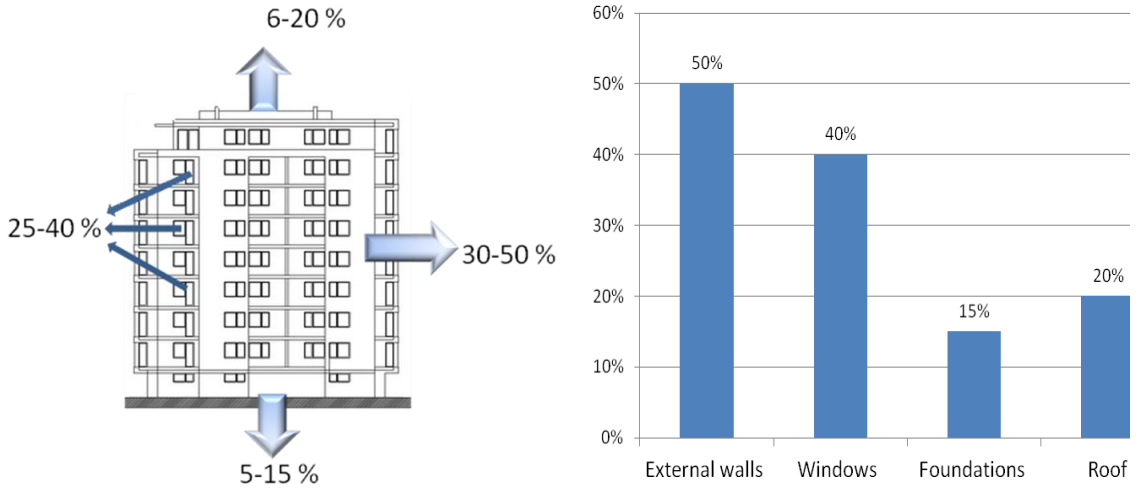

Figure 1. Possible thermal losses in the construction of the residential house.

Most contractors have in their promotional materials specified price per 1m^2 insulation. Examples include 28 €·m^{-2}, 35 €·m^{-2} or 45 €·m^{-2}. This paper presents the method of calculated estimated value. Next is presented the difference between the offer price per m^2 and the actual price per 1 m^2, which may affect the profit of the contract in the construction company. In conclusion, the substance of an accurate determination of the offer price, with an emphasis on minimizing of losses and maintaining of profit will be presented. Description of the contractor cost calculation is given to the particular example of the residential building reconstruction, where are analyzed the economic relationships between revenues, expenses, production volumes and profits arising for contractor [4], [5].

Determination of the Offer Price of Realized of Building Constructions

Distribution construction parameters are defined in itemized budget, which is the result of a final agreement with the investor and annexed to the contract for work. The offer calculation is to assess the economic benefits of the contract and establish the extent of profit. The total amount of the estimated cost providing in the Table 1, broken down by realized processes. In the table, these processes are referred as aggregate. The offer calculation consists of individual calculated items of materials, wages, cost of machinery and subcontracts. Total costs also include not calculated items, which include Ancillary Budgetary Costs (ABC). Between ABC include building site, out site transport, zoning and operational impacts.

Table 1. Recapitulation of construction - offer calculation.

Contract	**Costs total [€]**	**Material [€]**	**Wages and deductions [€]**	**Machinery [€]**	**Subcontracts [€]**	**No calculated items (ABC) [€]**
Revitalization of residential	**80 611.18**	**22 412.11**	**30 207.78**	**5 822.48**	**20 726.58**	**1 442.20**
Thermal Insulation	69 659.18	22 412.11	30 207.78	5 822.48	11 117.45	99.34
Repair of coating covering	4 462.00	0.00	0.00	0.00	4 462.00	0.00
Entrance door and stair windows	6 490.00	0.00	0.00	0.00	5 147.14	1 342.86

At the stage of submitting bids, based on the above assumptions of the revenues and expenses, were processed quantification of the expected financial results in the structure, by program CENKROS plus. CENKROS Plus is one of the most used and well known specialized software programs on the Slovak market, which are used for budgeting and calculated the price of building production.

Evaluation of buildings after realization

Controlling department in collaboration with an implementing production unit, after the end of the construction, should process the economic evaluation of the building, which can be seen in Table 2. For economic evaluation of the construction, contractor processes the production invoice, where are any changes that have occurred during construction. On this basis, it is possible to compare and evaluate projected costs with actual costs, and calculate the difference. Thus we find out the achieved economic result.

Resulting contract based on previous data:

- Net profit was 13 605 €, which represents 13.3 % of the sales price
- Actual result is better than the assumption (plan) about 3 391 €, respectively about 3.3 %
- In the budget is the price 48 €·m^{-2} for 1 m² insulated surface
- Actual cost of 1 m² is 31 €·m^{-2}
- Savings in material is 3 276 € because of the achievement of quantity discounts when buying insulation and adhesives, but we have over consumption of adhesives compared to standard, whereas we have used 10 kg / m², and calculated standard was 7 kg / m². (The cause is the uneven surface, which should be taken into consideration in costs calculation of the similar projects.)

Structure of economic result contract is displayed by individual works in Table 2. From the Table 2, we can see that positive gross margin (sales minus direct costs), business forms from activities, which were realized by own capacities. Conversely, a negative gross margin was achieved in the work which was made by subcontractors or in calculation of construction site costs.

Table 2. Structure of the profit and margin production.

Item	Budget		Costs		Gross margin		Overhead	Net margin		Comment
	[€]	[%]	[€]	[%]	[€]	[%]	[€]	[€]	[%]	
1. Insulation										
Own works	76 766	75	49 370	64	27 396	36	8 828	18 568	24	profit
Other works	2 808	3	2 183	3	625	22	323	302	11	profit
2. Subcontracts	18 634	18	19 822	26	-1 187	-6	2 143	-3 330	-18	loss
3. Production overhead (ABC 4,3%)	4 419	4,3	5 845	8	-1 426	-32	508	-1 934	-44	loss
TOTAL	**102 627**	100	**77 220**	100	**25 407**	**25**	**11 802**	**13 605**	**13**	profit

Analysis of Unit Price of Thermal Insulation

Based on the information about the total insulated surface can then analyze the creation of profit on production unit of insulation, which is the square meter. If the total area of the insulated area was 1.592 m², then unit sales price of insulation is about 48 €·m^{-2}. The actual cost of insulation (material, labour, machinery) were quite of 49 370 €, so the unit cost is about 31 €·m^{-2}. Achieved gross margin is 36 %, what on power for unit amounts to 17 €·m^{-2}. This margin is then used to

cover losses on other types of work, as well as to cover the overhead. The total economic result and net margin is 13 605 €, which represents about 8.5 €·m^{-2} (Table 3).

Table 3 Analysis of unit price of thermal insulation

Item	Budget		Acctual Costs		Gross margin			Margin of other work [€]	Overhead [€]	Net margin [€]
	[€]	[€·m^{-2}]	[€]	[€·m^{-2}]	[€]	[%]	[€·m^{-2}]			
Own works Ther. Insul.	**76 766**	**48**	**49 370**	**31**	**27 396**	**36**	**17**	**-1 988**	**-11 802**	**13 605**

Conclusion

Article presents an economic assessment of energy efficiency residential building with thermal insulation, from the perspective of contractors' company. According to the achieved economic result of the construction, is necessary for the contractor, to determine the reason for the negative differences, which arose in excess of planned subcontracting costs. There were also exceeded the planned budget cost ancillary, whereas according the facts was not sufficient to ancillary budgetary costs 4.3 % of the basic budgetary costs. Therefore, it is necessary, so that the contractor prepare the individual calculation of the ancillary budgetary costs, that the next contract did not create this costing loss item. Also, the content of the paper is evident, how it arise the price range of 28, 35 or 45 €·m^{-2} and what this price range includes.

References

[1] http://www.siea.sk/seminare-pre-bytove-domy-2011/c-1059/co-netreba-podcenit-pri-revitalizacii-bytovych-domov/

[2] Z. Struková, M. Kozlovská, Environmental impact reducing through less pollution from construction equipments, SGEM , 12th International Multidisciplinary Scientific GeoConference P. 401-408, Albena (2013)

[3] M. Spišáková, I. Hyben, P .Heredoš, Assessment of environmental risks during the construction process, SGEM 2012 12th International Multidisciplinary Scientific GeoConference, P. 75-82.Albena (2012)

[4] J. Čavojský, Oceňovanie stavebných prác, Cenekon, Bratislava (2012)

[5] M. Kozlovská a kol., Ako úspešne riadiť malú stavebnú firmu, Eurostav, Bratislava (2003)

Methodology for Quality and Optimal Design, Including its Own Implementation of the Recovery and Revitalization of Buildings

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Keywords: Age of the Building, Durability of Structures, Maintenance of Buildings, Humidity, Rehabilitation, Modernization, Change the Layout, Construction Administration, Department of Conservation, Original Condition, Static Security, Construction Survey, Contractual Arrangements, Price.

Abstract. This paper focuses on the overall design methodology quality restoration and revitalization of buildings with regard to their structure, function, age and future use. The paper highlights the serious fundamental flaws, which commits the entire process from design to implementation builder, designer and building contractor. The task of building offices in the process. The proposal recommended and certified materials and procedures for the renewal and revitalization of buildings with a maximum value, durability, security, recovery and quality environment inside the building restriction invasive interventions in the original designs.

Introduction

Based on many years of experience in construction and recently unfortunately quite very negative, especially in the quality of project management and the entire construction of new buildings and renovations of older buildings to think about it, why in the age of modern technology and construction market saturation lot of building materials build quality problems, we solve major problems and defects in quality buildings. Within the experience of the site manager, technical supervision, an estimator and finally an expert in the field of construction and teacher at the Technical University in Brno, field technology, mechanization and construction management, again and again encounter the same errors that accompany the construction process from the very investment plan to implementation, including lack of concept ideas other users on the operation and subsequent maintenance of buildings. In this document the errors that arise during the construction process and instructions how to remove them.

Investment Plan, Project Preparation Renewal and Revitalization of Buildings

Future builder, whether natural or legal person who enters the building process, you must know that he is an experienced professional in the field of construction and can handle everything without the help of an expert.

Here there is a fundamental problem, which, thanks to the Internet era concludes with a kind of lay people the illusion that the information obtained by them in this way to acquire the knowledge based industry in its breadth and in particular, expert knowledge and experience level. There are cases where customers want to build, and have the feeling that everything had already found materials to ensure through online stores buy as project type and simply let it cheaply rework. In most of these cases it is these customers came in during construction that is fundamentally wrong and ultimately the final settlement construction finds that it's all been worth much more than if you leave everything processed by specialists with excellent references. Deliberately here mention the word excellent reference. Business in the construction industry de-facto almost anyone, just as he finds a responsible representative and obtain a trade license. Company to design, and implementation time by looking primarily operating in the market, their professional maturity,

experience and references investors who already have them with practical experience. But even that may not capture all the great, because people change, companies are transforming, and after some unsuccessful operations, insolvency etc. will appear under a new name and can repeat their erroneous practices further. There is an urgent need for a radical legislative change. Just look for the legislation in force in developed countries and want to change something. From the above it follows therefore need to hire the very beginning of this project restoration or reconstruction consultant with high professional erudition and years of experience. Clearly it must be a person who is incorruptible and reliable, must again be recommended on the basis of real positive references.

1 - Before the start of the project, it is imperative to address and choose a quality and experienced experts, independent consultant and at the same time in one person Technical Supervision of the Client (TSC), which operates throughout the preparation and implementation of the handover in favor of the builder (closed mandatory contract with him, where mutually define future cooperation). Consultant = TSC choosing a quality solution at the best price and control the effectiveness of the project with regard to the requirements of the builder and his idea of the final price. It is necessary to select a reliable, experienced and empathetic designer (incorporated in the project builder requirements so that the builder was happy! Often seen in practice that imposes builder designer's ideas and then building on the fly changes in both the structure and at present) and static - a professional who has practical experience.

2 – Follow specific step in the right direction is a procedure for building condition survey and design quality construction and technical research, including any additional surveys, such as the survey of experts in the field of wood - mycological survey, a survey for the presence of wood-destroying insects, geological and hydrological surveys, further research on radon occurrence , asbestos in structures, CCTV survey of the sewer line measurement of moisture masonry, wood, check continuity of chimneys camera etc.

Critical point - Legislation only these surveys is recommended, but by practical experience is often carried out only preliminary visual exploration without destructive testing or just passport buildings - the focus of the current state and the other is solved until the actual construction, which again may result in disproportionately raise the final cost of the work. Any such survey builder sees mostly as a financial burden.

Remedy - It is therefore necessary that at this stage builder trusted consultant, on the basis of experience provides the scale of the survey, according to the state of the building and requests for new features building upon the renewal and revitalization.

3 - On the basis of detailed structural and technical survey and feasibility study (to address basic layout and materials of the object) can be calculated using the builder enclosed space expert calculated estimated cost of the work. Here is a very necessary based on experience and expertise budget calculator a database similar to the revitalized buildings. This price then with regard to any reserve estimate in the variance + 20 % - 20 % of future costs to the entire whole, and the added budgetary provision for the reconstruction ranges from 15 to 20 %.

Critical point - at this stage is very often the case that the designer right price make miscalculation - usually underestimate it and the owner is then unpleasantly surprised by the sum of which is in the final phase of the project will appear on the cover sheet of the itemized budget.

Remedy - The price must be established expert in the field of prices - calculator, which already has a database of other buildings and is best able to assess the cost of steps forward.

4 - Following the approval of this price you can start to work on your own project, including construction and structural design and Fire Safety Project (FSP). Architectural and structural design of the project - the structural analysis and design of static security building before major construction changes within the construction work is required to assess the costs and find the best solution for the builder. (These include the reinforcement of foundations, remediation of cracks in

the walls, ceiling reinforcement structures, truss adjustment, completion and maintenance of wreaths, etc.). As part of the preparation of the project suggest close and regular cooperation with the client, TSC and a structural engineer designer.

Critical Point - A common problem here is time-consuming preparation of the project, which in the context of major structural modifications and alterations subject to building control. At this stage the most unlikely event that the builder will require the designer to swiftly obtained a building permit. The designer then draw up the details of the project Documentation for Building Permission (DBP) for building office as soon as possible ran a construction management. Often financial costs for design and survey work at this stage are quite high amounts and the builder starts intensely and save the project. Finally, insists that the Contractor under the implementation of the project design documents processed at their own expense. The builder, who succumbs to the illusion of saving for a project falls into the trap of contractor work has room for objections to the project documentation in the range of a DBP approach to the calculations of the additional work (before extra work). Finally, the cost of the work climb as much as 20 % to 40 % higher than the original cost of the work provided for in the budget for the project for the DBP.

Remedy - complete processing of Project Documentation (PD) detailed implementation including all details, list of products, building structural design and FSP, for which completeness clearly throughout the implementation of the project corresponds to the design engineers and fire specialist. Dates for the execution of Building permit can be determined strictly in Contract for work with the designer with regard to the complexity of the project. I recommend building starts to move to a later date and would rather devote space quality project preparation, including safety measures during the construction and subsequent use of the building, we include here as measures to secure future maintenance.

5 - Choosing a building contractor. It is based on the selection process. Of course we have construction under public or private contract. However, common to both variants true overall trend: The best supplier is the one who offers the lowest price. The builder chooses the supplier who offers the lowest price and is pleased to spare. Contractors won the contract to literally generate an undervalued price at which the work cannot be realized. Area vendor selection for the lowest price by analysis of multiple-deserved describing the myriad of specific contracts, which follows price increases construction work as much as 20 % above the highest price that was given in the tender. Clients, however, are incorrigible, and still hear only at the lowest price. A wise builder works and trusts his TSC and let´s get these pitfalls, explain and demonstrate calculations, which it clearly demonstrates that the extremely low price is always redeemed poor performing works by using substandard materials and failure to technological processes. Aftermath follows selected orders again I could describe the multipage documents based on a large amount of expertise in which I dealt defective work and calculated damages, which often amounted to millions. In addition, prices for judgment, lawyers and the cost of putting the building in perfect condition to be borne by the builder will add endless litigation with no clear outcome, because very often, the company that this well filled, no longer exists.

Nor should the builder had a very well specified in a contractual relationship with a building contractor the exact purpose of the work, that in the event of defective performance avoid a situation where the contractor delivers his work, which cannot practically be used, but it must assume all risks and potential costs with the management of another. [1]

Implementation of Renewal and Revitalization Projects

The actual implementation of the work then is coordinated collaboration and design engineers, TSC and builder. During construction takes a large amount of change orders due to unforeseeable circumstances (for old buildings is to be expected with previous unprofessional interventions in building construction, such as unrelated masonry openings in bearing walls are bricked a slip and

completed backfill of rubble masonry is associated poor bonding, meet some structures - such as the bombed buildings in Second world war repaired after the war, so that was used as a carrier gable wall of the neighboring house, the place is interrupted beam clamps, dodging chimney vents, ceiling and other structures damaged by fire broken flue gas path in old chimneys, chimneys are kept in electrical wiring and other oddities) that must be addressed immediately. We therefore recommend that count on site with regular weekly inspection days with the active participation of statics, including TSC, designer and builder.

Suitable Materials and Technologies for the Restoration and Revitalization of Buildings

In the design stage the builder expects professionalism from the designer and relies of his skills and experience that he will propose solutions that are best suited for his building. In practice, it happens that some designers are motivated by different suppliers of building materials and systems, and these materials can be proposed for the building without consulting with TSC or client. The builder confidently entrust the building designer and have no idea what problems this solution can bring. Unfortunately, many developers do not have experience of operating conditions of buildings does not know the price of materials or labor, then it is a step that will appear in the project materials, processes, or solutions to some of the details completely unsuitable for the specified object. Just deal with TSC, which would themselves have a minimum of 4 - 7 years experiences in the construction work and years of experience in construction supervision, and then in good mutual communication can prevent these errors.
The basic rule for the revitalization of buildings is to maintain or restore as much of the original technical solutions that our ancestors had based on long experience in the building and realized the building could operate even without waterproofing the basement, overheat the facades or roofs, in buildings healthy and comfortable indoor climate. I am not talking here about the objects that have undergone revitalization in the pre-revolutionary period and were functionally impaired so that today it is very expensive to bring them in at least part of the original working state.
Basically, here I will mention a few of the principles that have an impact on the future use of quality construction and subsequent maintenance costs.

1. Restoration of damp walls - prefer classic venting damp masonry on the basis of changes in the partial pressure of air in combination with breathable technology renders properly made and appropriate sanitation ventilated insulation system of external walls below ground level. Not to deploy such premises rooms with high levels of expected internal humidity (bathrooms, showers, laundries, etc.). Ventilation system in the basement floor. In any case, not risking any of these hermetically sealed space.

2. Carefully follow the design of insulation, is not suitable for all stick insulation system (hereinafter referred ETICS for example of polystyrene foam) and the object completely sealed. The whole approach to solution design must be well considered. Very often I deal with reports on the formation of mold in such sealed and insulated buildings. Users of these flats are indeed happy to have a low cost of heat, but at the same time, the house does not feel good and sensitive individuals have health problems. In addition, starting at ETICS carried out in the years 1992 - 2007 show disturbances in the form of the growth of mildew, moss and algae to the north and shaded facades, with larger grain sizes of 2.5 - 3 mm are multiply (on bright coloured facades) spiders and the bright coloured facades building is aesthetically devalued black cobwebs. I recommend going with the renewal and revitalization of buildings through detailed calculation by actually recorded thicknesses of masonry and if it is necessary to design the insulation, so only ventilated system with mineral wool with vertical, or even long-grain. Vented systems have ranked among the most expensive solution, but already there have been some efforts to use water-resistant panels with a classic finish coloured plaster or paint system. On uneven surfaces of the original masonry is very time-consuming to perform the classic double grates that have a significant contribution to the high price of these ventilated padding. But there is also the possibility of using special anchors with

adjustable in length from recycled materials that can cope substrate in a simple way without having to grate.

3 - Solution attic space installation in existing roofs can also rely on increased financial costs especially in the summer when the attic apartments without air conditioning are not possible at all to stay. Air Conditioning brings us back health issues that we can greatly affect the future quality of life. I recommend highly considering the way the structural design of the loft. If the planning authority shall not authorize the superstructure with a classic flat roof or a roof rack recommend if it is at all possible to design the latest ceiling attic space above the ceiling as hard. The best time were the Hurdis that just because of poor standards and arbitrariness manufacturer, which began at the cost savings Hurdis boards produced with thinner internal partitions of the original 12 mm to 8 mm thick walls. In 1994, it began to appear the first failure (cracking walls and falling off the bottom edge of the board), which eventually led absolutely absurd to stop production. It was enough to again reinforce walls and making plates in original quality. For reconstruction, it was the perfect material for a reasonable price and with a little time consuming allow the reconstruction of buildings and build ceilings complement to varying degrees without the need to have heavy machinery. Ceilings Miako to replace this function, but so far not a single object except perhaps family houses, these ceilings do not realize the time demands a high price.

Doors and windows are also often discussed problem. Historical monuments are bringing the issue of replacement old degraded windows for new plastic windows and affordable for builder. The last word here has a department of conservation (the DC). DC approaches are sometimes very different and I am thinking about it, why is it possible to allow the construction of plastic windows in the downtown area and the next building must be double-glazed windows with wooden wainscoting course for much higher price. The methodology should be clear and should be measured by the same standards to all.

Summary

While writing, I realized that the topic and the issue of restoration of buildings is so wide that we are not in this range it generally hold. Finally, it must be said that so far my experience that all tools such as quality control, inspection plans, and many other measures we did not bring any significant improvement in the quality of buildings. On the contrary, when as the supervisor come to the house but everywhere I hear the cries of site managers that only securities and do not have time on their own inspection and construction management. Similarly, in the area of security plans addressing health and safety, risk plan, but nowhere in the price of the construction budget for these measures are not sufficient funds. I am afraid that this is not the right way and that you need to think very quickly, whether it's lost common sense. It meets us craft professions across the spectrum of civil engineering, especially to find quality mason aged around 25 years old, physically fit and will be for the company perspective is impossible. Businesses should necessarily cooperate with apprenticeships schools and get future quality employees for the company, who will be doing them a good name. Estimator with designers to solve complex structure in terms of both quality project, as well as safety in the construction and subsequent safe use of the building, including safe subsequent maintenance.

References

[1] Information on: http://www.tzb-info.cz/pravni-predpisy/10721-odpovednost-za-vady-dila-v-novem-obcanskem-zakoniku-ii

Additional Heat Insulation of Panel Buildings and its Influence on the Internal Environment

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Abstract. In the last two decades additional heat insulation of panel buildings became one of the most discussed topics amongst specialists and in public, too. It is a problem typical mostly for the post-communist countries of Middle and Eastern Europe, where panel buildings were built in large since the 1940s almost until the end of the last century. The first of the main goals of this article is to explore and introduce the current state of panel buldings in the Czech Republic awaiting additional insulation, with a focus on their systemic defects. This is followed by comparing the most popular materials used for additional insulation of panel buildings. The third step includes research of the changes that occured in the internal environment of panel buildings after their insulation, especially the change of humidity and the spread of mildew in the interiors.

Introduction

The original idea of prefab panel buildings comes from America, but in our region it is mostly connected to the socialistic regime and the building of communism in Czechoslovakia. Their main function –along with the expression of the power of the actual political regime, of course- was to solve the housing problems after World War II, when huge crowds of people needed to be provided with places to live in a very short period of time and in areas of firmly limited outspread. Prefab panel buildings in Czechoslovakia were built between the 1950's and the 1990's. To this day, they remain one of the most important forms of living, ant their physical state and revitalization are of greater importance year by year.

Current State of Prefab Buildings in the Czech Republic

In the time of their building prefab panel buildings represented the top of knowledge in the field of civil engineering. However, the field of heat insulation and building physics were just at their beginnings. This means, that even though prefabricated panels were designed to have a certain level of heat insulating qualities, and the requirements on these parameters become stricter, as time went by, under no circumstances can they fulfil the requirements of current regulations.

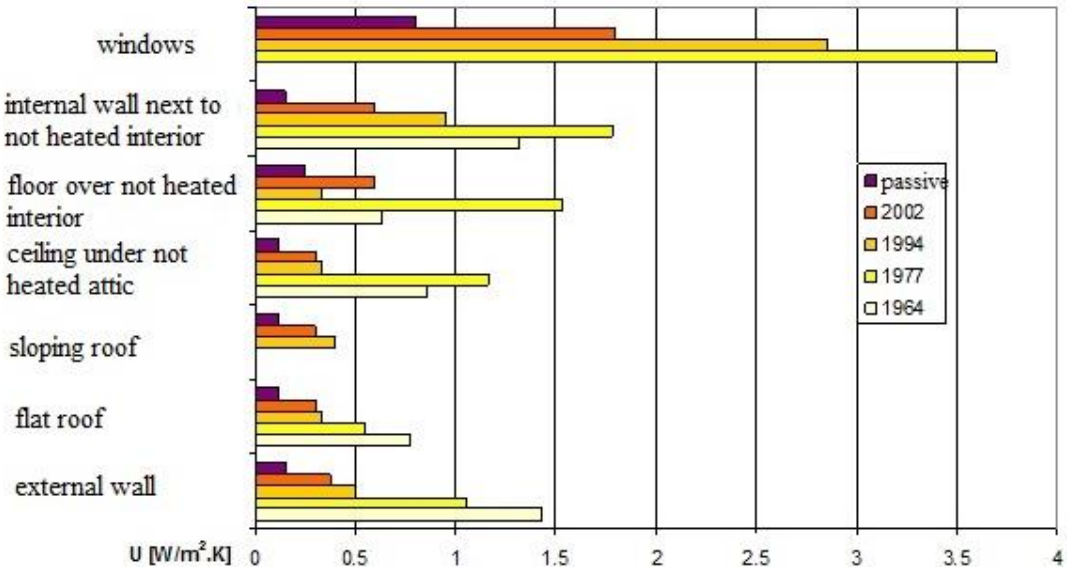

Figure1. comparison of required values of thermal transmittance of panel buildings according to ČSN 73 0540. [6]

Reinforced concrete itself has very poor heat insulating qualities, which led to the use of concrete with lighter additives such as Keramzit or gas-silicates. Envelope structures of prefabricated panel buildings are made of two types of panels:

Single-layer panels: the structure of the external wall consists of a sole Keramzit-concrete panel and plaster on both sides.

Multi-layer panels: these consist of a reinforced concrete panel, a layer of heat insulation and a protective layer of reinforced concrete.

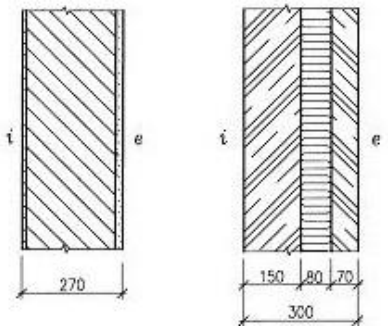

Figure 2. Single-layer panel (Keramzit-concrete - 270 mm), and multi-layer panel (reinforced concrete – 150 mm, heat insulation – 80 mm, reinforced concrete – 70 mm). [6]

Apart from the problems that are caused by not sufficient thermal insulation quality of building materials, buildings from prefabricated panels show other types of defects, too. These can be caused amongst others by the low quality of building materials, which were used in some cases. Another reason for these physical defects can be the poor quality of realization of construction details. Construction details for prefab panel buildings were carefully designed by engineers at the time of development of panel building systems. However, during the mass construction of these buildings the building industry was substantially overloaded and low on human resources. Also the dates of the start and the end of the construction had to be treated very strictly. The constellation of these circumstances led to the simplification of the neatly designed details, in some cases to a very significant rate.

Fig. 3: Physical defects of panel buildings. [7, 8]

The third type of defects that occur are so-called system defects. System defect is a defect of the envelope construction of panel buildings, which could not be influenced by the occupants of the building during its usage. In the Czech Republic we can find more than 50 types of construction systems for buildings from prefabricated panels. Each of these appears in more types depending on the particular location of the building. All types of these systems show system defects, most of them more than one.
System defects are standardly affecting these areas:

- Climatically most affected forefronts of panel buildings
- Contact of protruding constructions of staircases and other parts of the envelope construction
- Balconies and loggias
- Pilasters and ledges
- Attica
- Envelope constructions from different one-layer and multi-layer panels.

Figure 4. System defects of panel buildings. [9]

Each system defect is characteristic for certain types of construction systems. Their appearance is also always specific, and all of them demand a special method of removal. Most experts recommend application of full heat insulation after the reparation of system errors in order to maintain the good condition of the envelope construction.

Most Popular Materials for Additional Thermal Insulation and Their Application

In the Czech Republic the most popular form of additional thermal insulation of panel buildings are external thermal insulation composite systems (ETICS). These systems are considered as a complex product. It is delivered by the manufacturer as a complete system, a kit that consists of prefabricated parts. It does not require any further components therefore it can be applied to the facade immediately. External thermal insulation composite systems consist of:

- Adhesive and anchors (if required)
- Material for thermal insulation
- Reinforcement layer: either single-layer or multi-layer with one layer of reinforcement
- Finishing coat.

Apart from these basic components ETICS usually contains a wide range of accessories for the finishing coat such as fabricated corner beads, connection and edge profiles, expansion joint profiles, base profiles, etc.
Nowadays in the Czech Republic the most popular materials for thermal insulation are expanded polystyrene foam (EPS-F, also known as PPS) and mineral wool (MW-F) insulating boards. For insulation of typical details, extruded polystyrene (XPS-F) in often used.

Expanded polystyrene foam. One of the most accessible materials for thermal insulation, which is highly determined by its reasonable price. Its main disadvantage is its flammability (category of flammability C3). Therefore only EPS boards with extinguishing additives can be used for building purposes. This requirement excludes recycled EPS, which contains crushed packaging materials, and its flammability is basically undetermined. For building insulation purposes are required façade boards from solid, steady, self-extinguishing EPS-F (rate of flammability C1), with density 15 to 25 kg/m3. These boards may not contain any ingredients that originate in recycled EPS. When applying EPS it is essential to eliminate any effect of organic dissolvent, which may appear in coatings, plasticizers, waterproof materials or luting. EPS is highly sensitive for UV radiation; therefore it is significant to protect it from long exposure.

Table 1. Requirements for expanded polystyrene boards for ETICS. [3]

Characteristics	Required level
Length max. tolerated difference from nominal value	Max. 1m, ± 2 mm (± 0.2 %)
Width max. tolerated difference from nominal value	Max. 0.5 m, ± 2 mm (± 0.2 %)
Thickness additional pressure 250 Pa max. tolerated difference from nominal value	Min. 20 mm, ± 1 mm
Max. tolerated difference in perpendicularity	Max. 2 $mm \cdot m^{-1}$
Max. tolerated difference in flatness	Max. 5 mm (3 mm)
Density	15 to 35 $kg \cdot m^{-3}$
Dimensional stability at constant laboratory conditions (Method B1 for length and width, precision ±0.05 mm, exposed for 42 days)	± 0.20 % (± 0.15 %)
Dimensional stability at certain temperature and humidity (70±2°C, relative humidity 90±5%, exposed for 48hours)	± 1 %
Characteristic thermal conductivity $\lambda_{k,10}$	Max. 0.044 $W \cdot m^{-1} \cdot K^{-1}$
Strength tensile (perpendicular to the surface, sample 50x50 mm) - Fastening by adhesives or anchors - Fastening with ledges	 Min. 100 kPa Min. 150 kPa
Long-term absorption (partial submersion) (method 1A, 28 days)	 Max. 0.5 $kg \cdot m^{-2}$
Grade of flammability	Min. C1 – highly flammable

Mineral wool insulation. For heat insulation of buildings manufacturers provide special façade boards of mineral wool, which are heavier than polystyrene boards. Their density is usually 100 to 150 kg/m3. They have either lengthwise fibres, or fibres perpendicular to the surface they are applied on. The laminated boards with perpendicular fibres are more resistant to compression and it is easier to shape them along curved surfaces. The heat insulation quality of mineral wool approximates the same quality of polystyrene insulation, but its acoustic insulation quality and fire safety parameters are outstandingly better. This makes mineral wool insulation appropriate for use in case of high requirements on fire safety, insulation of fire escape routes or high constructions. Mineral wool is highly sensitive to moisture, so it is not suitable for insulation of continuously wet surfaces. During its transportation and storage mineral wool is usually protected against moisture by hydrophobization.

Table 2. Requirements for mineral wool boards for ETICS. [3]

Characteristics	Required level
Length max. tolerated difference from nominal value	Max. 1.2 m, ± 2 %
Width max. tolerated difference from nominal value	Max. 0.625 m, ± 1.5%
Thickness (additional pressure 50 Pa – strength compression up to 15kPa, otherwise 250Pa) max. tolerated difference from nominal value	Min. 20 mm, +3/-1 mm
Max. tolerated difference in perpendicularity - Boards with lengthwise fibres - Boards with fibres perpendicular to the surface	 Max. 5 $mm \cdot m^{-1}$ Max. 5 (2) $mm \cdot m^{-1}$
Max. tolerated difference in flatness	Max. 6 mm (5 mm)
Density	70 to 175 $kg \cdot m^{-3}$
Dimensional stability at certain temperature and humidity (70±2°C, relative humidity 90±5%, exposed for 48hours)	± 1%
Characteristic thermal conductivity $\lambda_{k,10}$	Max. 0.044 $W \cdot m^{-1} \cdot K^{-1}$
Strength tensile (perpendicular to the surface) - Boards fastened solely by adhesives - Boards fastened with ledges (and adhesives) - Boards fastened by anchors (and adhesives) - Boards fastened by anchors through reinforcement (and adhesives)	 Min. 80 (75) kPa Min. 15 kPa Min. 7.5 kPa Min. 5 (7.5) kPa
Strength compression	Min. 10 kPa
Long-term absorption (partial submersion) (method 1A, 28 days)	 Max. 3 $kg \cdot m^{-2}$
Grade of flammability	Min. B – difficult to ignite

Extruded polystyrene. Extruded polystyrene (XPS) has a density of 30 to 40 kg/m3. In comparison with expanded polystyrene, XPS has surely higher mechanical resistance and it is practically non-absorbent. These specific qualities of XPS compensate its significantly higher cost. The non-absorbent quality of XPS makes it suitable for use in places, which are highly affected by water or moisture, e.g. underground constructions or plinths. When applying XPS its volume changes have to be taken into consideration, which are much more significant than in the case of EPS. To avoid any defects caused by these changes in volume, XPS is applied in smaller boards, mainly in the area of plinth. As it has better thermal insulation qualities than EPS, XPS can be used in thinner layers, which is helpful in narrow, tight places.

Table 3. Requirements for extruded polystyrene boards for ETICS [3]

Characteristics	Required level
Length max. tolerated difference from nominal value - Boards with smooth edges - Boards with tongue and groove edges	Max. 1.25 m, ± 0.2 % ± 0.5 %
Width max. tolerated difference from nominal value - Boards with smooth edges - Boards with tongue and groove edges	Max. 0.65 m, ± 0.2 % ± 0.5 %
Thickness max. tolerated difference from nominal value - Boards with smooth edges - Boards with tongue and groove edges	 Min. 20 mm, ± 1 mm Min. 30 mm, ± 1 mm
Max. tolerated difference in perpendicularity	Max. 2 $mm \cdot m^{-1}$
Max. tolerated difference in flatness	Max. 3 mm
Density	Min. 25 $kg \cdot m^{-3}$
Dimensional stability at certain temperature and humidity (70±2°C, relative humidity 90±5%, exposed for 48hours) - Dimensions over 0.625 m^2 - Other dimensions	 ± 1 % ± 2 %
Characteristic thermal conductivity $\lambda_{k,10}$	Max. 0.035 $W \cdot m^{-1} \cdot K^{-1}$
Strength tensile (perpendicular to the surface, samples 50 x 50mm)	Min. 100 kPa
Long-term absorption (partial submersion) (method 1A, 28 days)	 Max. 0.5 % of volume
Grade of flammability	Min. C1 – highly flammable

Application of ETICS. Application of ETICS is really simple; it can be summarized in five basic steps.

1. Applying the adhesive
   Depending on the material of the insulated surface and the insulation board, adhesives can be different. The main types of adhesives in use are:
- Disperse adhesives based on aqueous dispersions of macromolecular substances for immediate use
- Disperse adhesives based on aqueous dispersions of macromolecular substances to which cement and binder has to be added
- Dry adhesives in form of powder, with cement-based binder, to which certain amount of water has to be added
  Today, adhesives in form of powder are used most frequently.
2. Applying the insulation
3. Doweling (if needed or prescribed by the project)
   Mechanical ways of fastening using anchors or rails made of plastic or metal, or of the combination of these two materials.

Table 4 : Requirements for fastening depending on the height of the building and the surface of external walls (basis weight of thermal insulation finishing plaster ≤ 10kg/m2) [3]

Height	Material of the surface		
	Without final adjustment (concrete, brickwork)	With final adjustment (plaster, paint)	Uneven, cracked, damaged plaster
< 8 m or max. 2 floors	adhesive	adhesive + anchors	ledges
8 to 20 m	adhesive	adhesive + anchors	ledges + anchors
> 20 m	adhesive + anchors	adhesive + anchors	ledges + anchors

4. Reinforcement
   Reinforcement is applied right onto the external surface of the insulation boards. It can be single-layer or multi-layer, where at least one layer contains reinforcement. Reinforcement in case of ETICS is usually made of glass-fiber mesh with aperture cca. 3 mm, which is on both sides protected by a layer of backfilling material thick min. 1mm. Strength tensile of the mesh should be min. 40 N/mm in environment without alkali, and this value should not decline under 50% of the original number in an alkali environment. Elasticity of reinforcement is tested together with the final plaster. Possible damages of the surface are monitored after hitting the surface with a ball made of steel.
5. Finishing plaster
   Finishing plaster fulfils two important roles: it protects the layers that are under it and has also decorative purpose.
   Basically we can divide finishing adjustments into two groups:
   - Plasters (disperse, silicate, silicon, silicon-disperse, mineral): these are often supplied with one final layer of coating or paint.
   - Tiles

Table 5. Advantages of different types of plasters. [3]

disperse	silicon	silicate	Mineral
Elasticity	Resistance to soiling	Resistance to soiling	Resistance to soiling
Water tightness	Vapour permeability	Vapour permeability	Vapour permeability
Wide range of colours	Water tightness	Minimum organic materials contained	Minimum organic materials contained

Effect of additional heat insulation on internal environment and human health

Additional heat insulation of panel buildings is mainly done in order to increase thermal protection of buildings and to lower the expenses on heating. However, their effects are not limited to the field of building physics and thermal comfort. Additional heat insulation of buildings has various biological impacts, amongst which the most frequently mentioned are the so-called Sick Building Syndrome and the spread of mildew in interiors. In this paper I would like to devote a few words to the second topic, to spread of mildew.

Mildew spreads in places where water vapour condensates on the surface of constructions or the surface temperature of the structure indicates ca. 80 % relative humidity in the interior.
In most cases, decrease of mildews is also mentioned among the advantages of additional thermal insulation. On one hand it can be true, as by insulating thermal bridges the surface temperature of the structures rises which reduces condensation of water vapour and therefore the spread of mildew. On the other hand, this effect does not have to appear in buildings with insufficient ventilation and/or inadequate heating. Mildew often appears in buildings, where it has never appeared before, only just after thermal insulation is finished. This phenomenon is most frequently caused by the

fact, that along with the process of additional heat insulation old doors and windows are replaced with new, modern ones. This decreases the intensity of ventilation followed by the rise of relative humidity and the temperature of dew point, which terminates in condensation of water vapour on the surfaces and appearance of mildew.

Effects of Mildew in Interiors on Human Health. Mildew is not just aesthetically unpleasant; if it appears in interiors it also has a significant impact on inhabitants' health. The symptoms of illnesses caused by mildew are mainly itchy eyes, nasal congestion, sore throat, hoarseness various skin problems and repeated inflammations of the respiratory system. This complex of symptoms is often called as Damp Building Syndrome. Damp building syndrome is often accompanied by allergic reactions and mycosis. Allergic reactions – mycoallergies are the increased reactions of the human immune system to the allergens of microscopic fungi. It causes hay fever, in serious cases even allergic asthma. Mycosis is an infection in the human body. It is caused by some types of mildew that are capable of parasitical growth and reproduction in the human body. The most common type of mycotic infections is dermatomycosis, which appears on the skin, nails and hair. Mycosis mainly affects people with damaged immune system, elder people and children. Both mycoallergies and mycosis lead to degradation of the human immune system and therefore to other (not necessarily mycotic) diseases.

Summary

Damp building syndrome is often connected to additional thermal insulation of buildings; to be more specific, the use of buildings by their inhabitants after the insulation. It is a topic, that is rarely discussed in public forums (however, taking into consideration, that only in the Czech Republic more than 1 million people live in panel buildings, which are gradually undergoing insulation) it is a topic, that can affect huge masses of people.

References

[1] J. Beranovský, et al., Pasivní panelák? A to myslíte vážně? 1st ed. EkoWATT, Prague, 2011

[2] J. Drápalová, Regenerace panelových domů, ERA, Prague, 2006.

[3] J. Šála, M. Machatka, Zateplování v praxi: Provádění vnějších kontaktních zateplovacích systémů. 1st ed., GRADA, Prague, 2002.

[4] R. Šubrt, Tepelné izolace v otázkách a odpovědích, 1st ed. BEN, Praha, 2005.

[5] K. Klánová, Plísně v domě a bytě: Odstraňování a prevence. 1st ed., GRADA, Prague, 2013.

[6] Information on www.panelovedomy.ekowatt.cz

[7] Information on www.tzbportal.sk

[8] Information on www.pspadv.cz

[9] Information on www.tsus.sk

[10] European Association for External thermal insulation composite systems, www.ea-etics.com

Methodology of Security Features in Removing Cladding of Buildings Containing Asbestos

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Abstract. This paper focuses on an important issue that is related to the renewal and revitalization of building envelopes, in relation to the presence of hazardous substances, specifically asbestos. In connection with the European Union (EU) is necessary to address not only the correct implementation of the procedure, but particularly to identify appropriate safety features such as the construction of scaffolding, tarpaulin design and delivery of decontamination container to create a safety loop, which together form a significant cost, which is necessary for the investor to quantify preferably, before starting work.

Introduction

The priority of the current architecture, are safe and energy efficient building. In The construction market there are new materials and technologies that meet these requirements. What at old objects? They often fail in terms of energy savings, do not meet the requirements for indoor environmental quality and here we meet with unsuitable materials or with even health hazardous materials. A typical representative, are of the building envelope formed by from Boletice panels that contain asbestos. This panel was in 1984 in the former Czechoslovak Republic classified as proven carcinogen for humans.

Asbestos and asbestos products used at construction were most of the 70s and 80s of the 20th century. Asbestos fibers resist high temperature. Fibres was used for its extraordinary strengths and electrical non-conductivity. At that time asbestos was considered the material of the future. Today is one of the hazardous materials. Countries of Europe adopted the first restrictions on the production of asbestos in 1976, but for us the production of panels formed by Boletice ended in 1991 [1,2]. Production roof coverings of asbestos ended in 1996, and since 1997 is the production of asbestos prohibited. In the Member States of the European Union is strictly prohibited the use of asbestos since 1999.

Text

The objects mainly civil amenities throughout the Czech Republic are formed from Boletice panels. The analysis of the Czech School Inspectorate showed that have from panels formed by Boletice we built min. 239 schools [3]. Today's envelope buildings do not meet the thermal requirements of standards. It leads to energy loss, lack of the thermal comfort, moisture starts to condense and large temperature differences arise inside the building. The envelope buildings are damaged - cover strips are leaky. Penetrating moisture generally significantly disrupts agglomerated outer fibreboard and glass panel falls out. These building must we reconstruct.

Significant health and safety risk associated with the restoration and revitalization of the envelopes building, formed from Boletice panels are works with asbestos. Risk is greatest when asbestos fibers are inhaled asbestos is dangerous even on contact with the skin. If are the envelopes buildings structure intact - nothing bad happens. The problem occurs, we when to in these to constructions will be drilled or cut. It leads to the release of microscopic asbestos fibers into the air.

From this it is clear that the greatest threat to human health arises, are when the buildings demolished and in reconstructed. A particularly where the is lack of executed construction engineering research

There are very strict rules for working with asbestos. Before working in building construction, where it is assumed incidence of asbestos, it is necessary to do a survey for the presence of asbestos and then take action. The envelopes buildings which are formed from Boletice panels containing asbestos fibers placed inside the panel. It is therefore necessary with the utmost care carry out a probe to determine whether in the construction is a plate with asbestos. If the presence of this material is confirmed, it is the responsibility of the builder to invite to implement accredited company. Professional construction, company professionally remove the board so that in the surrounding area are not released asbestos fibers. At the same time cannot be compromised health workers who carry out such work. Diseases caused by asbestos fibers have an incubation period of 10-40 years after exposure to asbestos fibers. Therefore, it is necessary to keep records of hazardous work [4], which is an the asbestos set at 40 years from the end of exposure.

Before Reconstruction of the envelopes buildings formed by Boletice panels, it is necessary to:

- undertake a professional survey on the basis of which assesses the risk of exposure to asbestos fibers
- propose a correct procedure of works
- Propose appropriate safety features to prevent the spread of asbestos contamination and to prevent exposure of other people
- Submit to the sanitary station reporting work with asbestos [5]. Particulars of the reports are given in § 5, of Decree No. 432/2003 Coll.
- take samples from breathing apparatus of workers and take them at health department

Workers Must

- pass a medical examination for work with asbestos
- be trained to work with chemicals, especially asbestos and be familiar with the procedure works
- be led by the exposure card, which records the length and type of work performed

Methodics of safety elements to the removal of envelope building formed from Boletice panels:

When removing, you must first create a controlled area. Quote of the Act No. 309/2006 Coll. § 7, paragraph 3: "The employer shall ensure that work with asbestos ... the extent specified in the implementing legislation were always carried out in controlled areas, which will be marked and secured so that they do not enter into them the staff who there do not exercise, repair, maintenance, testing, inspection, supervision or control."

From the outside the building structure, form the controlled area modular frame scaffolding which is coated impermeable tarpaulin. On the inside page the controlled area is simple temporary wall, located 1-2 m from the building envelope. The wall is coated with a special plastic film or impervious sail. Construction joints must be sealed with impermeable tape and foamed acrylic sealer or polyurethane foam to achieve a hermetically sealed space.

Controlled area must be marked with warning signs (Figure 1): "Controlled Zone", "No entry for unauthorized", "No Smoking", "No food and drink", "Beware of working with asbestos, "Entry only in the protective clothing", "Entry only in the mask."

Throughout the implementation of the work is in the controlled area must ensure vacuum. To do this, we used suction unit with HEPA filters H13 to capture even the smallest asbestos fibers. Extraction units (Figure 2) must provide air exchange in a controlled area every 15 minutes.

Figure 1. Warning signs.

Figure 2. Extraction unit provides air exchange in a controlled area.

Once the work is necessary to working space (floors and surfaces) was cleared from residues from using vacuum industrial vacuum cleaners with HEPA filters H14, so that concentration of the microfibers in a controlled area was minimal.

The controlled area is connected to the decontamination chambers. Decontamination chambers are designed for the decontamination of workers at the output. The decontamination chamber is intended to balance demolitions asbestos material out and transport equipment and materials inside in the controlled area. When dismantling, despite all efforts occurs to release asbestos fibers from the material. The fibers cling on to garment workers. In case of insufficient decontamination on the output could ultimately lead to contamination of the rest of the facility. The decontamination chamber should be three-chamber - clean room, shower or the cleansing of and a dirty room. At the entrance to the decontamination chamber must staff dress special protective clothing for work with asbestos and deploy a full-face respirator with HEPA filter. The filter prevents the inhalation of asbestos microfibers. When the output must workers personal protective equipment (PPE) for multiple use cleanse, disposable protective equipment (disposable protective clothing, gloves and shoe covers) to store in a sealed container with a sealable lid. The container is then discarded. Workers go through a decontamination shower and get dressed into their clothes.

When dismantling must be all waste, including asbestos-containing plates, inserted into special plastic bags or containers which are sealed with tape and labeled with a sign warning of the asbestos content. Despite the decontamination chamber, these bags will move to advance the waiting special containers marked with a graphic symbol of danger. The containers will be transported by an authorized person for the transport of hazardous waste and disposed of in a landfill for hazardous

waste. The liquidation shall be subjected to the "registration form waste." Waste management is governed by Act No. 185/2001 Coll. on waste and amending certain other acts, as amended by Act No. 188/2004 Coll., Act No. 7/2005 Coll. and Act No. 106/2005 Coll. in Part 6 (asbestos wastes), §35 (Duties in the handling of asbestos waste).

After completion will the space cleaned up using high-powered air cleaners and using specialized measuring equipment is performed control measurements. Based on this measurement is drawn up a final report on the safety and about clean air in the sanitized environment.

Summary

If we want to work with asbestos safely, it is necessary that the investor was informed prior to the commencement of work about the costs of building a safety loop. In short, high cost of security specialized companies are at a disadvantage compared with companies that do not provide professional behavior. The award for the construction of scaffolding and light rail can be easily obtained from the budget programs, but prices for the safe construction for the establishment loop cannot be found there. That's why I felt it is necessary to create a guide table (Table 1), where these prices are listed.

The issue of valuation of security features and related special procedures when working with asbestos is still in practice very little explored. The awards, which are used in the article, have only been established for a few selected important security elements, in consultation with the suppliers of these elements and the experience of the real building. It was not a determination of the final price for the acquisition of the entire security structure for the disposal of asbestos in the revitalization of building envelopes. Asbestos removal is extensive enough problem that it suffices to several separate articles.

Table 1. Indicative prices for the design of safety features when working with asbestos.

Security element	**Description**	**Price**
Decontamination container 3-chamber SK6 (TOI TOI)	Rigid container it is designed for 10 people, a lifespan of 10 years, unless it is possible to connect the waste can be deposited on fecal tank with a capacity of 9 m3. Dimensions: 2438 x 6058 x 2800 mm	Container rental / month: 12 000, - CZK Rent fecal tank / month: 4000, - CZK Transport container (imports, removal and cleaning after use) according to the distance: 7000 to 12 000 CZK. Sale of Container: 278 300, - CZK
Decontamination container 3-chamber DCON	Easily foldable foil container. Including shower room, without its own water distribution. Dimensions: 2520 x 840 x 1960 mm	Container Sales: 8900, - CZK Mobile Water Filtration: 42 000, - CZK Mobile showers: 35 000, - CZK Door system: from 700, - CZK
Cooker Nitro 600	Middle-performance hood with a nominal flow rate of 1000 m3 / h.	to 26 000, - CZK
Cooker PURE 5500	hood Executive with a nominal flow rate of 5500 m3 / h	55 000, - CZK
HEPA filter	for cooker hood	from 5800, - CZK
Vacuum One 102 incl. basic accessories	for use in contaminants in foodstuffs. bands for working with asbestos dust. 2 engines. For asbestos environment must be purchased absolute HEPA filter.	27 500, - CZK
200 micron PE	film masking to create an airtight space	1200, - CZK / pack
big bag for asbestos waste	Dimensions: 900 x 900 x 1150 mm Material: 195gr/m2;Capacity:1,000 kg	from 199, - CZK
Full face mask		from 2700, - CZK
Disposable Coverall		from 125, - CZK

References

[1] Information on http://www.khsusti.cz/php/kousky/aktual/20111220/1/azbest.pdf

[2] Information about http://www.ekostar.cz/cz/sanace-a-likvidace-azbestu

[3] Information about http://www.szu.cz/2012-problematika-azbestu-ve-vnitrnim-prostredi-skol

[4] Law No. 309/2006 Coll., Stipulating further requirements for safety and health at work in labor relations and ensure the safety and health activities or services outside labor relations (Act on other conditions of health and safety at work).

[5] Law No. 258/2000 Coll., The protection of public health and amendment to some related Acts, as amended.

Humidity Issues in Inappropriately Carried out Details within the External Structure

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Keywords: Vertical Grooves, Thermal Insulation, Condensation Zones, Structural Details.

Abstract. In case of the improper revitalization of the existing buildings the grooves can be the source of thermal bridges with a negative impact on the quality of the peripheral structures and subsequent degradation of the inner surface layers of the external walls. This article connects the existing non-insulated construction with an inappropriately made detail at a vertical roof drain. The inappropriateness of the solution is considered on the basis of the modeling of solved details in this article in terms of thermal technical properties and condensation zones.

Introduction

Residential buildings built in the past of solid burnt bricks had some external walls with vertical groove which was used to insert vertical spout pipes. This groove was carried out in the face of the external wall and was passed through all the floors. The vertical spout pipes were inserted and anchored into the grooves so as not to stick out from the front façade. They were kept in the grooves and thus protected against the mechanical damage. If the building was divided by an expansion joint into individual sections, the grooves were lined with bricks so that the expansion joint was bordered by these grooves from both sides. The thickness of the external walls 450 or 600 mm corresponded to the module of the brickwork of solid clay bricks and the cross-section of the groove was 150 x 150 mm.

In the case of today revitalizations and assemblies of thermal insulations of these existing buildings the inappropriate performance of the detail [1,2] in the place of the groove can become a source of the future defects in the peripheral structure. This includes those situations when the vertical spout pipe remains, after its exchange, in its original position so that it fills the grove and the thermal insulation is only pulled over the groove. If the inner surface of the groove is made irrespective of the thermal technical requirements, significant condensation zones occur and they are the source of the defects in the thermally insulated structure.

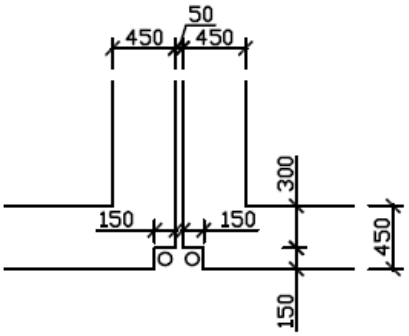
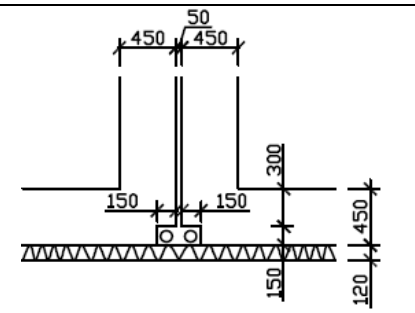
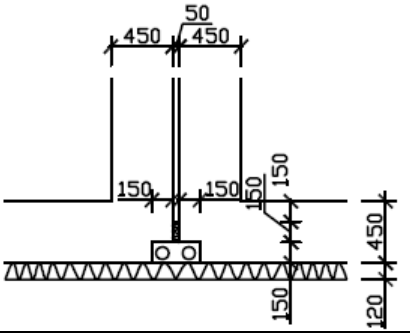
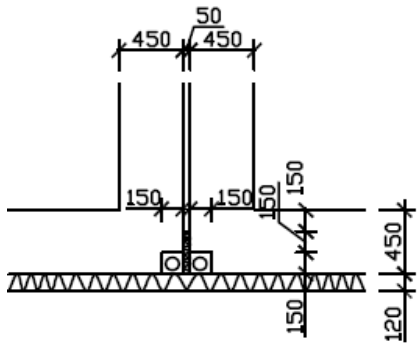
Problem Formulation

The insulation of the above mentioned buildings should meet the requirements of the valid thermal technical standards. The condensation zones with the negative balance of water vapor in the structure occur in the case of buildings with faultily implemented details. The core of the incorrect solution of the detail is in the fact that the air with the parameters of the external environment (table 1) is between the internal surface of the groove and the thermal insulation which covers vertical spout pipe from the outside view. The groove is connected with external environment in the top and bottom of the groove. Air flow moderate moisture in the groove, thus it was not calculated with the influence of this air flow in all variants.

Quantification of Particular Variants Using Modeling Software AREA 2009

External air temperature was - 15 °C and relative humidity was 84 %. Internal air temperature was 22 °C and relative humidity was 50 %.

Table 1. Schemes of structural variants of possible solution.

Scheme of solved structural variants	Description of variants
	**1. Current state.** The current brickwork from solid burnt bricks with cement/lime mortar, structure thickness is 450 mm. Dimensions of vertical grooves in the corners are 150 x 150 mm. Vertical spout pipes (diameter 100 - 125mm) are inserted and anchored in the grooves. The external face of the brickwork is provided with cement-lime plaster (th. 15 – 20 mm). The internal surface of the brickwork is provided with the lime plaster (th.15 – 20 mm). The width of the expansion joint, which divides the structure into the separate sections, is 50 mm. Currently the structure is not provided with the thermal insulation.
	**2. Variant A (detail of thermal insulation only in the face of external wall).** The thermal insulation is applied to the structure in the current state (1. Current state). The thermal insulation is polystyrene foam, 120 mm thick, meeting the requirements given by the standard. The group of strata of the implemented thermal insulation is in accordance with ETICS system. This solution does not involve the thermal insulation inserted into the expansion joint and the thermal insulation of the vertical grooves.
	**3. Variant B (detail of the thermal insulation in the face of external wall and with the thermal insulation inserted into the expansion joint)**. The thermal insulation is applied to the structure in the current state (1. Current state). The thermal insulation is polystyrene foam, 120 mm thick, meeting the requirements given by the standard. The group of strata of the implemented thermal insulation is in accordance with ETICS system. This solution involves the thermal insulation (th.50mm) inserted into the expansion joint 150mm deep.
	**4. Variant C (detail of the thermal insulation in the face of external wall and with the thermal insulation inserted into the expansion joint).** The thermal insulation is applied on the structure in the current state (1. Current state). The thermal insulation is polystyrene foam, 120 mm thick, meeting the requirements given by the standard. The group of strata of the implemented thermal insulation is in accordance with ETICS system. This solution involves the thermal insulation (th.50mm) between the vertical grooves which is inserted into the expansion joint 150mm deep.

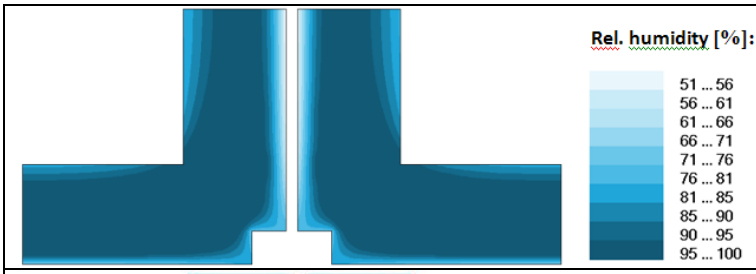
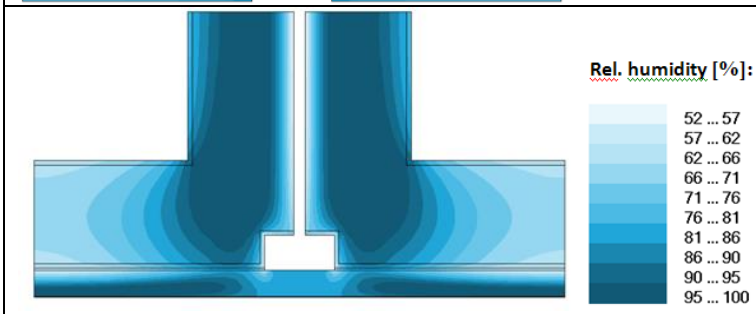
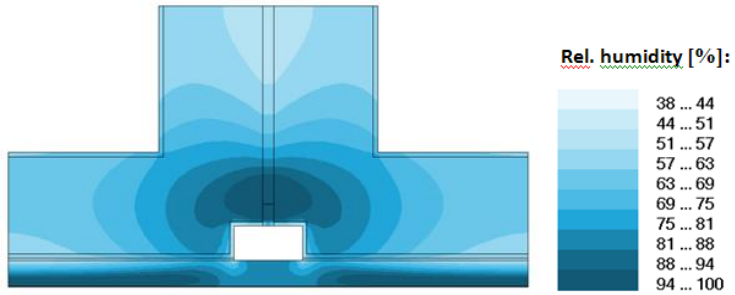
Material specifications can be seen in Table 2. The lime plaster in the models using AREA 2009 software is applied to the inner surface of the modeled structure. Parameters of the modeled masonry, are determined by AREA 2009 software.

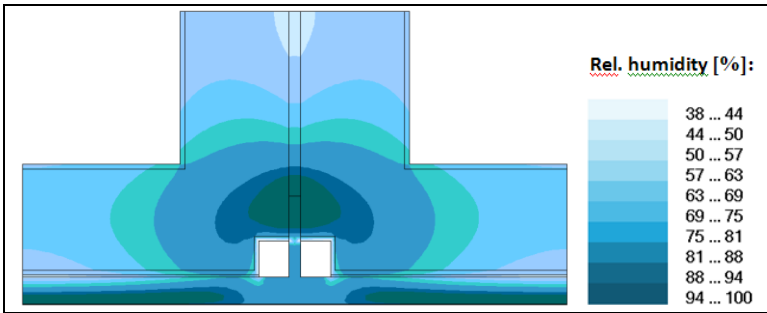
Table 2. Characteristics of the used materials.

Material	Thermal conductivity coefficient λ_u [$W \cdot m^2 \cdot K^{-1}$]	Specific heat capacity c_u [$J \cdot kg^{-1} \cdot K^{-1}$]	Density ρ_u [$kg \cdot m^{-3}$]	Moisture resistance factor μ_u [-]	Diffusion conductivity factor δ_u [s]
Lime plaster	0.87	840	1600	6	$0.031 \cdot 10^{-9}$
Brickwork (solid burnt bricks)	0.80	900	1700	8.5	$0.022 \cdot 10^{-9}$
Cement-lime plaster	0.99	790	2000	19	$0.01 \cdot 10^{-9}$
Adhesive mortar ETICS	0.70	840	1300	40	$0.0047 \cdot 10^{-9}$
Polystyrene foam	0.04	1270	20	35	$0.0053 \cdot 10^{-9}$
Reinforcing layer ETICS	0.75	840	1000	50	$0.0037 \cdot 10^{-9}$
Silicate plaster ETICS	0.8	840	1750	50	$0.0037 \cdot 10^{-9}$

The modeling in AREA 2009 software shows the formation of condensation zones in the case of the construction without thermal insulation and without the thermally insulated expansion joint.

Table 3. Condensation zones in particular variants.

	**Current state** Approx. condensation zone Te = -15.0°C Flows of water vapor: Into the structure: $3.66 \cdot 10^{-7}$ kg·m^{-1}·s^{-1} From the structure: $1.85 \cdot 10^{-7}$ kg·m^{-1}·s^{-1} **difference: $1.82 \cdot 10^{-7}$ kg·m^{-1}·s^{-1}**
	**Variant A** Approx. condensation zone Te = -15.0°C Flows of water vapor: Into the structure: $1.65 \cdot 10^{-7}$ kg·m^{-1}·s^{-1} From the structure: $1.52 \cdot 10^{-7}$ kg·m^{-1}·s^{-1} **difference: $1.38\ 10^{-8}$ kg·m^{-1}·s^{-1}**
	**Variant B** Approx. condensation zone Te = -15.0°C Flows of water vapor: Into the structure: $9.63 \cdot 10^{-8}$ kg·m^{-1}·s^{-1} From the structure: $8.79 \cdot 10^{-8}$ kg·m^{-1}·s^{-1} **difference: $8.44 \cdot 10^{-9}$ kg·m^{-1}·s^{-1}**



Variant C
Approx. condensation zone
Te = -15.0°C
Flows of water vapor:
Into the structure: $9.10 \cdot 10^{-8}$ kg·m^{-1}·s^{-1}
From the structure: $8.53 \cdot 10^{-8}$ kg·m^{-1}·s^{-1}
difference: $5.74 \cdot 10^{-9}$ kg·m^{-1}·s^{-1}

Summary

The evaluation of the condensation zones in AREA 2009 software shows that no presented solution of the implementation of the thermal insulation in the detail can be recommended. Even the variant C shows the amount of the condensate that will not evaporate from the structure during the year. The condensate which will accumulate in the structure over the years will be the cause of the possibility of mould attack and will be visible on the inner surface of the structure as wet maps and may require more rehabilitation interventions that will solve these „enforced defects“ of the brickwork, especially humidity. Due to the difficult accessibility one of the more demanding methods is likely to be used (air insulating or grouting) [1, 3, 4]. The issues of mould in residential buildings are generally known [5, 6]. The only possible solution is the thermal insulation of the inner surface of the grooves. The real state of detail will be diagnosed by infrared thermocamera [7].

References

[1] H. Ševčíková, Vliv větracích kanálků na stavebně fyzikální vlastnosti obvodových stěn/ Effect of the ventilation ducts on thermal properties of the exterior walls, Ostrava: VŠB – TUO, 2008. ISBN 978-80-248-1699-9

[2] H. Ševčíková, E. Rykalová, R. Fabian, Comparison of the impact of the ventilation ducts on thermal properties of the exterior walls. In Journal Applied Mechanics and Materials. October 2013, volume 899, pp 241-244, ISBN: 978-303835040-8 ISSN: 10226680

[3] Z. Peřina, B. Plšek, M. Wolfová, Verification of Range of Chemical Grouting of Mansonry by Non-Destructive Method Using Infrared Thermography. Proceedings of the Conference on the Rehabilitation and Reconstruction of Buildings CRRB 2013: Selected, peer reviewed papers from the conference, November 14-15, 2013, Prague, Czech Republic, Trans Tech Publications, 2014, pp. 191-194. ISBN: 978-3-03835-083-5

[4] M. Halířová, M. Hušková, H. Ševčíková, Sanation of damp walling. In 27.konference České stavební společnosti, 7.konference WTA CZ, Sanace a rekonstrukce staveb 2005. 2005. pp.145-148. ISBN 80-02-01768-4

[5] R. Fabian, Detekce tepelných mostů termovizí / Detection of thermal bridges using infrared camera. Materiály pro stavbu, roč. III, 2010, Praha: Business Media CZ, Praha 2010, s. 42-44. ISSN 1213-0311

[6] H. Ševčíková, M. Hušková, M. Halířová, Sanation of external rendering relicly protected site. In 28. konference České stavební společnosti, 8.konference WTA CZ, Sanace a rekonstrukce staveb 2006. s. 73-75. ISBN 80-02-01866-4

[7] J. Pašek, Infračervená termografie jako metoda moderní stavební diagnostiky / Infrared thermography as a method of modern building diagnostic. In: Materiály pro stavbu. 2007, roč. 13, č. 3, s. 42-46. ISSN 1213-0311

Comparison of the Impact of the Ventilation Ducts on Thermal Properties of the Exterior Walls

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Keywords: Loggia, Indoor Environment Insulation, Moisture, Temperature Factor at Internal Surface, Dew Point Temperature, Infrared Radiometric Long-Waved System.

Abstract. The thermal insulating of the building envelope, including the replacement of doors openings in the facade of existing buildings, housing construction (prefabricated buildings), is implemented to improve the technical thermal properties of the internal environment. Many of these objects are reconstructed by transformation balconies into loggias. The reason for the implementation of the glazing of these areas is the idea of improving the indoor climate of the living space. This article deals with the comparison of the original and compared state of the prefabricated residential buildings.

Introduction

The existing residential houses are improved by thermal insulation of the envelope and the replacement of the opening infillings in the facade to improve the thermal technical parameters of the indoor environment [1, 2]. In some cases the implementation of glazing (but always safety glass [3]) of the loggia space in individual flats is done with the idea of improving the indoor climate.

This measure not always improves the parameters of the indoor environment. Non conceptual, individual implementation of glazing [4] without previous thermal insulation of the facade and without the replacement of the opening infilling is common. The way of using loggia e.g. as an indoor garden [5] results in increased humidity with the possibility to define this environment as humid (humidity higher than 60 %) or wet (humidity higher than 80 %). The temperature increase in the loggia is due to the closing of the loggia which has the immediate effect of changing the position of the condensate zones, potential reach of the dew point temperature on the adjoining structures, the risk of moulds on the structures [6] and the change of the regime of the air exchange.

An example of the solution is the prefabricated house, the structural system VP-OS, whose wall panels (th. 220 mm) continue as loggia walls. The thermal insulation is made up of two boards of polystyrene foam which were in the factory built into the structure of reinforced concrete external walls.

The specific structure of these layered panels consists of a load-bearing core (reinforced concrete th. 150 mm), thermal insulation (polystyrene foam th. 40 mm) and a covering layer (reinforced concrete th. 30 mm).

Type of glazing used in models is certified frameless glazing system commonly used in loggias. Material specifications can be seen in Table 1.

Table 1. Characteristics of the used materials.

Material	Thermal conductivity coefficient λ_u [W·m^{-2} · K^{-1}]	Specific heat capacity c_u [J·kg^{-1}· K^{-1}]	Density ρ_u [kg·m^{-3}]	Moisture resistance factor μ_u [-]	Diffusion conductivity factor δ_u [s]
Reinforced concrete	1.74	1020	2500	32	$0.006 \cdot 10^{-9}$
Wallpaper	0.2	2510	900	570	$0.00033 \cdot 10^{-9}$
Polystyrene foam	0.04	1270	20	35	$0.0053 \cdot 10^{-9}$
Adhesive mortar ETICS	0.70	840	1300	40	$0.0047 \cdot 10^{-9}$
Reinforcing layer	0.75	840	1000	50	$0.0037 \cdot 10^{-9}$
Silicate plaster	0.8	840	1750	50	$0.0037 \cdot 10^{-9}$
Glass	0.76	840	2600	1,000,000	$0.0000 \cdot 10^{-9}$

The original embedded thermal insulation is not continuous at the external walls which form a vertical corner in the loggia. At this point it leads to the formation of faults due to the existence of a thermal bridge (see variant 1 in table 2).

The risk of mould is evident for example in the shape of the isotherms in variant 1 (original state) which were modeled in AREA 2009 software.

Next modeled variant 2 has glazing of the loggia without previous additional thermal insulation of the structure.

Table 2. Location of the isotherms and the distribution of relative humidity in the assessed structure (ground plan sections)

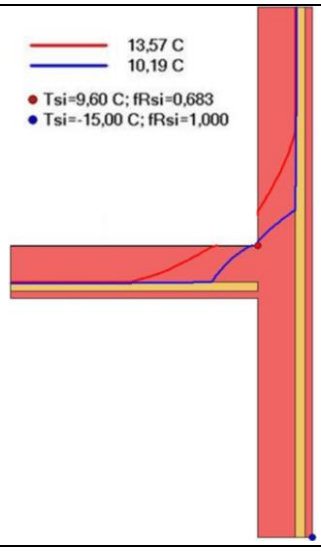
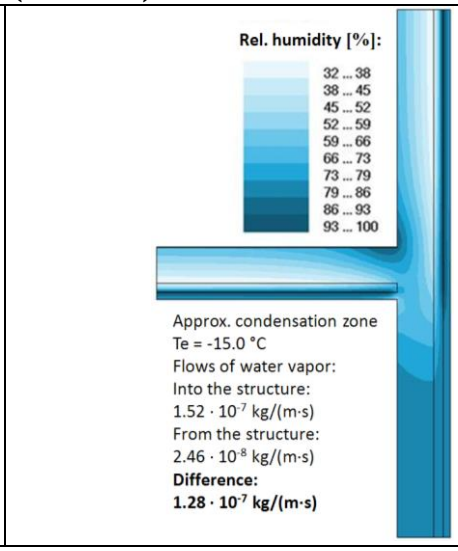
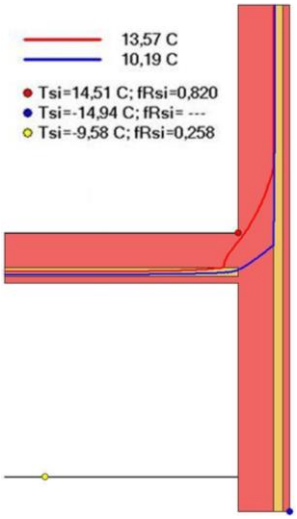
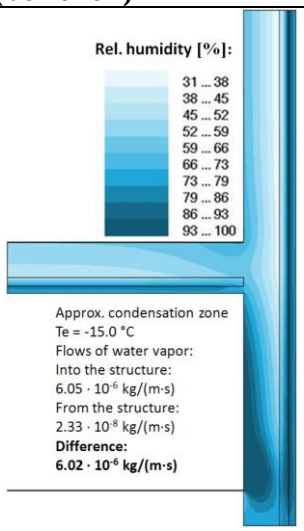
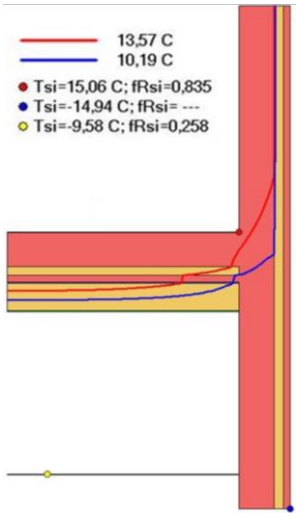
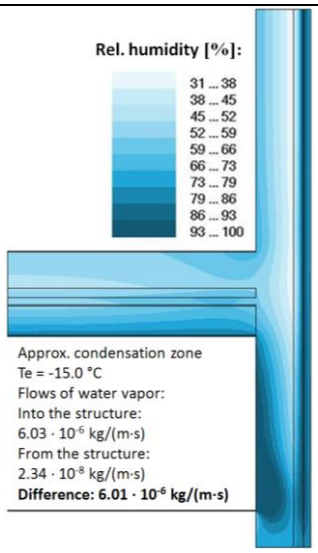
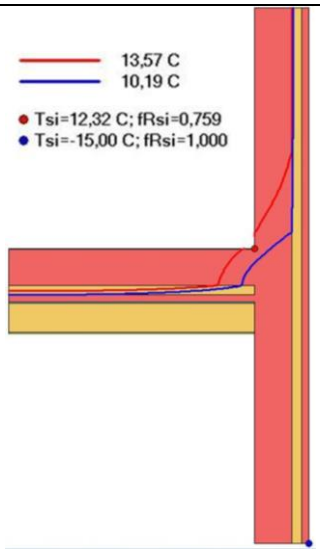
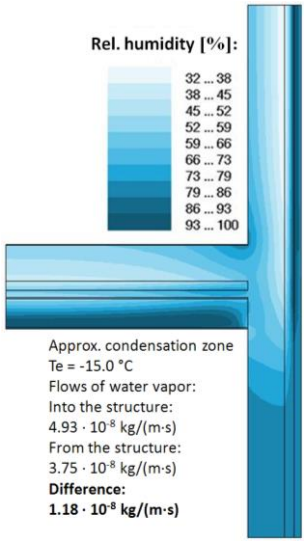
Original state (Variant 1)	
	

Table 2. Location of the isotherms and the distribution of relative humidity in the assessed structure (ground plan sections).

State after the glazing of the loggia (Variant 2)	
	
State after the glazing of the loggia and additional thermal insulation of the loggia wall (Variant 3)	
	
State after the additional thermal insulation of the loggia wall (Variant 4)	
	

Modeled variant 3 has glazing of the loggia with additional thermal insulation (th. 120 mm) of the front wall of the loggia.

The last variant 4 is a modeled example of the specific reconstruction of the building where only the additional thermal insulation of the front wall of the loggia with thermal insulation (thickness 120 mm) was implemented. External air temperature was -15 °C and relative humidity was 84 %. Internal air temperature (in the room) was 21 °C and relative humidity was 50 %. Internal air temperature (in the glazed loggia) was 6 °C and relative humidity was 80 %.

Selection of the solved detail was based on the measurement using infrared radiometric long-waved system [8] (FLIR® ThermaCAM SC 640) where can be seen imperfections in the envelope (Fig. 1).The measurement and models are made on on the prefabricated residential house (structural system VP-OS) in Ostrava in the Czech Republic. The detail of the thermally non-insulated ceiling panel and the thermally insulated cladding of the unglazed loggia is diagnosed here. The imperfect connection of the vertical thermal insulation of the cladding with the ceiling loggia panel is obvious in the thermogram (Fig. 1) which shows the temperature field on the surface of the ceiling loggia panel with the surface temperature higher than 5 °C! (it depends on the selected ambient environmental influences [7, 9, 10]). This detected fault corresponds essentially to the modeled variant 4 (table 2).

Figure 1: Corner of the external wall and the loggia wall – the front loggia wall is thermally insulated, the side walls and the ceiling are not thermally insulated – thermogram from the measurement by infrared thermocamera.

Summary

The most significant difference in the shape and size of the condensation zones in the loggia is noticeable in the variant which is not thermally insulated before the glazing of the loggia. The outputs of the AREA 2009 software show that just thermal insulation of the front loggia wall is insufficient and the noticeable condensation zone which is formed behind the glazing of the loggia (in the side loggia wall) is not significantly influenced. Currently the measurements of real characteristics of the indoor environment in the glazed loggia are being performed. The results of these measurements will be a specific input data for the assessment of the solved issues.

Acknowledgement

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References

[1] M. Halířová, E. Rykalová, Use of multi-criteria optimization for selection of building materials for reconstruction. In Journal Advanced Materials Research. October 2013,volume 899, pp 474 – 477, ISSN: 10226680 ISBN: 978-303835040-8

[2] H. Ševčíková, Vliv větracích kanálků na stavebně fyzikální vlastnosti obvodových stěn, Ostrava: VŠB – TUO, 2008. ISBN 978-80-248-1699-9

[3] E. Rykalová, R. Fabian, Safety glass at the public transportations stops. In Sborník vědeckých prací Vysoké školy báňské – Technické univerzity Ostrava, , 2011, vydavatel:Vysoká škola báňská- Technická univerzita Ostrava, s. 131-138, číslo 1, ISSN 1213-1962

[4] E. Rykalová, R. Fabian, Analysis of the behavior of glass claddings. In Journal Advanced Materials Research. November 2012, volume 649, pp 41-44, ISBN: 978-303785596-6 ISSN: 10226680

[5] E. Rykalová, Analysis of glass elements fasted into the steel frame. In Journal Applied Mechanics and Materials. May 2013, volume 351-352, pp 208-212, ISBN:978-303785774-8 ISSN:16609336

[6] R. Fabian, Detekce tepelných mostů termovizí. Materiály pro stavbu, 3/2010, Praha : Business Media CZ, s. r. o., 2010, s. 42-44, ISSN 1213-0311.

[7] Z. Peřina, Verification of the values taken by long infrared radiometric system depending on the selected ambient environmental influences. In Sborník vědeckých prací VŠB-TUO, řada stavební, 2012, vol. XII, n. 2012, pp. 113-122, ISSN 1213-1962

[8] Z. Peřina, B. Plšek, M. Wolfová, Verification of Range of Chemical Grouting of Mansonry by Non-Destructive Method Using Infrared Thermography. Proceedings of the Conference on the Rehabilitation and Reconstruction of Buildings. In Journal Advanced Materials Research. November 2013, volume 923, pp 191-194, ISBN: 978-3-03835-083-5 ISSN: 10226680

[9] J. Pašek, Významná specifika nekontaktních měření teploty obvodových plášťů budov. In: Poruchy a rekonštrukcie obvodových plášťov a striech. Košice: Technical University of Košice, 2004, s. 57-62. ISBN 80-232-0225-1

[10] J. Pašek, Analýza spolehlivosti a trvanlivosti kontaktních zateplovacích systémů s použitím infračervené termografie. In: Regenerace bytových domů – dynamika bydlení. Ostrava: VŠB – Technická univerzita Ostrava, 2009, s. 104-111. ISBN 978-80-248-1954-9

Conversion of Historic Buildings in Terms of Architectural Design and Building Construction

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Keywords: Conversion, Historical Building, Architecture, Building Construction

Abstract. Major challenge in the conversion of historic buildings is to find new uses, which fully exploits the potential of these buildings in terms of architectural and building technical. This may be a small working-class house from the period of the Industrial Revolution, outbuilding or giant industrial complexes in which thousands of workers used to work. This process requires qualified professionals who are well versed in architecture, civil engineering, but also have knowledge of such disciplines as sociology, regional development, ecology, etc. We must not forget the return on investment, which is a very important factor for realization. Converted object should be economically self-sufficient.

Introduction

The term of conversion was created in English-speaking countries where the recycling of architecture has a long tradition. Abroad, it is used as a synonym for converting the term "adaptive reuse", which is generally defined as an adaptation of the building for a new purpose. Conversions of historic buildings are expensive. Sometimes the cost of conversion can climb to the costs of demolition and subsequent new construction. It is a process that helps revitalize and repopulate the old abandoned buildings, parts of cities, or industrial wasteland. During redevelopment these objects arises a large amount of construction waste the removal of rubble and its subsequent recycling are exhausted the large amount of energy and it isn't very environmentally friendly.[1] The renovated buildings must fulfil all of today's standards. The object have to be the most energy efficient, it must have low operating costs, the reconstruction should be performed by using the most environmentally friendly materials from local sources, etc.[2] The converted objects by these methods acquire the spirit of the place, which are much more attractive to investors than new construction, which grow on green meadows. As an example, here is a factual analysis of the conversion of an industrial complex at the headquarters of Fronius International - Wels, Austria.

Company Headquarters Fronius International - Wels, Austria

Picture 1. A new object of the company.

Picture 2. Connecting corridor.

The construction of low-energy, passive houses and zero are one of the best of our colleagues in Austria, which sets the direction and new trends in the field of construction. Architectural and engineering office PAUAT Architekten has had dozens of projects of new construction and conversion of low-energy and passive houses. they claims to have found a kind of model of sustainable low energy architecture that each project is enhanced by.[3] One such project, which is adapted historic building with traditional architecture, is the revitalization of former industrial area for the company Fronius International in Wels in Austria (picture 1).

Picture 3. Parking with green wall.

Picture 4. Green wall in the interior.

This structure consists of individual buildings of the former industrial area and new modern buildings, which are connected by new corridors (picture 2). In the courtyard of a former industrial site was built underground car park, where are a ceiling holes blocked by a steel grates, which is naturally aspirated fresh air from outside the garage to do without any ventilation (picture 3). The design team had to address the problem with little space for greenery (picture 4) it was found ingenious solutions in green walls in a stand-off of the facade of the new object. Parthenocissus was chosen as a creeper plant of construction, which has in the summer months foliage and protects the main facade from direct sunlight. In the autumn the plant is fading, and may leak during the winter months the sun's rays into the building (picture 6). Green wall with a simple irrigation system using horizontal tubes where excess water drains drainage channels, this building was designed by French architect Patrick Blanc, which is a major expert in the field of landscape architecture (picture 5).

Picture 5. Green exterior wall.

Picture 6. Předsazená konstrukce.

The historic buildings of the former industrial area have been renovated to meet the standards of low-energy and passive house using the latest technology in energy generation from renewable sources. [3] They are insulated from the inside to maintain the industrial character of its brickwork with visible segment lintel are highlighted in white (picture 7). The entire building had to be installed new windows contemporary without breakdown due to thermal-technical properties. These new windows do not match the original historical character and are also fitted with the additional

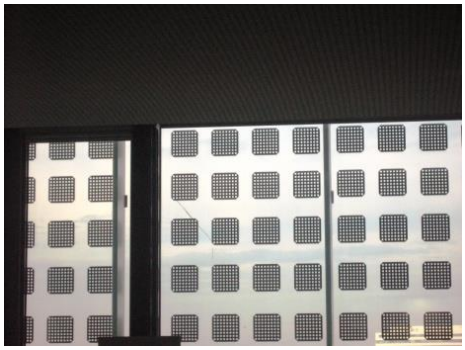
level of thermal insulation. Before them were opening in each window fitted with glass panes, which are irregularly placed and spaced from the lining around them that air can circulate and didn't affect the overall impression of the monotone facade. Moreover, these glass panes visually mitigated the negative impression of unnaturally massive insulated construction. Simulations were also carried out on all types of thermal bridges and simultaneously dealing with them bridge the condensation of water vapour. [3] Corridors related objects there is the contrast between the old and new structures. Roof structures are fitted with photovoltaic panels (picture 8).

Picture 7. Historic façade.

Picture 8. View from the roof.

The new facility, that we can see this is a passive office building. On the solar side is installed photovoltaic glass facade, the less sunny or facade without sun is placed imitation of photovoltaic glass facades (picture 9). Imitation is performed so that the glass is glued dimensionally identical squares of the same grid as the photovoltaic (picture 10). The difference is in any view from outside unrecognizable. Before the main curtain walls are already mentioned hanging structures for green vegetation and a variety of lamellar systems for maintaining the necessary climate in the building. Architects tried on flat roofs as much as possible to use extensive green roof layers instead of using gravel, mainly because of the stability of the internal environment and for reasons of aesthetic and ecological, because the roof is visible from the terrace and windows higher objects. In the construction project was also included, for example, the concept of utilization of local resources so that the whole revitalization of the greenest. Modernization of old equipment, passive cooling and highly efficient energy intake decreased total energy consumption in the entire complex to max 100 $kWh \cdot m^{-2}$ per year[3]. This new seat of distribution companies is an excellent showcase for both domestic and foreign clients.

Picture 9. Photovoltaics.



Picture 10. Imitation photovoltaics.

Conclusion

The conversion of historic buildings is usually a combination of methods to work with space and construction. The intent usually requires building historical research to clarify the historically

valuable structures and parts of the building and then study works by filling the space with new functions. Partial demolition and demolition are necessarily added as extensions or built-in. [4] Abroad, the conversion of historic buildings have been making for many years in Czech republic (Slovak republic) are more widely implemented in last two decades. However, it is already possible to give some examples of successful conversions of historic buildings and brownfield sites. For example, we can mention the conversion of the former small breweries and mills to office buildings and housing in Bratislava and Košice, the conversion of a former industrial site foundry Vaňkovka in Brno, conversion of former industrial complex area of Lower Vítkovice in science, technology museum, the conversion of a former Carthusian monastery in baroque campus of school VUT Brno, and more.

We will meet more frequently with the conversion of small or large objects in today's density built-up that it does not fulfil its original function for which they were designed. The process of conversion of historic buildings, protected monument care or not, is expensive and most investors they are often not achieve its investment options. There are grant programs that help finance these buildings, or use drawing money from EU funds. Because of the historical objects are unique identification of carriers of the population, it is very likely that the trend of their remediation, reconstruction and conversion will continue.

References

[1] PEŘINKOVÁ, M. a kol. Současné formy užívání industriálních historických objektů. Praha: Gasset, 2012. ISBN 978-80-87079-25-6, str. 123

[2] SVOBODOVÁ, M. a kol. Zelené stavby: Možnost snižování energetické náročnosti památkově cenných staveb. Slavonice: Slavonická renesanční, 2011. ISBN 978-80-904577-2-0

[3] PAUT ARCHITEKTEN, Dokumentační zpráva společnosti, 2011.

Information on: www.paut.at

[4] PEŘINKOVÁ, M. a kol. Současné formy užívání industriálních historických objektů. Praha: Gasset, 2012. ISBN 978-80-87079-25-6, str. 133

When Less Is More. Reducing Energy Consumption of Historical Buildings.

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Keywords: Architectural Heritage, Restoration, Energy Saving, Renewable Resources

Abstract. The pursuit of sustainable development, protection and renewable resources often takes effect in increased energy consumption of buildings. The benefit of this long-term trend is undeniable for new constructions. In reconstructing some conventional energy-wasteful structures using progressive methods, we may achieve significant savings or even the passive standard. However, when reconstructing and restoring existing buildings, this may also cause problems, especially in case of historically valuable buildings. Architectural heritage is a component part of the established image of our towns and cultural landscape in which we live. It carries the cultural and social values we protect because they document the history, abilities and spiritual diversity of our society. Insulation of facades, ceilings, historical roofs or "traditional" replacement of window panels can deprive us of valuable parts of the historical building stock we have committed to protect. Is it possible to align strict requirements for energy saving with the principles of protection of the monuments' authentic features? Is it possible to reach a compromise which will decide in favour of the monument acknowledging that sometimes "less is more"?

Protection of Architectural Heritage versus Reduction of Energy Consumption

The subject of energy consumption reduction is currently highly topical both in global and local context. Prices of fossil fuels necessary for energy production are growing and therefore we are forced to handle them economically, trying to use renewable energy sources. These efforts are reflected in tightening legislative requirements for energy consumption and grant support of the "green" projects. Decreasing energy consumption of the existing historical building stock is a separate issue of ecologic efforts in the construction sector. The subject of interest includes various objects with different architectural expression, typology and function. A great part of historical objects belongs to the group of valuable architectural works subject to monument protection. The question is, whether it is possible to decrease the energy consumption when trying to modernize them without endangering their heritage value.

In our Europe-oriented monument protection model, preference of the physical product value is still prevailing, whereby our cultural community perceives a monument in position of an exhibit. This is also the way it is treated within monument protection which is manifested in two basic attitudes: in definition of general method of monument protection and in preference of creative procedures focusing on preservation of the authentic material value as well as authenticity of the work itself. In practice, it means that within conservation and restoration, we are trying to preserve not only the appearance and expression of an architectural work but also to prevent disruption of authenticity of its individual parts and original materials.[1] Therefore, the subject of protection also includes exterior and interior plaster layers, face constructions of ceilings, historical roofs, floors and last but not least also the aperture constructions such as windows and doors. In traditional and simple method of the buildings' energetic consumption reduction, which consists of exterior insulation and replacement of window panels, the monument's appearance is fundamentally

Figure 1. Copy of the original object's vocabulary created in the insulation material. Kulturpark, Košice SR. [archive FA STU]

changing. It is an unsatisfactory solution to create a copy of the original facade segmentation in the contact insulation system and window panels, where the profiling of elements usually must be modified due to applying insulation double glazing units. Such formalism contradicts both the protection of the monument and modernist apprehension of architectural design. As an example, we may provide the reconstruction of barracks in Košice (SR) and their adaptation for cultural purposes on the occasion of awarding Košice the title of European Capital of Culture 2013. Due to grant requirements of the European Union for the energy consumption criteria in projects implemented, the architect was forced to insulate the historical object on the exterior side whereas some of the facade elements had to be copied in artificial stone and installed on the insulation system. The object's geison was even copied in cut out facade polystyrene. If such procedures were applied in historical objects in general, there would be irreversible losses in cultural values of protected monuments and the historical image of our towns would be destroyed. We are obliged to approach modernization of architectural heritage thoughtfully and to achieve decreased energy consumption with such construction methods and technologies not leading to degradation of cultural values. Let us consider some arrangements in detail and describe advantages and disadvantages thereof.

Exterior Insulation of Outer Walls. Method inadmissible in listed buildings. Exceptionally, it may be used for the parts of buildings without any plastic architectural vocabulary or preserved historical surfaces or cladding. These may include side walls, inside walls or extended parts which have become an integral part of the monument. However, the condition for such procedure shall be to create a final treatment of the insulation system in the same material as the original wall. Only a surface treated this way will not disturb the overall appearance of the monument and its effect in the surrounding area.

Interior Insulation of Outer Walls: Method usually implemented in cases when exterior insulation is out of question. Unlike external insulation, the interior method may be even applied just in intentionally selected parts of buildings. However, there are several disadvantages to this procedure – masonry can freeze up in winter, water vapours may condensate between insulation and masonry, the cladding has no accumulative ability, thermal bridges cannot be completely eliminated and the interior space is reduced. In terms of monument protection, the interior expression is degraded.

Insulation of Floor. Method is only applicable for a limited number of objects. It is inadmissible in buildings with preserved floor layers (e.g. stone, brick floor). It is also inappropriate in case the foundations have poor waterproofing and the foundation walls and basement floors are wetting.

Insulation of Roof. Basically, there are no problems with this method. Insulation should be well planned to avoid technical problems caused by microclimate changes. The only difficulty may occur in case of protection of a preserved historical roof.

Replacement of Window Panels. Window panels are characteristic elements of a historical facade and their reconstruction has to be considered prior to replacement. In case of minor damage, joinery restoration and sealing can be applied; in case of simple windows, an additional frame can be used. In double windows, one of the options may be to replace the external or internal wings with a copy made of insulation double glazing unit. When the window panel is to be fully replaced, the new design must be based on proportions, segmentation, profiling, type, colour and surface finish corresponding with the original window.

New Technologies. Influence of new technologies on the monument's appearance has to be considered on a case-by-case basis. Such choice is determined by a number of undesirable

construction interventions (e.g. cut-outs) or deterioration of external appearance (e.g. solar panels on the building's roof). In principle, however, it may be said that new technologies of heating and water heating can balance the energy consumption of listed buildings where any insulation method is out of question.

(Hyper)energetic Heritage?

A large group of building structures waiting for reconstruction and restoration contains especially buildings from the 2nd half of the 20th century. These are constructions built in brick, panel, skeleton, with a number of reinforced concrete structures, creating ideal conditions for thermal bridges. Buildings constructed in this period are characterized by high energy consumption, about 140 - 150 $kWh \cdot m^{-2}$, ranking them in the E energy class. [2] However, there is still an option to achieve lower heat consumption of the buildings in question through implementation of building and technological measures. These are often reconstructions with conservation of functions or conversions of different typology of buildings. It should be noted that these are not problems exclusively of the Eastern European countries, the locality of Austria, Germany or France are also concerned. After all, the beginnings of panel structures are dated back to the era of Le Corbusier.

According to architect Werner Nussmüller (Nussmüller Architekten), these buildings represent the greatest potential in the field of reconstructions in the building industry as well as a challenge for architects to react in an adequate innovative way. It should be noted in this context that in recent years, the European Union issued several directives, resolutions and supporting documents (2002/91EC, 2010/31/EU, 2009/28/EC, 406/2009/EC etc.) on energy sustainability, on utilization and potentials of renewable energy sources as well as binding emission limits for individual countries. Decrease of energy consumption and utilization of energy from renewable sources in the construction sector account for significant measures necessary for decrease of the EU's energy dependence and greenhouse gas emissions. (Legeny, Morgenstein 2013). [3]

Buildings represent 40 % of total energy consumption (Directive 2010/31/EU) and significantly contribute to environmental problems. From the global point of view, in construction sector, i.e. in restoration as well, it is important to use sources and materials with low carbon foot. Within implementation of the Europe 2020 strategy, one of the tasks of architects and project engineers in terms of sustainability will be, sooner or later, to increasingly use materials and constructions with low energy consumption in the context of its production, incorporation and finally recycling. Natural materials are an ideal choice, with wood being the most widely used. New forms of application of this material are emerging, which will be shown on the example from Austria. New technologies and innovative approach of all participants provided designs, visions and impulses for the construction segment of neighbouring countries.

The example shows an old 4-storey apartment house in the town of Kapfenberg in Styria, where Nussmüller Architekten together with AEE INTEC (Energy concept) took an innovative approach to reconstruction and in addition to significant decrease of energy consumption also achieved progressive architecture in terms of design and obtaining energy from alternative sources. Wooden panels with insulation, 3 metres wide, reaching through all four of the over-ground floors, have provided the construction basis for this reconstruction. The object is wrapped in them all round, with added protruding steel constructions of porches, balconies and terraces. The new facade achieves U-value < 0.17 $W \cdot m^{-2}K^{-1}$, the original U-value being 0.87 $W \cdot m^{-2}K^{-1}$. New windows and doors of high quality are directly integrated into the prefabricated facade and achieve U-value < 0.90 $W \cdot m^{-2}K^{-1}$ instead of original U-value 2.5 $W \cdot m^{-2}K^{-1}$. The gabled roof was transformed into a platform one, with 35 - 40 cm thick thermal insulation, which improved the original roof U-value from 0.74 to 0.1 $W \cdot m^{-2}K^{-1}$. The whole roof is completed with attractive light steel construction supporting photovoltaic panels of 550 m^2, or 80 kWp, which provides the whole object with modern appearance. Additional photovoltaic panels are located on the southern side, of 80 m^2 or 12 kWp.

Figure 2. View of the original apartment house building prior to reconstruction.
Figure 3. View of the reconstructed apartment house.
Figure 4. View of the implementation process – installation of wooden panel on the apartment house facade. [archive Fa STU]

Following further technological innovations in the field of heating and hot water preparation using renewable energy sources and after addition of controlled ventilation, the object achieves considerable energy savings. Prior to reconstruction, 337 MWh·year^{-1} of energy was calculated for heating and hot water preparation, reduced to 85 MWh·year^{-1} afterwards. The calculated annual solar panel production is 39.5 MWh and the photovoltaic production of the system is 80 MWh. [4] [5] Considering the goals set, the 80 % decrease of energy requirements compared to original, 80 % of total energy requirements covered from renewable energy sources and 80 % decrease of CO_2 emissions, the object achieves excellent results thanks to the reconstruction.

Summary

When decreasing energy consumption of the existing building stock, it is necessary to approach every case individually. For historical buildings with heritage values, methodologies must be prepared to decrease operational energy consumption. Such solution requires interdisciplinary cooperation of conservationists, project engineers and construction specialists. On the contrary, reconstruction of objects without heritage values can become an interesting challenge for architects, enabling to apply progressive technologies, materials and procedures.

References

[1] J. Gregorova, Reverzibilita a transparentnosť - hlavné trendy architektonickej tvorby v pamiatkovo chránenýchštruktúrach, in:Monumentorum tutela 19, PÚ SR,Bratislava, 2008, pp 319

[2] D. Petráš, Komplexná obnova stavebného fondu, in: Rukoväť udržateľnej architektúry (Complex Renewal of Building Stock, in: Sustainable Architecture Manual), SKA, Bratislava, 2013, pp. 106-110

[3] J. Legény, P. Morgenstein, Stratégia Európa 2020 in: Rukoväť udržateľnej architektúry (Europe 2020 Strategy, in: Sustainable Architecture Manual), SKA, Bratislava, 2013, pp. 122-125

[4] Collective of Authors, Kapfenberg, in: Shining Examples of Cost-Effective Energy and Carbon Emissions Optimization in Building Renovation (IEA EBC Annex 56), University of Minho, 2014, pp. 41-46

[5] K. Höfler, E. Guttmann, Gesamtheitlicher Ansatz der Sanierung am Beispiel der Wohnhausanlage Johann-Böhm-Straße, Kapfenberg/AT, In: att.Zuschnitt – Thermische Sanierung und Modernisierung von Bestandgebäude, proHolz Austria, 2013, Nu. 50, p. 13-14

Indoor Environment and Office Buildings Revitalization in Favor of Sustainable Development

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Keywords: Revitalization, Office Building, Administrative Activities, Teamwork, Mobile Working

Abstract. Nowadays people spend about 90 % of their lives inside. They spend more than half of this time at workplace, mostly in office buildings. Therefore the debate over office building architectonic conception can no longer be conducted without taking account of sustainability criteria. 'Sustainable development' is a question of integrating economic, social and cultural values in planning concepts. From this perspective, the aim must be to avoid optimising energetic building concepts one-sidedly and exclusively for their own sake at the cost of spatial qualities and quality of life, particularly in office buildings. This form of architectural concept must be part of each proposal and revitalization of buildings planned for the current administrative activity.

Introduction - the Function of the Building and Rehabilitation of Architecture in Relation to the Environment

At the time of its inception architectural object respond to the requirements imposed on it by the established method of use. This was particularly the performance of activities for which it was intended, also be applied cultural practices, architectural and compositional principles, expectations. Determinants were also building and technical procedures, tools and uses of materials and structures. Of course, the solutions of indoor environment and working conditions in these buildings also were based on the useful options. At the same time in all these aspects of the creation and use of buildings showed a relationship to the environment typical of industrial society. Nature provided resources to be used and the environmental parameters before which we should be protected. It can not be expected that the architecture, that originated in completely different conditions and for completely different assumptions its use, fit without adaptation requirements that are typical of our time and society. Often, however, the original function of the object provides options that are of benefit to a completely new functional use, including benefits to the ecological concept of such buildings. Proposals for the revitalization of buildings must respond in particular the fact that nearly half of the energy consumed in Europe is used for the operation of buildings. This involves energy, which they draw largely from non-renewable sources. Significant share of this consumption have mainly office buildings.

Development of Relations Architectural Object and Office Activity

Denoted as office buildings is used mainly for carrying out the work of an administrative nature, i.e. activities related to acquisition, processing, sorting and storage of information. Managing relations between citizens and between citizens and the community or communities each other in our history is developed through institutional actions, which we now understand as the administrative work. Historically architectural forms of these activities gradually manifested primarily by creating specialized areas for fulfilling the requirements for their implementation in different buildings. Design of buildings includes a relatively large number of economic, health and safety regulations and restrictions, which are reflected in the possible architectural and urban solutions. Workspaces for administrative staff was specified to large halls with rows of tables for ordinary workers of one

department, but also the typical cell three wings solutions with cellular offices around the central corridor or around the central hall. These two basic spatial concepts are maintained in the next period when they can react through quite different ways more and more sophisticated office machines and since the early 20th century is fully manifested in expanding the administrative tower skyscraper with a relatively large depth of disposition, with variably adapted breakdown by size of each department. Finding of new structural and material options brought to the creation of architectural concepts of separation the envelope from the structure and the creation of large, flexible interior spaces behind glass facades. "However, it also represents a radical declaration of independence from nature; the artificial air-conditioning on the basis of seemingly unlimited energy resources enabled a fully self-sufficient working environment cut off from the external climate conditions." [1] Efforts to obtain maximum performance in office activities developed on the basis of Taylor's research reflected in the large area preferred concepts.

Spatial expression of the utilization of human potential was the use of so-called "Office landscape" concept, which set certain parts of open space for leisure and communication zones, assign or conference room facilities and refreshments in late 60s of the 20th century. New impetus to the architectural solutions of administrative buildings has brought in the last decades of the 20th century a knowledge exhaustibility our energy sources on the one hand and the huge development of office equipment and later data processing technologies on the other. Increasingly understand the environmental impact of architectural, structural and technological solutions of buildings, which currently provide a working environment for more than half the population of developed countries. "Deep disposition of open space is perceived negatively not only for its high level of artificial lighting and ventilation to the premises, but also social impacts on the environment for administrative work." [2] Through the acquisition of a certain intimacy and optical interconnection of departments brought in the eighties in combined office largely new conjunction the advantages of both basic spatial concepts.

Current Office Operations - Architectural Features

Computing and especially the personal computer in the office activities brought a new wave of expansion construction impacts. Original premises cease to meet the demands due to new technologies, and most of the buildings had to overcome serious interventions not only to office equipment, as well as the total construction recovery. At the end of the 20th century showed that most of the spaces that were directly designed for administrative work, do not comply with the new requirements. Data networks further questioned the original spatial scheme increased mobility of workers also caused to independence in a fixed location and time of the administrative work. Administrative work now is primarily dependent on information and communication technologies.

The rapid development of these technologies has brought a rapid shift away from traditional forms of administrative work and tasks that the worker performs. Office worker may now be much more focused on their own, individual creative work, or to provide their expertise to work together for the team. Changes required by the concept of employee work on joint projects, are also reflected in the organization of office departments, including changes in their spatial definition (adjustable partitions, furniture structuring sets, mobile devices). Large share of knowledge-based office work is an individual, concentrated work that expert can perform relatively independently of the other team members. Current technologies also allow an appropriate level of information exchange between team members not to depend only on the random encounter in their work, but especially technology-mediated (paperless and wireless communications), or intentionally and purposefully organized in zones designated for staff meeting.

Restoration of Buildings and Options Create the Conditions for Administrative Work

Sufficient spatial comfort of office space is usually through health-fixing and similar laws, regulations or recommendations, although very different in different countries. Is often determined as a minimum standard desktop workstation (Germany: 8 – 10 m^2, UK: 4.6 m^2, Slovakia: 2 m^2 of

free floor space including facilities and routes in workplaces), or by the volume of space needed for the workplace (UK: 11 m^3, Slovakia: more than 12 m^3 of airspace in workplaces). Part of the staff care is also setting hygiene standards related to air quality that is needed in the areas of work performed. Architectural and technical design of each office building must allow sufficiently meet the conditions set by the binding rules - for example with regard to air temperature. The recommended temperature of administrative work is 20 to 22 °C (26 °C at work output drops to 85 % at 30 °C drops already at 75 %). For warm and cold season sets of Government Regulation [3] optimal and acceptable air temperature in the workplace:

Table 1. Optimal range and limit values microclimate conditions for the administrative work – a warm period of the year. [3]

Operational temperature in °C		Permissible air velocity in [$m \cdot s^{-1}$]	Relative air humidity in [%]
optimal	admissible		
21 – 25	20 – 28	≤ 0.2	30 – 70

Table 2. Optimal range and limit values microclimate conditions for the administrative work - a cold time of the year. [3]

Operational temperature in °C		Permissible air velocity in [$m \cdot s^{-1}$]	Relative air humidity in [%]
optimal	admissible		
20 – 23	20 – 26	≤ 0.2	30 – 70

Ensured the thermal comfort and air exchange in office space may also be provided by integrating intelligent climate and natural ventilation systems and heating (including pre-heating or pre-cooling the air) and hinged parts fillings window openings, in particular by creating a second skin reconstructed facade. Solution depends not only on the economy of building, but also on the options that defines the essence of the original building, such as the type of construction (wall, skeletal support system), or the special size (span, structural height and p.). In this way, the revitalization of the building Western authors suspension new facade on the ceilings of each floor only get better energy balance but also sufficient daylight and natural ventilation option. At the same time "in the newly we structured the interior and exterior. In order to increase the functionality of offices, we reduce the existing grid from 1.8 m to 1.3 m. This grid does not correspond anymore to the design, offices, however, are compact and allow more efficient use of space. "[4]

Standardized dimensions of the structures are often the main obstacle to the use of an existing building to current needs paperwork and environment. Distribution of ventilation tends to be too limiting element which is easier to situate the areas with higher overall height than was usual for example in office buildings cell type from 60th to 80th years of the last century. Clearance height building space originally designed for completely different functional use, turn permit through the raised floor and suspended ceilings or open supply lines addressing the latest requirements of administrative work. Therefore, the conversion of production and warehouse hall space, and even areas with sufficient clearance, the office building appears to be extremely effective solution. . The conversion of a former warehouse on the open office space for about 60 designers Siemens-Design und Messe GmbH in Munich architects Thomas Herzog and José Luis Moro used a combination of several approaches. For adequate natural lighting of administrative departments “a new continuous roof-light strip was inserted along the ridge, and openable windows at eye level ensure direct visual links from the workplaces to the outside world. The principal measure, however, lay in optimizing thermal conditions within the building, which was achieved by inserting a two-layer membrane."[5] Creating a new floor plus 40 cm is sufficient thermal insulation and also space for air distribution systems and cable networks, as well as the variability of the use of space and its ability of adapting to the individual needs of workers. Energy intensity of the current administrative work also led the Norman Foster's Reichstag Building reconstruction to the architectural solution which uses the

maximum extent renewables. Daylight of the Chamber provides light cone from the roof glazed dome, which is also used to natural air circulation, replacing ventilation. Ventilation and heating through the vegetable oil and heat pump draws energy from photovoltaic panels on the roof of the reconstructed building. The whole energy concept is complemented by the use of underground reservoirs of hot and cold water located in a former salt mine 300 m below the building.

Conclusion

The reconstructed premises can take full advantage of current knowledge, teamwork, which also brings quite a considerable saving in time when individual sites are actually occupied by workers. It also results in potential savings the real cost of renting and operating administrative spaces. By combining the use of combined office or place of business club cell-like offices can get 20 – 30 % of the desktop, sharing of work (desk-sharing, hotelling) also 30 % and marginal example mobile working from home in the form of teleworking to 20 % of the week. Inside such a way to solve administrative service in the reconstructed building exhibits a rich variety of differentiated work areas, space for formal and informal communication as well as subject-oriented quality assurance environment for employees.

All these principles are also accompanied by ecological concepts restoration of the building as a whole. “Nowadays, when the trend of reducing energy consumption (and not just from a cost perspective, but especially in terms of availability of resources), energy-efficient buildings current requirement today. For architects and builders here opens the way to the sensitive environment friendly and innovative solutions while using the various forms of renewable energy and within them the direct integration of photovoltaic power generation into the architecture.” [6] Implementation of existing current requirements for reducing energy consumption of buildings, and today the expected standard and desired comfort indoor environment with all its attributes, but at the same time with more and more present interest in protecting the architectural heritage of the future will need to be clear, but sensitive to formulate and articulate with each other. “It goes almost without saying that concepts of sustainability in building to be incorporated. The remarkable aspect that necessary changes result not only in an upgrading of the building in an ecologically sound form, but that through the innovative use of economical, simple materials, new spatial qualities were achieved that made a reuse of the existing structure seem more logical than demolition and new reconstruction. "[5]

References

[1] T. Arnold, et al., Design Principles of the Office Building. Berlin: Birkhäuser, 2002. 265 p. ISBN 3-7643-6650-8.

[2] M. Andráš, Retailing in the transformation process of industrial buildings. In: Restoration of Cultural Heritage.: Proceedings of the Scientific Conference with international participation. Bratislava, Slovakia, 21.6.2012. - Bratislava: Slovak University of Technology in Bratislava, 2012. - ISBN 978-80-227-3811-8. - P. 195-197

[3] Slovak Government Regulation from May 24, 2006, about minimum security and health requirements on a work-place, Statute-book No 391/2006, Addendum 1, Paragraph 15. Dimensions of room and free space in rooms… at a work-place, pg. 2882

[4] H. Meyer, Office building Revitalization - Am Seestern Düsseldorf, http://www.asb.sk/stavebnictvo/konstrukcie-a-prvky/fasady/revitalizacia-administrativnej-budovy-am-seestern-v-dusseldorfe 09.06.2014

[5] T. Herzog J. L. Moro, Conversion of a former warehouse into a Design Studio, Munich / D / 1997 http://www.thomasherzogarchitekten.de/Projects.html 11.07.2014

[6] E. Oravcová Construction in the Trend of Sustainability - Wooden Houses with Integraf Photovoltaic Systems. In: Advanced Materials Research. - ISSN 1022-6680(P). - ISSN 1662-8985(E). - Vol. 899, (2014), p. 209-212

Potentiality of Materials for Evening Illumination of Historic Building Construction

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Keywords: Floodlighting, Design, Illumination, Historic Building Construction, Culture Heritage

Abstract. The basic element of creating a particular evening atmosphere of historic places is the illumination of buildings and public spaces. For reasons of comfort perception it is primarily necessary to respect both technical criteria and architectural quality criteria in the design of lighting. Our paper is focused only on architectural criteria of illumination. The contribution mentions frequented materials and their illumination requirements, which support the presentation of cultural - historic values.

Introduction

The concerns of quality and gradual conversion of the lighting requirements can be observed in the new EU member countries where the townscape has changed markedly in the last twenty years. Their rich cultural heritage provokes to a presentation of the exterior part as well as the interior building part [1]. Sure, daytime and evening image of the historic environment is different. For a long time it has been true that the evening image of a city is a part of its identity. In practice, implementations and proposals are often in naive position. It is appropriate to ask the important question: Is the lighting design primarily defined by the owner creativity or do we have other objective requirements for illumination?

The evening image created by the artificial lighting is being monitored as a separate issue and this applies to both exterior and interior. The artificial lighting of buildings is the domain of the light-technical proposals and research. In this paper we focus on criteria of the illumination quality based on the architectural point of view. These criteria follow what the final image is like and what this image says or mediates/ conveys. The idea as an intended image is best expressed in the architectural concept of illumination [2]. Several authors here prefer an aesthetic aspect [4]. However, it is necessary to accent that the goal of continuous illumination design of historic buildings is to present their cultural a historical values, not just a personal idea. The cultural and historical values have broader meaning and potency than aesthetical values [3]. It should be noted that a properly conducted implementation presupposes the conceptual design to be completed and corrected in partnership with the light-technological designer in accordance with other important aspects of the implementation.

The architectural expression of premises and objects is defined by several components. In this contribution we focus on the various construction materials presented as a part of cultural and historical value. It is a small fragment of the problem connected with/ related to the illumination of historical buildings. Therefore, we do not distinguish whether construction surfaces can be illuminated as a central purpose or just an accent. The objects of monitoring are construction surfaces which are registered in our own archival database of application practice.

Methods and Materials

We describe the basic concept of illumination which is the illumination of an area in a way that benefits its artistic and historical value. Presented pictures illustrate suitable methods and the results are empirical. Observations are made without measuring the lighting parameters.

Wood. The shingle roof cladding enables us to create free and delicate shapes of roofs. But its surface reflects minimum light and therefore it is difficult to present shingle roofs as a shape. The final result is affected by the source intensity and temperature of source chromaticity, Etc. This also applies to all-wood objects, such as sacral architecture (Fig.1a). If the roof is situated above the plastered brick wall object, final effect is influenced by the different reflectance factors. If the situation allows us to observe the historic object from a short distance, it is important to present not only the roof shape but also a roof structure or a structure of wood. Then there is also important a direction of light. The next frequented example is a painting on wood. Mainly in interior, we handle with an artificial lighting of historic panting on wood. Here, the intensity for the interpretation of colours, uniform illumination and mostly orthogonal direction of illumination seem to be very important. It is necessary to maintain an intimate atmosphere (Fig. 1b).

Figure 1.Architectural and aesthetical value of wooden (1a – 1b) and stone construction (1c).

Fair-faced brickwork. The illumination of stonework masonry, particularly the illumination of the system of walls is a common case. Here a function of castle fortification is presented. In case of stonework masonry a detail is not presented preferentially. There are urban and architectural values in the foreground of illumination which should be focused on. The stone object – ruins are the similar case, for example, ruins of castles. Their walls were covered with plaster but today we present their weathered remains. The shape and outline of presented object as a whole gets to the forefront rather than a presentation of the specific structure. If we take into account only a material of the construction, the lighting design depends on the composition of the aggregates (proportional representation of elements, their colour which is original in a given situation) and reflectance factor for walls. There are special cases as well when a historical construction is a value, such as stone arrangement, evidence of technological process, binder material etc. The natural structure of material which today represents artistic aspect of design can be represented with lighting as well. In Figure 2a there is shown an example of the construction from 19th century presenting another stone arrangement in the role of plastic façade using side illumination. Brick wall masonry can create a deliberate aesthetic value which is based on the potentiality of different composition of load-bearing and decorative brick wall. The part of vault structure area is presented as an example (Fig.2a). A value of the perception is presented by the geometry of imposed brick elements which are different in every row. It is a reason for using area lights with direct lighting. A different case is a spatial structure of a decoration where the side lighting is needed to highlight the depth and aesthetic effect (Fig. 2b). The variety of material composition as it is in the case of composite masonry may also document certain historical aspects of the building and thus present its complex history. The presented Figure 2c of the former fortification is illuminated with high intensity in

full-area and shows the material of the construction from a short distance as well as from a distant viewpoint (Fig. 2c).

Plastered brick work

Figure 2. Aesthetical and documentary value (2a – 2c). Combination of stone articles and frescoes (2d).

The original plaster surface or renovated plaster, a case without artistic finish, can demonstrate its cultural and historical values in case of uneven surfaces reflecting handwork or an original technology. It is necessary to choose an adequate way of lighting to excel historical authenticity (Fig.3a). In case of frescoes or graffito, the plasters with art decoration, we have to put emphasis on colour rendering and adequate light equability of artistic element (Fig.2d). The next case is a decoration on the facades. In Figure 3b we can see decorative plaster (a plant motif) which is specific for its uniqueness and richness. The highlighting of the motif we achieve with the illumination on sloping in this case from above. The enormous potential for the interpretation have plasters in the load bearing constructions, especially vaults. The beauty of the construction excels mainly by plasticity form. It is important to find the right direction of light and game of light and shadow. Many times only the proofs "in situ" bring the best solution (Fig.3c).

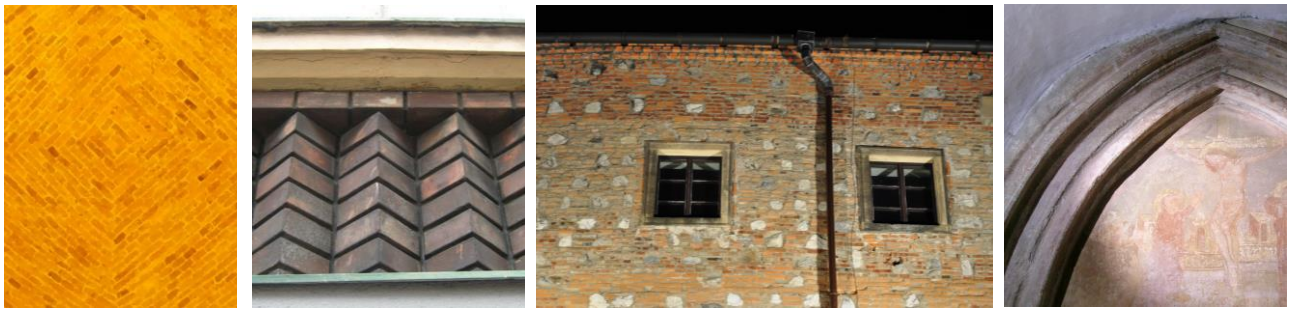

Figure 3a–3c. Plasters with different functions. 3d. Demonstration of concrete ceiling.

Reinforced concrete. This shapable material can be found in a special position where a construction is clearly artistically designed. The lighting has to be designed adequately to its architectural characteristics. In Figure 3d it is a construction from the first half of the 20th century where the primary value is a form. The presentation acts positively in many lighting modes.

Metal Structures. The lighting of metal structures is applied because of/ due to their architectural forming or structural and aesthetic function. A design has to take into account metal finishing and colour. The Figure 4a points to the typical example of a tin helmet where it is necessary to present a shape and silhouette of the tower. In Figure 4b we identify a steel decoration which has a week reflection of light and therefore it is important to use higher intensity of source and direction of light.

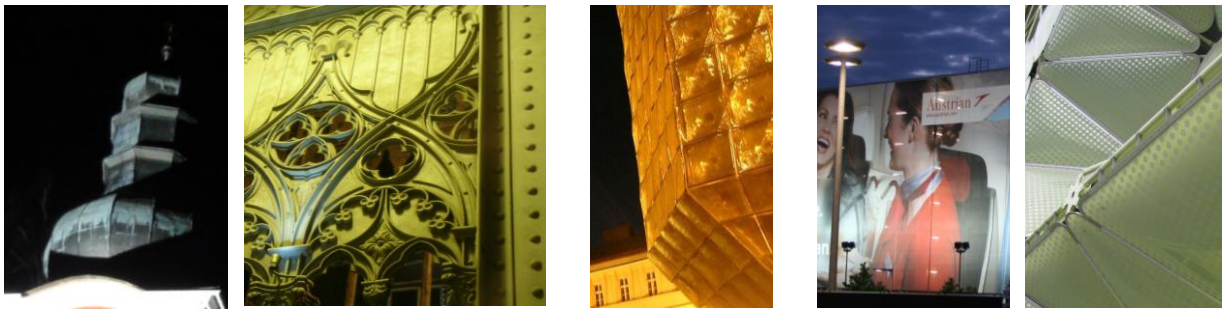

Figure 4. New constructions simple illuminated (4a – 4c). Luminous motifs by means of PC control (4d – 4e).

Glass and new materials (textile). Glass could also be a subject of lighting in a situation where it is not in the role of a transparent structure. In Figure 4c we can see the image from the second half of the 20th century where the value consists of the art authenticity and original structure of building glass surfaces. The reflective material as well as the urban context has the impact on the way of light. Nowadays, textile facades represent a very impressive alternative solution for/ of the building envelope. They are appealing with their extended surface, variability of appearance, interesting technical solution of anchorage and long life-cycle of material. The original envelope shaping, a surface structure as well as an art motif on the textile surfaces (drawings, coloured surfaces, paintings, and photographs) are the medium of authors work without repetition. Contrary to historic buildings where the work with light and illumination of an object is additional, aesthetic value created with illumination becomes a part of building conception (Fig.4d, 4e).

Discussion and Conclusions

A personal experience contributes to the quality of illumination therefore there is a possibility to create a continuous database of visual situations which could have the educational character for architects and lighting engineers. This contribution provides a suggestion for lighting engineering as well. It means to prepare an extensive list of materials to determine the reflectivity for a large number of situations that we find in historic buildings. A comfortable observation depends on the quality of continuous illumination design. The paper highlights the range of materials that could be a carriers of historical value, and thereby a potential element for lighting.

References

[1] J. Gregorová et all, Prezentácia architektonického dedičstva. /Presentation of architectural heritage/. Editorship: STU Bratislava, 2003. 140 s. , ISBN 80-2271837-8. p. 23-29, 46-97.In slovak language.

[2] L. Monzer, Venkovní osvětlení architektur. /Outdoor lighting architectures/. Editorship: SNTL Praha, 1980, ISBN: 04-703-80, p.61. In czech language.

[3] B. Polomová. Illumination of historical objects from the view of an architect. In: Przeglad elektrotechniczny. ISSN 0033-2097. Vol.84, Nr. 8, 2008, p. 5-7.

[4] L. M. Sánchez, L. Balažová, Lighting design, profession with future? In: Light - Svetlo 2013, Conference proceedings (CD), p. 302 -311, 23.-25. 10. 2013, Podbanské Permon, Slovakia, ISBN 978-80-89275-35-9. , p.305.

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Numerical Simulation of Air Channel in Church Gemerský Jablonec

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Keywords: Rising Damp, Ventilation of Air Channel, Drainage, Historical Building, Masonry

Abstract: Moisture is a major source of damage in historic solid masonry. Rising damp is a well-known phenomenon around the world and occurs when groundwater flows into the base of a construction and is allowed to rise through the pore structure. From practical experience it is known that many factors may play a role regarding permeability problems in masonry. The amount of possible causes of moisture problems in historic masonry underlines the complexity of this phenomenon. Evaporation is an important factor in rising damp. The surface of an affected wall contains moisture that has risen from the ground and this moisture is then subject to evaporation. The factors controlling evaporation include: temperature, humidity, air movement and surface.

The Windows in the Modular Structure - Air Tightness and Quality of Installation Diagnostics

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Keywords: Openings Filling, Airtightness Measuring, Tightness of the Connection Joints, Infrared Thermocamera

Abstract. Renewal windows and doors in residential buildings is a big trend at present. On windows, as products, a number of strict requirements that are fulfilled during laboratory testing are placed. What is the real condition after installation in the construction? The subject of this paper is the assessment of the tightness of replaced windows and doors in apartment situated in a prefabricated apartment building. For the diagnosis measuring devices Blower Door was used. At the same time scanning by infrared thermocamera was done. Critical points of leakage were detected. In the conclusion possibilities of solving leading to ensuring the required tightness are described.

Revitalization of Facade Cladding with the Use of Bonded Joints

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Keywords: Lightweight Cladding, Revitalization, Bonded Joints, Cement Tiles, Aluminum Substructure

Abstract. One of the current issues in the Czech building industry is the revitalization of buildings, or their outer shells, that were constructed before 1990. Vented facades are a suitable option. At present, the vast majority of such facades utilise mechanical joints; however, facades with bonded joints are also a suitable alternative. The following article, where the potential use of bonded joints in practice is verified via experimental measurements, deals with this technology in great detail. This article focuses on the preparation and subsequent production of test specimens, and also on the experimental verification of the bonding of substructure to cladding and the determination of shear strength under tensile stress at a temperature of (20 ± 3) °C and a relative humidity of (55 ± 10) %. For the tests, Cetris cement-bonded particleboard was chosen for the cladding and aluminium profiles for the supporting substructure. In order to find the most suitable connecting material, five types of industrial adhesives intended for structural bonding were selected. At the same time, emphasis was placed on featuring adhesives from various price categories. The test procedures verified the suitability of the selected adhesives for the chosen combination of materials, and the method also suggested that the use of the most expensive adhesive doesn´t always provide the best results.

The Verification of Range of Chemical Grouting of Wet Masonry by Theoretical Modeling and by Using Infrared Camera

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Keywords: Chemical, Grouting, Masonry, Infrared, Thermography, Verification, Detection, Emissivity, Efficiency

Abstract. Improving properties of materials is an integral part of almost of all remedial interventions; one of the most challenging remediation is the remediation of damp masonry. With the development of advanced technologies in the field of remedial chemicals there is one of the increasingly used methods – the method of high-pressure chemical grouting. Its use, however, raises the question how to control the quality of the design. This article deals with the possibility of mathematical modeling of grouting design of damp masonry and using the indirect method based on infrared radiation for subsequent checks.

Underfloor Air Cavity Created from Special Shaped Units and Different Intensity of Outdoor Wind Flow

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Keywords: Underfloor Ventilation, Special Shaped Unit, CFD Simulation, Wind Flow

Abstract. Underfloor air cavities are commonly used in connection with remedial treatments of damp masonry, especially in historic buildings, but in new buildings respectively, and further also by the realization of foundation boards, and as a protection against radon. The materials used can be original, but it is also possible to use modern special shaped units. To assessment the airflow in the air cavity the recently often used CFD simulations can be employed. The application of simple geometric models can accurately confirm or refute the appropriateness of a proposed solution. Of the two completed simulations, the first overall geometry of a modeled house, ascertains the actual pressure on the walls due to wind effects. Results from the first simulation are applied as boundary conditions, where the geometric model represents the underfloor air cavity created from special shaped units. The overall geometric models are simulated by a different intensity of outdoor wind flow.

Improvement of Low Inner Surface Temperature with Use of Linear Heating Component

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Keywords: Linear Heating Component, Thermal Bridges, Pipe-in-Pipe System, Mould, Power Supply

Abstract: Not only in Austria but also in EU and worldwide is the problem concerning restoration of old buildings very present. In the soaked massive brick walls are very often, moist caused, low thermal resistance and very low surface temperature, especially in the walls corner. At the Research Centre of Building Physics, TU Vienna, was an investigation carried out, which should act solution to this problem. To compensate thermal deficits of a cold wall corner (thermal bridge) area a linear heating component has been studied in the form of a pipe-in-pipe system, which raises the temperature of the wall corner and prevents the condensation. Through a targeted local heat supply, the necessary heating power is registered, within the temperature doesn't fall below the critical value, at which it can come to building of condense water or to formation of mould. The calculations performed with a COMSOL program were carried out using tests on a real object. Thus, the calculated and the measured values could be compared. The first results can be seen as promising in terms of heating power saving, where you don't need to heat the whole room to a high temperature. Through the selective heat power supply in the corner area thermal bridge effect will be eliminated.

Making the Concept of Old Industrial Buildings in Terms of Sustainability in Architecture

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Keywords: Old Industrial, Conversion, Transposition, Manual, SWOT Analysis, Buildings Values, Sustainability, Magnesite Factory.

Abstract. Industry since its origin gradually takes typical characteristics which interfere into the economics of a country; it has a specific localisation and its own identity. Nowadays a problematic old industry on one hand creates a potential of lucrative areas in the cities and on the other hand it is itself a carrier of culture and historic values. That is why it is necessary so that the values which it represents are presented to the wide public and not only to a relatively narrow circle of specialists. From the nowadays view, industrial has got a new dimension of equivalence with architectonic sights of modern. The content of article is aimed at methodology of concept creation of changing the objects from potentials of usage of objects, level of adaptability of construction and innovation of original details to determination of alternative procedures.

Environmental-Economic Assessment of Thermal Insulation for External Load Bearing Walls

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Keywords: Thermal Insulation, Load Bearing Wall, Assessment, Environment, Aspect

Abstract. The construction industry has a significant environmental footprint, especially in terms of greenhouse gas emissions and energy consumption. On the other hand, the climate change and energy sustainability presents one of the five targets for the European Union in 2020. The strategy 2020 sets greenhouse gas emissions 20 % lower than 1990, 20 % of energy from renewable and 20 % increase in energy efficiency. However, the construction sector provides many opportunities for achieving of strategy 2020 targets. One of them is optimize of the design or renovation of the thermal insulation of external load-bearing walls.

This paper presents the assessment of environmental and economics parameters of thermal insulation for the three selected constructions according the criteria ever more stringent standard STN 73 0540. Compliance with the standards requirements crucially affecting the selection of type and volume used construction materials. Each build respectively additionally built building material is identified by the environmental and economic characteristics. Based on these characteristics, the paper deals with the comparison of basic criteria for building environmental assessment (BEAS) and construction costs needed for additional insulation of external load bearing walls.

Introduction

The construction has a great impact on natural resources, energy, the environment and climate change. Significant improvements in construction activities and construction works all over their life cycle have the potential to contribute to a competitive construction sector and to the development of a resource and energy efficient building stock, with all new buildings being near zero energy consumers and materials resource-efficient as presented in the strategy 2020 [1]. The members of European Union are obliged to implement the targets of strategy into the national legislative or standards. On the other hand, the building performance is one of major concerns of professionals in the building industry and environmental building performance assessment has emerged as one of the major issues in sustainable construction [2,3]. Various methods for the environmental assessment of construction (BREEAM, Green Globes, LEED, CASBEE, SBTool, HK-BEAM, NABERS, LEnSE, etc.) are available in presents. Within the environmental and economic assessment of thermal insulation has been used the building environmental assessment system – BEAS which was developed in Slovakia [4].

Requirements of Thermal Protection of Buildings

The project documentation and standardized assessment of energy performance of construction designed after 1st January 2013 have to be processed according the new Slovak Technical Standard 730540-2:2013. This standard determines the minimum value of thermal performance according the strategy 2020 targets for the buildings and renovations realized since 1st January 2013. The requirements for the construction realized since 1st January 2015 are given as recommended and the requirements for the construction realized since 2020 are given as a target recommendation. Thus, the standard requirements of thermal protection for construction will be more stringent than currently. Each designer is obliged to comply the minimum energy performance requirements during the design of construction or renovation [5]. We can assume that the stringent standards requirements will encourage the need of additional thermal insulation of external walls for the

designed construction or renovation. This paper presents the two assessment aspects of additional thermal insulation of masonry load bearing system, which is typical of housing in Slovakia.

Technical, Economic and Environmental Assessment of External Load Bearing Walls

The quantification of monitored technical, economic and environmental parameters was processed for three constructions with various layouts (Fig. 1):

- construction "A" – family house, gross floor area 64 m^2 , simple square floor plan,
- construction "B" – family house, gross floor area 170 m^2, L-shaped floor plan,
- construction "C" – residential building, gross floor area 1100 m^2.

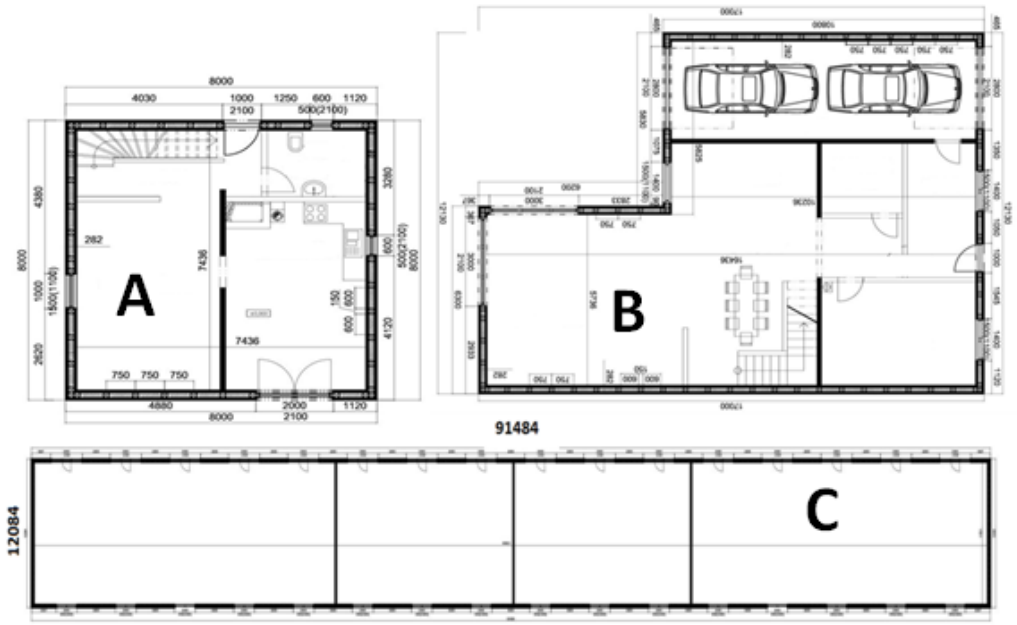

Figure 1. The floor plans of solved constructions A, B, C.

Thought the selected construction is possible to estimate the interval of the monitored parameters for technical, economic and environmental assessment. The project documentation of projects presented the background for this assessment. The detailed economic assessment - budget, material costs and construction works costs for external load bearing walls were determined based on the quantity take-off.

The three selected characteristic (part B.2 – building construction) of system BEAS [4] were used for detailed environmental assessment of construction:

- B2.1 – primary energy embodied in building materials (PEI) – called "grey energy", unit of measure – MJ

This grey energy presents the volume of primary energy consumed to obtain raw materials, production and transportation of particular construction material. The equivalent value of 1 MJ approximately presents 0.27KWh.

- B2.2 – global warming potential (GWP), unit of measure – kg

This data determines the volume of greenhouse gas (CO_2) emitted during the production of particular construction material.

- B2.3 – acidification potential (AP), unit of measure – kg

Based on this data is possible to determine the volume of gas (NO_x) which involved in the acidification of environment.

The calculation of B2.1, B2.2 and B2.3 values (PEI, GWP, AP) which are needed to quantify the environmental aspects was done through MS Excel application [6]. This software allowed the

calculation of the additional thermal insulation (objects A, B, C) for different variants of two insulating materials – mineral wool and polystyrene.

Table 1. Selected parameters of construction design of external load bearing walls.

Construction	A – family house	B – family house	C – residential house
TECHNICAL PARAMETERS:			
Gross floor area GFA (m^2)	64	170	1100
Building volume BV (m^3)	176	468	3040
Area of load-bearing walls (without holes) ALBW (m^2)	79.6	127.4	443.3
ECONOMIC PARAMETERS:			
Realization costs (building material + construction works) (EUR)	7 753.44	13 400.51	46 300.43
Building material costs per 1 m^2 ALBW (EUR/m^2)	69.02	75.54	73.92
Construction works costs per 1 m^2 ALBW (EUR/m^2)	28.39	29.61	30.52
Total costs per 1 m^2 ALBW (EUR/m^2)	97.41	105.15	104.44
ENVIRONMENTAL PARAMETERS			
PEI (MJ)	72 137.34	116 603.40	407 166.54
GWP (kg)	5 616.08	9 087.66	31 707.55
AP (kg)	17.75	28.76	100.47
PEI per m^2 ALBW (MJ /m^2)	906.25	915.25	918.49
GWP per m^2 ALBW (k) /m^2)	70.55	71.33	71.53
AP per m^2 ALBW (kg /m^2)	0.223	0.226	0.227

Table 2. Modification of selected parameters of design for external load bearing walls (A)

Structural system Object "A"	Base variant	Type of addit. insulation	Thickness of the additional insulation					Parameter change (%) of external load bearing walls suitable since 2020 given the base variant (year 2013)
			+50 mm	+60 mm	+70 mm	+80 mm	+100 mm	
Technical parameters:								
Heat transfer coefficient U (W/m^2.K)	0.26	Mineral wool	0.2*	0.18*	0.18*	0.17*	0.15**	
		Polystyr.	0.19*	0.18*	0.17*	0.16*	0.14**	
Thickness of const. (mm)	431	Both (MW and P)	481	491	501	511	521	
Economic parameters:								
Building material costs per 1 m^2 ALBW (EUR/m^2)	69.02	Mineral wool	79.88	81.56	83.6	85.76	89.84	121
		Polystyr.	71.9	72.48	73.05	73.63	74.78	108
Environmental parameters – influence of insulation material production to environment								%
PEI (MJ) per m^2 ALBW	906.25	Min. wool	1086.6	1122.7	1158.8	1194.9	1267.0	140
		Polystyr.	1000.9	1019.9	1038.8	1057.7	1095.6	121
GWP (kg) per m^2 ALBW	70.55	Min. wool	83.25	85.79	88.33	90.86	95.94	136
		Polystyr.	73.77	74.41	75.06	75.70	76.99	109
AP (kg) per m^2 ALBW	0.22	Min. wool	0.30	0.32	0.33	0.35	0.38	173
		Polystyr.	0.24	0.24	0.25	0.25	0.26	118

* complies with the standard requirements since 2015

** complies with the standard requirements since 2020

These values were consequently calculated per m^2 of external walls. The table 1 provides the summary data concerning the technical, economic and environmental parameters for the design of external load bearing walls for selected objects.

The economic and environmental assessment [7,8] of construction materials for additional thermal insulation depending on improvement of thermal characteristics for the load bearing walls of object "A" is in table 2.. The same way of calculation was used for the assessment of technical, economic and environmental characteristics of object "B" and "C".

Based on the data in table 2 is clear that the polystyrene insulation affects less environmental and economic terms than the mineral wool insulation during the thermal insulation of object "A". On the other hand, this assessment shows only a partial field of decision-making process. Very important aspects of additional thermal insulation of construction are a change of fire resistance of structures, increased risk of materials bio corrosion, etc.

Conclusion

Currently, the activities of construction sector are aimed to environmentally friendly building materials and sustainable constructions by implementing the strategy 2020 targets. However, it is important to point out the negative aspects of reduce energy thought additional thermal insulation of external load bear walls. There is the expected positive impact on energy consumption and environment at the time of insulated building using. On the other hand, it is necessary to consider the increase costs (construction material and works) for additional thermal insulation and the environmental negative impact of the insulation material production. This paper was focused on the calculation of selected parameters for thermal insulation according the standards requirements.

Acknowledgment

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References

[1] Strategy for the sustainable competitiveness of the construction sector and its enterprises, information on: http://eur-lex.europa.eu

[2] G. K. C. Ding, Sustainable construction – The role of environmental assessment tools, Journal of Environmental Management, 86 (2008) 451-464.

[3] M. Kozlovska, A. Tazikova, Mutual calculating building and environmental costs as tool for integrated design solution, in: 9. International Scientific Conference FCE TUKE, (2012) 1-8.

[4] E. K. Burdova, S. Vilcekova, Environmental assessment of building materials and constructions, Applied Mechanics and Materials, 174 (2012) 3161-3165.

[5] V. Geletka, A. Sedlakova, Thermal behavior of low energy house using uncertainty analysis, in: SGEM 2013, (2013) 785-792.

[6] Information on http://www.oebox.at

[7] Z. Strukova, M. Kozlovska, Environmental impact reducing through less pollution from construction equipments, in: SGEM 2013, (2013) 401-408.

[8] I. Hyben, D. Kosicanova, M. Kosican, Energy management in historic buildings, in: SGEM 2013, (2013) 99-102.

Small Green Roofs as a Means of Improving Sustainability and City Design

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Keywords: Climate, Ecological Roof, Extensive Green Roof, Sedums, Small Roof, Thin Soil Depth

Abstract. Claim of this article is showing the necessity of green in urbanized environment. Nature in modern city understood in a small scale. This article is about shelters, their position in the city, access for the habitants, constructive solution and the most important - green top of the shelter. This article is also about the shelter for bicycles, designed for Technical University of Košice. One and only possible way of finding balance between natural and artificial places is using nature as a toll. Tool for the way we live, tool for the way we build. Doesn´t matter how much we agree with this fact, but humans have brought evil to working natural system. Now we need to figure out how to bring good to urbanized system. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole of nature in its beauty.

Introduction

We want to believe, humans are not the main cause of the current global warming and climate changing. Sun is getting brighter, planet is receiving more and more energy and it is warming up. Volcanoes are erupting, emitting particles into the atmosphere that reflect sunlight and the planet is cooling down. The greenhouse gases are causing that planet is warming up. But it is worthy to remember that without greenhouse gases the Earth would be a ball of ice.

The fact is that the climate has been always changing. The Earth had some ice ages, warmer periods. Other ice ages have occurred in a hundred thousand year cycle for the last 700 thousand years. There have been previous periods that appear to have been warmer than the present despite CO_2 levels being lower than nowadays [1].

Question of this article is what kind of period the Earth is having now. Is this temporary, is it real, is this caused by nature, by lack of nature, lack of water, or is this really caused by human´s activities? The Earth and nature has always found its own way how to solve issues causing troubles. Very simply and absolutely not scientifically said, ages of dinosaurs passed, because they could not live any longer on the Earth. Right now we are struggling with many Earth´s issues. Question is how the Earth is going to solve these problems and what is it going to mean for humans. Are we going to be another ´dinosaurs´, or are we going to be the ones to change it?

Material and methods

As the human population began expanding and being more disturbing to nature, cities, towns and suburbs were full of constructed roads, buildings and parkings. Because of land being full of concrete and asphalt, impervious surface, water flows off surfaces and reduces infiltration into ground water. Agricultural fields, suburban and urban lands are being replaced with non natural surfaces. Necessity of recovering the green areas is becoming increasingly critical.

Green art in architectural concepts such as integrating nature into dwelling has been applied for thousands of years. Buildings have been being covered in green since ancient times. Hanging Gardens of Babylon are the very first example. Scandinavian sod roofs are another one. Bringing nature into cities and urban dwellings has always been an amenity for many landscape architects and engineers [2].

On the other hand, different countries in past were using green very tactically. Lack of material led to using natural resources for very logical reasons. Using nature affected architects and city planners later. Bringing wildness into planned urban dwelling. Towns should be in the parks, parks should be in every city, access to green should be very easy for all the habitants. What is important about these examples is that in all these cases are caused by one mutual reason. People missing the smell of the grass and flowers, gardens where they can spend their free time etc.

In just few years, green roofs have gone from a historical curiosity to a booming growth industry - primarily because the environmental benefits of extensively planted roofs are now beyond dispute, whether for industrial or governmental complexes or private homes in urban or suburban settings. This paper deals with small extensive green roofs.

There have been many studies claiming green roofs can improve urban environment [3]. These studies confirm benefits of these roofs from different approaches. Besides environmental helpfulness, very important is aesthetic aspect of these roofs, because they are part of urban environment. Idea is to make buildings transparent or invisible among plants. The plants are present. The colorness and purity of the air close to a vegetative roof evokes mental images of forests, waterfalls. Green roofs create new living spaces for people, for fauna and flora [4, 5].

Rooftops with plant material provide numerous benefits. Ecology, economy, sustainability, health, water management, energy conservation, aesthetic pleasing. Construction of green roofs also provides work opportunities for landscape architects, specialists, members of environmental stewardship etc. Term green roof is commonly used to refer a vegetated roof cover, or a permanent roof top planting system that supports plants to cover a significant portion of the roof of a building. Green roofs involve growing plants on rooftops, thus replacing the vegetated footprint that was destroyed when the building was constructed [3, 6]. Green roofs can be categorized as intensive or extensive. According to substrate and plants and planned usage, there are extensive roofs with shallow substrate and intensive roofs with deeper substrate [7, 8].

Results

Extensive green roofs are lightweight veneer systems of thin soil or substrate layers of drought tolerant self-seeding vegetated roof covers. The parameters that can influence the roof purpose can be grouped into three main areas corresponding to the layer of vegetation, to the substrate layer and, finally, to the climatic conditions. [9, 10].

Extensive green roofs require special types of plants. Plants are usually native from dry locations, semi-dry locations, stony surfaces such as alpine environment. These kinds of plants have typical mechanism to survive extreme conditions. Mechanisms like water storage organs, thick leaves, thick leaves surfaces, narrow leaves requiring little or no irrigation, fertilization or maintenance after establishment. Plants selected tend to be of the low maintenance and self-generative type. Also, they can be constructed on existing structures with little, or no additional structural support. Construction of this kind of roof is mostly single, or double layered. They are not intended for people´s recreation, human weight, larger shrubs or trees. The main reason for installing an extensive green roof is visual, mostly creating building performance of flora for habitants [7].

“When I first saw a photo of living green roof in Downtown Buffalo, I thought that someone had done a good job in Photoshop. I assumed that the project was a proposal rather than a finished product. I’m happy to say that I was wrong. Earlier that morning I paid a visit to the NFTA bus shelter to see what if I could find any signs of the living roof. A functioning green roof on top of the shelter. When I got home I checked out eco_logic STUDIO’s facebook page and found some photos of the roof-in-progress. A demonstration project for NFTA utilizing an existing bus shelter. In the last year NFTA has installed about 100 photovoltaics systems on bus shelters. This is the first green living roof.” says Connor [11].

The benefits of the living roof at the bus shelter range from oxygenation to pollution absorption, cooling measures to rain retention. “Though the size of this particular roof is largely symbolic.”

says Connors. “NFTA has done some very extreme green things at the airport, with glycol treatment. They also covered the root of the Frontier Bus Garage with PVs. We wanted to promote green infrastructure, but we also really liked the challenge of covering one of these. We worked very collaboratively to do the design, we have done a lot of research into soil mixes, especially using recycled materials. We had to do a load test on the polycarbonate, because the literature didn´t go that high.“ [11].

Discussion

Small green roofs, when we talk about small green roofs in a small urban scale, they are very important for every city, every street, every district. When we compare them with standard black roof, their features are incomparable. What they do to air, water, people, psychology, aesthetic of the place. Physical, ecological, water runoff aspects are very significant.

There are many green roofs features. Lowering surrounding air temperature through water evaporation. Lowering the presence of allergens. Cleaning air. Forming oxygen. Capturing CO_2. Absorbing light smog. Creating new environment. Aesthetic factor of the green roof. Psychological effects. Lowering surrounding air and creating new living space. Visions of wood, meadow. Creating new living space. Water retention. Unloading surface drainage. Green roof aroma. Modern city design.

Figure 1: Bicycle shelter, TUKE campus, Košice

Claim of this article is to show small green roof features in little urban scale. Many examples of bus stops, garage shelters exist abroad. The goal of this article is to show that designing one small green roof in a city in middle Europe could help. Help people think about nature brought back to the city, make them think about going back to nature we have been give, help town creating habitats in the middle of asphalt jungle, make politics thinks about creating green roof bylaws that are so common abroad sometimes thanks to the people and their natural needs of having green around them, around places they live work, raise children, make climate changes in a small scale, but it may be understood as a help in a big scale. Creating micro climate. Filtering dust and harmful substances. Humidifying air. Lowering surrounding air temperature etc.

Bicycle shelter in TUKE campus in Košice is about to be designed in a very short period of time. The goal of making the top of the shelter green is to observe vegetation on the top of the shelter. The vegetation will be planted in three different rooftop layers. Layer n.01: soil 80 mm, filter fabric 300 $g \cdot m^{-2}$. Layer n.02: soil 80 mm, filter fabric300 $g \cdot m^{-2}$, water holding drainage layer 20 mm, filter fabric 300 $g \cdot m^{-2}$. Layer n.03: insulation board 50 mm, drainage mat 400 $g \cdot m^{-2}$, filter fabric 300 $g \cdot m^{-2}$. These layers will be placed on rigid insulation (different heights), roof protection barrier and trapezium metal plate that will be joined to load bearing structure. Another goal of this shelter is to observe bioremediation, heavy metal presence detection (Cu, Zn, Fe, Mn, Al), pH

measurement of rainwater and pH measurement of water filtered through vegetation and soil and monitoring different environment physical parameters (temperature, humidity, flow, solar radiation).

Conclusion

Green roofs are on the agenda worldwide. It is caused because of many challenges. Climate changes, more dense cities. Green roofs could be unique infrastructures of our cities. This article is about realized small green roof, little bus shelter. Shelter, its position in the city, access for the habitants, constructive solution and the most important - green top of the shelter. This article is about the project of shelter for bicycles designed as a tool helping the Earth solve its issues. Project of this shelter is really largely symbolic when we compare it with standard big top of the building.

Acknowledgement

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Summary

Bringing nature into our lives makes deep statement about the way we see the world. It is teaching us the way how we should see the world. Wildness, green, plants should fascinate us in nature, in city, anywhere. No matter how idealistic it seems, this is how we should start. Our task must be to free ourselves from prison by widening our circle of compassion to embrace all living creatures and the whole of nature in its beauty.

References

[1] Information on: https://www.skepticalscience.com/climate-change-little-ice-age-medieval-warm-period.htm

[2] Information on: http://www.greenroofs.com/Greenroofs101/history.htm

[3] Information on: http://www.asla.org/uploadedFiles/CMS/Green_Roof/SustainabilityWithStyle.pdf

[4] E. C. Snodgrass, Green roof plants, Timber press, Portland*London, 2006.

[5] N. Dunett, N. Kingsbury, Planting green roofs and living walls, Timber press, Portland*Oregon, 2004.

[6] P. Jodidio, Green architecture now!, Taschen, Cologne, 2012.

[7] N. Dunett, N. Kingsbury, Planting green roofs and living walls, Timber press, Portland, 2008.

[8] C. E. Thuring, Green roof plants response to different media depth under various drought conditions, online http://horttech.ashspublications.org/content/20/2/395.full (2014-05-31)

[9] N. H Wong, P. Y. Tan, Y. Chen, Study of thermal performance of extensice rooftop greenery in the tropical climate: Building and environment 42 p. 25-54 (2005)

[10] Information on: http://www.greenroofs.com/Greenroofs101/extensive_greenroofs.htm

[11] Information on: http://buffalorising.com/2012/09/nfta-bus-shelter-gets-a-living-green-roof/

Selecting the Evaporator of the Heat Pump

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Keywords: Heat Pump, Evaporator, COP, Defrost.

Abstract. This paper deals with the test procedure for evaluating performance parameters of the heat pump air water system. The objective of measurements was tuning errors and optimizes the work of the whole system. The main aim was to find the most acceptable evaporator with which the heat pump COP reached the best results.

Heat Pump

Heat pump is one of many heat sources for low-energy buildings. For the heating of one-family houses is using heat pump systems: Heat pump ground-water, heat pump water-water and head pump air-water.

The principle of the heat pump is reversed Carnot cycle. It is the use of latent heat of refrigerant in the compressor circuit. The circuit consists of four main parts. The first is compressor. The purpose of the compressor is raising pressure of vapor from the evaporator to the condenser. Next part is condenser. In this part of system the refrigerant transfers latent heat to heating water, the refrigerant changes from gas to liquid. The third part of system is expansion valve. The Expansion valve control flow of refrigerant from the high-pressure condensing side of system into the low-pressure evaporator. The last one is evaporator. The purpose of the evaporator is to receive fluid from expansion valve. The refrigerant takes the low-temperature heat from the vicinity of the evaporator and refrigerant is changes from liquid to gas.

Evaporators for Heat Pump Air-Water

Construction materials of evaporators for the air-water heat pump are aluminum fins on cooper tubes. The aluminum fins are oriented vertical and tubes are oriented horizontal. The slats may be coated by a hydrophilic layer and may be formed for better drainage of condensed water. Spacing of slats is a compromise between compactness and the tendency to block with condensed moisture or frost. All evaporators for heat pumps are equipped with a fan or more fans.

The Types of Evaporators According to the Orientation and Location of the Fan

The main orientation of evaporator is vertical with fan in the front. Air stream is horizontal and condensate water goes down only by gravity. This is the cheapest variant of evaporator.

Next type of orientation of evaporator is horizontal with fan in upper side. Air stream is vertical from up to down. Condensate water is pushed by the wind down, outside evaporator.

A third option is to use an inclined evaporator. The fan can be tilted with the evaporator or horizontally. This system allows drops of water flow down to the drip edge.

Fan Speed Control

Using the fan speed control can reduce the delivered energy by reducing the fan speed. At the same time reducing the speed of the fan reduces the noise level of the fan and extend the service life of bearings. In climate chambers we tested evaporators with both types of fans.

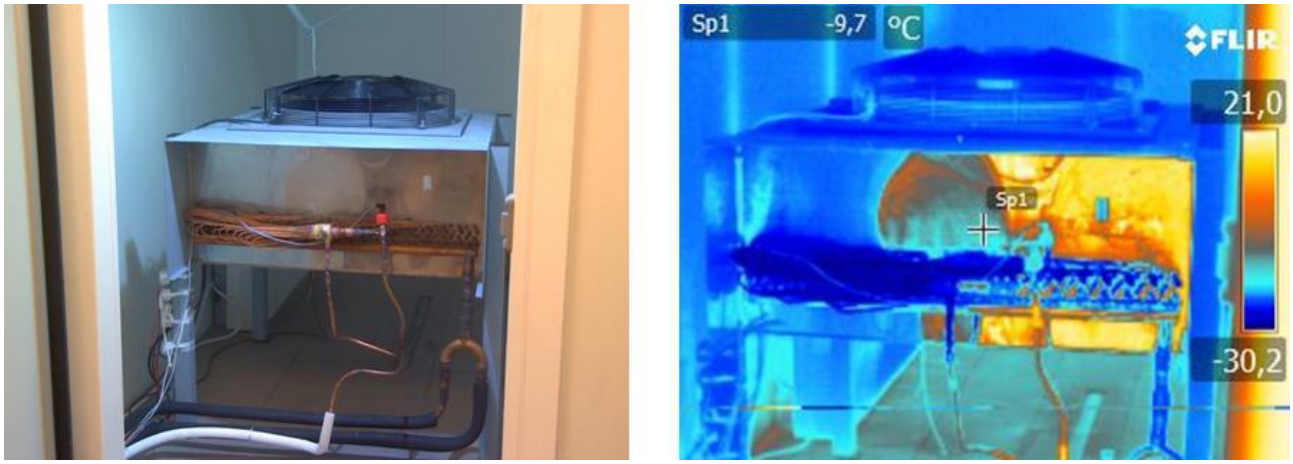
Design of Tested Evaporators

We tested evaporators with combination of parameters.

Number of rows of pipes (evaporators with 4, 5 or 6 rows of pipes). Using hydrophilic layer (evaporators with or without layer). We used evaporators with spacing of slats from 3,17mm to 4,23mm. We tested the vertical, horizontal and inclined evaporators.

Testing

Throughout the testing were electronically recorded values of temperature, pressure, flow, consumed energy and time course of each component. Condensation and evaporation temperatures were also calculated from the set pressure of the refrigerant. To record the pressure ratio of the refrigerant circuit was equipped with a digital service unit TESTO. All evaporators were captured using infrared camera. Thermal images showed the temperature distribution in the evaporator and the quality of injections.



Photographs and thermal image of the evaporator.

Evaluation

The evaluation of the measured values was carried out in three phases. First, the calculation and comparison of the heat factor by Carnot. The second option is to assess the evaluation of evaporators in terms of net hourly output. The third is a combination of both.

COP (Coefficient of Performance, Heat Factor by Carnot)

For the energy evaluation of heat pump is used the heat factor ε. Heating capacity of the heat pump (Q_T) is equal to the sum of heat received the evaporator (Q_O) and power supplied compressor (P_{el}). (P) is the power input of the compressor.

$$\varepsilon = Q_T / P, \text{ where is } Q_T = Q_O + P_{el} \quad (1)$$

For cooling factor as reverse Carnot cycle ε_{ch} then apply the next formula. In formula is the temperature of the heat supply (T_C) and temperature of heat dissipation (T_H).

$$\varepsilon_{ch} = T_C / (T_H - T_C) \quad (2)$$

Net hourly output

The value of the evaporator performance with respect to power dissipation, frequency and duration of defrost necessary to thaw frozen exchanger fins. The surface of the evaporator at low temperatures, the controller gets to below freezing. The heat thus condensed air moisture, which then freezes thereby it significantly impairs heat transfer. This further decreases evaporation temperature, and this leads to even more significant icing. At a time when the evaporator is frozen so that the evaporation temperature begins to drop rapidly, the heat pump switches to defrost and ice begins to thaw. This is to supply the quantity of heat exchanger, which makes the pump can not supply power to the heating system.

Summary

By comparing the measured of values, we chose the most suitable evaporator for heat pump air water, exerted by the contracting authority.

Selected evaporator had 5 rows of pipes with spacing of slats 4.23 mm. The evaporator had a hydrophilic layer. And the evaporator was inclined orientation.

Our results are applicable to similar equipment (heat pump with a heating capacity of about 10 kW).

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References

[1] H.-J. Ullrich, Chladící technika: Díl II., 1st ed. Praha: Svaz CHKT, 2000.

[2] Hundy, Trott, Welch, Refrigeration and Air-Conditioning, 4th ed., Elsevier Ltd, Oxford, 2008.

[3] NEPA. Company documents, Information on http://www.nepa.cz/

Analysis of the Use of Transfer of Energy Produced from Renewable Sources

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Keywords: Energy Balance, Transfer of Energy, Renewable Energy Sources

Abstract

To reduce the energy performance of buildings mainly helps production of energy from renewable sources. That the benefits of these renewable sources have been most used, it is necessary to analyze the amount of energy produced and consumed in time and further use the potential of the produced excess of energy.
In the case of adjoining buildings with different operation modes may be considered with the transfer of energy produced from renewable sources. This makes it possible to achieve higher power efficiency compared to the accumulation or dissipation of produced energy. The quantity of produced and consumed energy is variable in time therefore it is necessary to quantify the amount in shorter time intervals. It is devoted little attention to energy transfer between buildings but it is a possibility through which may be achieved further reducing of energy performance of buildings. This article is an introduction to the issue with these possibilities and aspects of the use of renewable resources and transfer of energy and aims to evoke interest in this area and expansion considerations.

Introduction

The use of excess energy is one of the many options to reduce the energy performance of buildings, mainly if it is a complex of several buildings in close proximity. In this case, it is mainly used the excess energy produced from renewable sources.

The possibility of using energy transfer, however, is influenced by many factors, such as buildings, renewable energy sources and distribution systems described in this article. Given that the issue of transfer of energy from renewable sources provided non-constant amount of energy produced and consumed in time has not been closely analyzed, this article is an introduction to the field of the possibility of further reducing of the energy performance of buildings and a springboard for further research in this area.

Renewable Energy Sources

Renewable energy sources in the course of their use are naturally renewed. They can be divided into three main groups according to basic energy they use. They are sources based on rotational and gravitational energy of the Earth and neighboring celestial bodies (tidal energy), heat energy from the Earth's core and the energy of the incident solar radiation. The greatest potential of use have the renewable sources based on incident solar radiation. This energy is directly useful - like energy direct and diffuse solar radiation or transformed forms - hydropower, wind and biomass. We gain two forms of energy from renewable sources - electricity and heat.

Renewable energy sources for electricity generation are hydro, solar, wind, biomass, biogas, fuel cells and geothermal energy. Renewable energy sources for heat production are solar energy, geothermal energy, biomass, biogas and fuel cells.

In the objects of resident type are most frequently used sources based on solar radiation - solar collectors for heat energy and photovoltaic panels to generate electricity, or in the case of heat pumps the heat at low temperature from the surroundings - air, water, earth.

Systems based on the distribution of energy are solar power, hydro and wind. For the production and distribution of thermal energy and mostly also the electric are used the biogas plants using anaerobic digestion of biodegradable material - biomass.

Use of Renewable Sources

Directive 2010/31/EU orders to member states to reduce the energy consumption, increase use of energy from renewable sources and reduce of greenhouse gas emission. In the Czech Republic, current legislation establishes achievement energy performance of buildings at almost zero energy consumption in buildings owned by public authorities in January 2016 and, in the case of other buildings, from January 2018. In this case, it is necessary to use the potential of renewable energy sources, [1].

For reaching the almost zero energy consumption it is necessary to produce such amount of energy that would be in the overall balance almost zero. In the case of a single energy source, however, such concept would not be achieved because the building consumes energy as heat (heating and hot water) and electricity (lighting, ventilation, cooling).

If the only source of energy production should produce an amount of energy that is approximately equal to the sum of the amount of energy consumed in the building, the source had to be oversized and excess heat would have to be obstructed.

In doing so, the concept of low energy houses does not end gradually by reducing the energy performance of the object to zero, but may even make more total power than it consumes. It is an Active house, which can be occasionally met in the European Union, especially as pilot projects of family houses. Meaning of active means that the overall balance between the energy produced in the house and its surroundings is greater than the energy consumed. The concept of the importance of Active house but lies not only in the energy balance, but consists of three basic aspects - Energy, Indoor Climate and Environment. The Active house shall be a building which is energy efficient and easy to operate, a building which ensures a good indoor air quality, adequate thermal climate and appropriate visual and acoustical comfort and a building which exerts the minimum impact on environmental and cultural resources and avoids ecological damages, [2].

If we focus on energy, the quantity produced has an annual balance sheet total exceed the amount of energy consumed, it is clear that when dealing with partial balances in short intervals will also develop excess energy. Obstruction of thermal energy (for example in the summer heat production from solar collectors or heat pump) would be highly inefficient, thermal energy storage options would be limited by technical properties of heating system and in the case of electricity (produced from photovoltaic panels during sunny day) for its technical disability of storage assumes its use of the transfer via transmission networks. Globally, for the evaluation of active house by all the energy produced in the property and its surroundings were included in the balance of this object, but that is part of the energy transferred to the neighboring objects, while the actual energy consumption would be lower.

Use of Energy Transfer

The amount of energy produced from renewable sources and energy consumed in the building is variable in time. On the side of the building is the consumption of energy dependent on its operation. It is necessary to consider whether the building is open all day, how many days of the week, year round or only seasonally. The typical examples are the school buildings during the school year, which consume large amounts of energy, especially during the heating season, while during the summer are not in operation.

For energy production it depends on the type of renewable source, what kind of energy is produced and what natural sources to use. More stable sources are those that draw low-potential heat from the ground. In greater depth of the earth's crust is soil temperature more constant throughout the year. However, the heat from this source is often used in the heating season, while in summer the use of hot water for the same building is order of magnitude lower. Conversely, the amount of energy produced from solar radiation is variable during the day and throughout the year. Therefore in these cases, such system for the production of energy from renewable sources can not be dimensioned so that the amount of energy produced was exactly equal to the amount of energy consumed at the same time, and it completely or deficiency.

The generated energy, if not consumed at the same time, you can either accumulate or deliver to the surrounding buildings. With system of energy bridges between buildings also deals a concept of Smart region.

Smart Regions

In the concept of Smart regions it is used the power supply between the buildings.

Smart Cities and Communities integrate energy, transport and Information and Communication Technologies solutions to increase energy efficiency in urban environments. The goal is also to create new markets for the industry and to provide new or enhanced services to the end users and the citizens, [3].

SMART objectives are:

- Optimizing energy needs with regard to the possible use of renewable natural sources
- Ensuring quality indoor environment using hybrid systems
- Expansion of the draft regional energy supply from renewable energy sources
- To design an effective combination of technical equipment
- Quality monitoring to enable the intelligent management of production, distribution, storage and consumption of energy, [4].

Possibilities of Energy Transfer

Transfer of energy is applied when the amount of energy produced from renewable sources exceeds the amount of energy consumed in a building in the same time interval. Figure 1 shows the possibility of using the surplus energy of one building in the second building with a lack of energy in the same time interval.

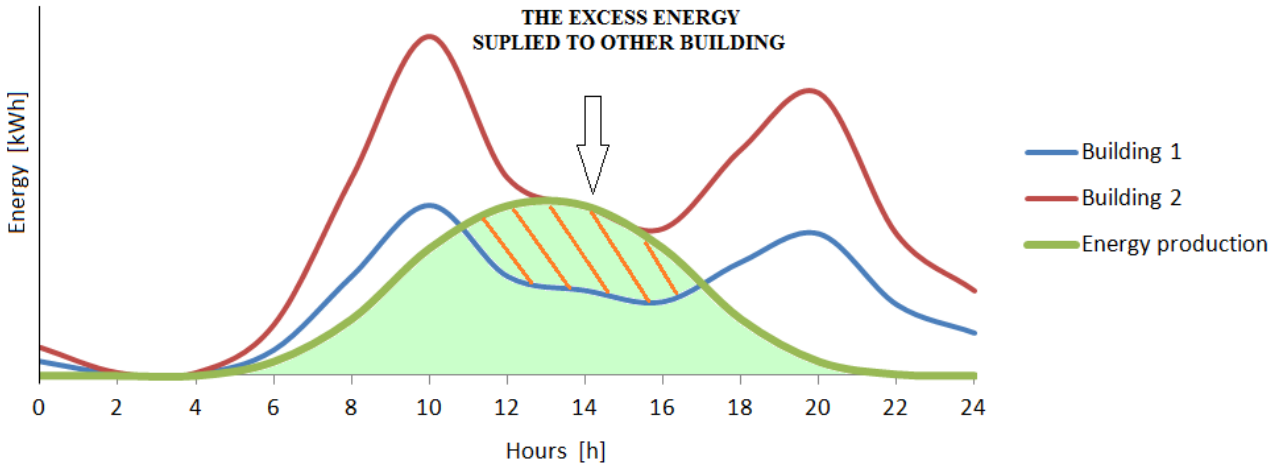

Figure 1: Demonstration of the use of transfer energy from one building to second building

One example is the production of electricity from photovoltaic panels. Each building consumes considerable amount of energy. But the electricity produced from photovoltaic cells it is still not

possible to effectively accumulate. The excess of production can be supplied back to the grid, but in this case there are significant energy losses in the transmission system. In case of two or more adjacent buildings, the amount of energy can be distributed between them and the short distances. This would achieve an overall more efficient energy production without undesirable losses.

Another possibility is the use of energy transfer in the case of solar water heating. Energy can be supplied between the buildings ideally with different annual operational use. Examples of buildings that consume hot water all year round except summer are e.g. schools and kindergartens, boarding schools and college. Near those buildings can be not only residential houses but also buildings for sports that within the organization of sports activities consume a large amount of year-round warm water.

In the case of biogas plants is the possibility of using transfer energy is more effective. The biogas plant may produce not only heat but also electricity. Primarily for purposes of heat, it is advisable to build a biogas plant at the optimum distance from residential housing or other types of objects that are connected to district heating. Otherwise, all the heat generated from combustion of biowaste will thwart to the air.

Summary

Energy, which can not be is the relevant place and time consumed, can be not only electricity and heat from renewable sources, but it can also include waste heat from industry or from the cooling process. It is more efficient to use such excess energy than dissipate, even though technically more difficult. Energy has become an integral part of life so that its consumption is increasingly growing. A man poses high demands and its impact consumes more and more energy. This is not in our interest, but we need to make better use of the potential energy that is around us.

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References

[1] Zákon č. 318/2012Sb., ze dne 19. července 2012, kterým se mění *zákon č.* 406/2000 Sb., o hospodaření energií, ve znění pozdějších předpisů. (LAW 318/2012 Coll. dated July 19, 2012, amending Act No. 406/2000 Coll., on energy, as amended), (in Czech)

[2] Information on http://www.activehouse.info/node/40/11-key-principles

[3] Information on http://ec.europa.eu/enterprise/policies/space/files/research/orientation_paper_en.pdf

[4] Information on http://www.top-expo.cz/domain/top-expo/files/smart-city/brno/prednasky/hirs_jiri.pdf

Façade Concepts with the Energy - Contribution to Sustainability

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Keywords: Sustainability, Alternative Energy Sources, Renewable Energy Sources, Clean Energy, Photovoltaic Façade Modules, Integration, Architectural Concepts

Abstract. The issue of reducing energy consumption and fuel are increasingly gaining prominence. Using renewable energy is one of the necessary road to sustainability, the achievement of ecological principles and the need for environmental protection. There is no doubt that photovoltaics is a booming technology and one of the most promising sources of renewable energy. Is one of the alternatives for the saturation of essential energy needs in the building industry. The façade can achieve more ambitious goals than the simple utility function. The facade becomes a structural component, which not only creates space and tries to retain received energy but also creates elements capable of actively producing energy. Currently available modern system façade concepts create the opportunity for use of extensive, visually attractive, structurally- and broad color-range of photovoltaic panels.

The paper refers to the possibilities, methods and forms of integration of PV systems in the architecture - into building facades.

Introduction

In the time when the world is debating on climate change issues which is basically due to use of fossil fuel, the use of solar energy in various form is relevant. Past decades have seen alarming fluctuations in energy prices, reliability issues, and increasing awareness regarding buildings intensive energy consumption and environmental impact. The existing buildings are responsible for use of large amount of energy for lighting, heating, cooling and use of various energy run equipments mostly powered by fossil energy. Today's intention should be to replace this fossil fuel by solar energy which is free and available in abundance.

In recent years, the European Union, the United States and other advanced countries have issued the design or construction case of zero-energy building (or nearly zero energy building). Goals for the implementation of zero energy buildings are discussed and proposed at the international level. For example, the European Union has set ambitious targets to ensure that from 2020 all new buildings consume very little energy and it has created the term "nearly zero-energy building" or nZEB.

Meeting minimum energy performance requirements is an obligation under the law.[1]

After energy conservation, supplying reliable, renewable, on-site energy to buildings is fast becoming an inviting solution.

There is no doubt that photovoltaics are a booming technology and one of the most promising sources of renewable energy. Considerable technological progress has been achieved in this area, aiming to maximize performance and reduce the price. A broadly decentralized deployment of small PVP in the buildings across the country may help 'solar' electricity to reduce dependency on the conventional energy sources (gas, coal and nuclear).

Photovoltaics

Photovoltaics (PV) is a technology of the direct transformation of solar energy into electricity. The advantage of PV systems is that they do not require direct sunlight to function. The system can

be installed anywhere irrespective of geographical location. However, the amount of solar radiation affects the amount of power it produces.

In view of their enhanced material efficiency, low production costs and better integration into the structural elements of buildings, new thin-film technologies (thin-film, a-Si, CdTe, CGSi, etc.) show additional promise. The use of crystalline silicon still prevails (c-Si, mono and polycrystalline), even though experts expect increased efficiency and significantly lower prices from the experimental materials (multi-layer, polymer, Nano fiber, organic, etc.),

Photovoltaics in Architecture

Long-term research has resulted real practical applications, integrating photovoltaics in the construction, reconstructions and revitalization of family and residential buildings, buildings of public utilities, objects for agricultural and industrial production - in its various forms of applications into roofs and foresides of buildings.

A well-designed and properly dimensioned photovoltaic system is a small power plant (PVP), capable of meeting the energy needs of property users in terms of ensuring their thermal comfort (heating, air conditioning), lighting requirements, operation of household appliances, and the preparation of domestic hot water.

The goal of each installation is to maximize electricity generated during long –term use. How much power a PV module can produce depends on many factors. Of major importance is orientation of the module, angle gradient, insulation, shadow and the need for ventilation gaps between construction and PV panel (facade - panel). Provided that the requirements have been met and negative effects have been removed from the vicinity the building, the surfaces most suitable for the installation of photovoltaics include the roof and facade of the building in their various forms.

Photovoltaic Facades

A solar panel façade is visually impressive and at the same time produces electrical energy. There's no other equally effortless way for a building to generate electricity. This is also one of ways to achieve improved energy performance of buildings as required under new building regulations in Europe.

Effective integration of solar systems directly into the facade elements of windows, shading systems, railings, awnings, overlapping courtier, foyers, halls, connecting roads, skylights, pitched and flat roof multiplies the value of the building and at same time in all these applications should be considered photovoltaic not only as an energy generating source but also as a full replacement building constructions materials. The building industry is recognizing the increasing importance of energy efficiency.

In principle, BIPV can be used in all parts of the building envelope. Optimum power production is from a south-facing wall and any shadows must also be taken into account. Although roof surfaces are the preferred area for installing PV elements due to their advantageous irradiation values, façades also offer enormous potential, specially in Nordic region where the angle of the sun is low all throughout the year.

A solar panel façade is ideal not only for office and commercial construction, but also for residential and commercial construction_for modern energy-efficient construction and for buildings where more prominent visibility is required. It is suitable for newbuild and renovation construction alike, to buildings that require updating or need a facelift, or where a solar panel project on the façade is all that is required. The system does not limit choice of base materials or type of buildings.

A PV facade is most effective if there is sufficient ventilation of the cavity between the PV panel and the wall or if it is even uses generated heat discharged. Facade modules meet all the criteria applicable to a modern facade design, such as protection from the weather, sunlight, noise, fire insulation, protection against burglary.

PV modules can be used on inclined surfaces, vertical - either to the entire façade surface or to a part of façade surface in vertical or horizontal strips (or combinations thereof). The panels used on facades can perform various functions and serve as a:

- Full substitution of another material (for examples instead of stone tiles)
- Protruding hanging surface on its own individual structure, with a ventilated wall – module Cavity, which is secured to the facade
- Glass facade (glass-glass) with integrated PV modules, also known as a transparent facade

Transparent PV modules (in general) have a dual areas usage – capture sunrays and convert their energy to electricity while shielding protects the interior and protecting it from excessive glare and overheating. We distinguish between them dispending on

- The degree of shading (transparency stated in %)
- The shading level (or density, the ratio of full to transparent surface area of the panel due to the different sizes of gaps, i.e. spacing between elements)

With the availability of thin-film PV, integration into the facades has become even more relevant and look attractive thanks to their consistent colour enabling a high standard of harmonious, nuanced architectural solutions.

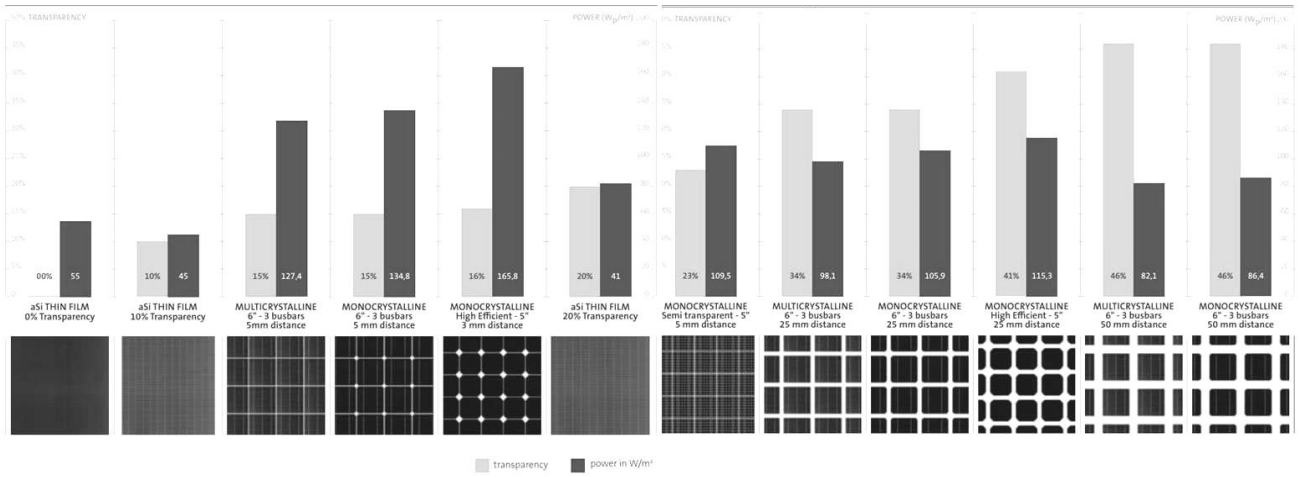

Figure. 1. Some possible combinations of cell-types and cell distances (Example is compilation of cell-types Sapa Solar Companies).

Integration PV into additional elements of the façade_ thus integrated PV cells and modules fulfil a dual function – attain their intended purpose (intensity of shading, etc. ..) and, thanks to integrated photovoltaics are simultaneously involved in electricity generation - awnings, canopies, sun shades, blinds (vertical, horizontal, fixed, variable), railings of balconies, loggias, terraces, integrated into apertures (PV film on windows).

Photovoltaics and other surfaces

These are surfaces which are a form of architecture itself. The PV modules used - whether transparent panels (transparent, translucent to varying degrees or shading level) carry a strong architectural message of the entire project itself i.e. they wrap, protect, define the interior. They are different forms of cylindrical segments, spherical, irregular and concave curved surfaces (when not distinguishing exactly "where the facade ends and the roof construction begins" and vice versa).
When designing PV systems emphasis should be put on

- compliance of the intended solutions with specific local conditions (wind strength, amount of snowfall, light conditions, urban area ... etc.)

- consistency with (linkage to) existing building structures with the other elements of the structure

(roof, cladding, etc.)

- technology interconnection with HVAC systems,
- aesthetic integration into the overall expression of the projects,
- method of using of produced energy (direct consumption, storage batteries sale to the grid or a combination of these methods).

Conclusion Types of PV panel layers, thickness and type of glass, etc. vary according to static and thermal requirements, according to the specific needs of use.

Conclusion

When proposing and designing new buildings or the rehabilitation and reconstruction of existing ones, one must be aware that standard solutions with standard technological equipment not have a prospect. The application of photovoltaics offers compositionally interesting, structurally undemanding construction, energy-efficient, nearly self-sufficient, virtually almost profitable solutions for construction design. The facade becomes a structural component, which not only creates space and tries to retain received energy but also creates elements capable of actively producing energy.
An opportunity presents itself to create and successfully use a new architectural style "solar design" – in the field of designing.

Note in conclusion: "The sun is not to blame for price increases ..."

References

[1] Ministry of construction and regional development. Law Nr. 555/2005 J. of L, Law on energyefficiency in buildings and on amendments to certain Acts, National Council of the Slovak Republic Act.,

[2] I.B. Hagemann, Gebäudeintegrierte Photovoltaik. Architektonische Integration der Photovoltaik in die Gebäudehülle, Köln: Rudolf Müller, 2002

[3] S. Roberts, N. Guariento, Building Integrated Photovoltaics - A Handbook

[4] T. H. Reijenga, H. F. Kaan, PV in Architecture. In: LUQUE, A. & HEDEDUS, S. (eds.) Handbook of Photovoltaic Science and Engineering. Second ed.: John Wiley & Sons., 2011

[5] M. Budiaková, Energy Concept Design of Zero Energy Buildings, Advanced Materials Research. - ISSN 1022-6680(P). - ISSN 1662-8985(E). - Vol. 649 (2013), p. 7-10

[6] E. Oravcová, Support for low-energy housing concepts – Photovoltaics, in: Technologicalequipment for the construction of low-energy and passive houses, in the series Build and dwell with us, 2009, pp. 98-101

[7] P. Nahálka, Architecture and the Internal Environment in the Current Office Buildings – Environmental Aspects. In: Advanced Materials Research 899 (2014), p. 273-276

[8] M. Andráš, The shading Equipment of Buildings to Optimizing the Working Environment, In: New technological systems in building design I: Scientific Proceedings-reviewed scientific papers. Bratislava, STU Bratislava, 2008, p. 30-32

[9] Sapa Solar Architectural Energy Solutions – BIPV by Sapa Solar, http://www.sapagroup.com/companies/Sapa%20Building%20System%20AB/Pictures/brochures/Sapa_Solar_2012_SE_low.pdf

The Use of Certified Methodologies of environmental risk assessment

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Keywords: Forensic Science, Forensic Engineering, Risk, Risk Analysis, Risk Management, Damage, Defect, Failure

Abstract. In accordance with savings in all areas of life, we always try to search for new methods. It is also possible to use existing methods. Such use may be in the areas in which these methods were originally designed. This applies to the use of risk analysis methods for the evaluation of existing areas, buildings, structures and components of structures. Assessment methods of risk analysis allow the use existing certified methodology.

Introduction

In all spheres of human activity is evident in the effort to improve procedures used on humans, but also to simplify these procedures. If we don't have this kind of effort, the world would not progress. It will miss the driving force that pushes us on.

In the area of risk management and risk analysis is developed a considerable amount of methods. Individual methods are suitable for different areas of human activity. The dominant areas are activities in the areas of insurance, banking and the management of companies or processes [1]. In the construction industry in the Czech Republic is the use of risk analysis relatively new and not common.

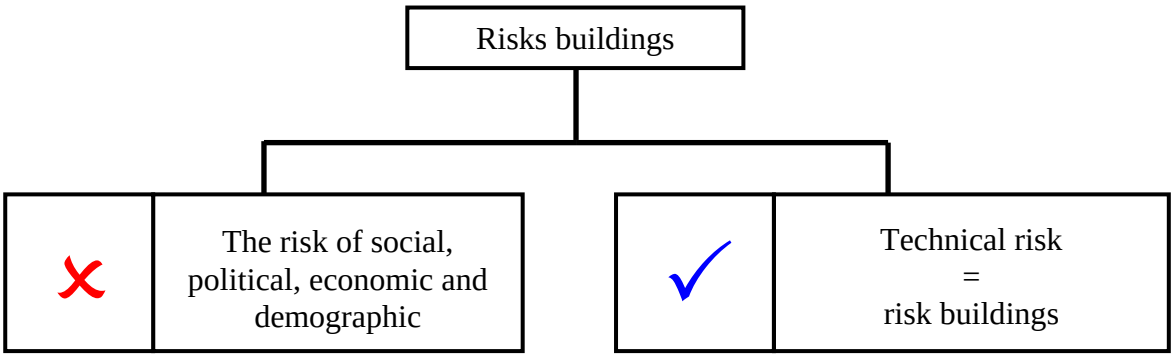

Fig. 1: Basic risk sharing

Given that there are many ways and methods which can assess risks, is important to select an appropriate method, an appropriate approach, given the situation, purpose and context in which the assessment is conducted. Each approach and each risk assessment method has its advantages and its drawbacks. Selecting the right approach and appropriate method is dependent on the purpose of the evaluation, the nature of the data that are available, funding and often the socially political context. The biggest obstacle in risk assessment is usually a lack of data and information.

This is such. Data on equipment failure, human error factors including characteristics of the consequences of those failures.

The effort to simplify and speed up procedures have led the author [2] to the idea to apply the General methods of risk analysis in an area where has not yet been used [3, 4].

This is the only application in the technical area, when the target group is the construction industry. The new application is only in narrow areas of the construction process. It is not, therefore, assessed the social, political or geographical and the effects (the effects of) to this area (Figure 1) but only and only the technical area, including economic aspects of construction. Economic aspects currently play in the construction of a very important role. Many builders are trying to reduce the price paid construction work at the expense of the quality of the materials used. Not always is build inexpensive means well, just as well mean build dearly.

Area of Use

The first areas where risk analysis methods were successfully applied were areas of forensic sciences. Successfully for the taking of evidence before the Court uses the UMRA method.

Analysis of UMRA [***U**niversal **M**atrix of **R**isk **A**nalysis*] is mixed verbal and logical-numeric expert method, in which the first identify vulnerable segments of the project, sources of danger affecting the project, and joint action resources, segments, these joint action are then rated based on their severity. The method can handle the answers of experts with varying degrees of knowledge about the project and with different levels of perception of danger. The principle of this method is similar to the FMEA method.

Usage is different [5]. Generally comes from guest experts summarized in the matrix (1, 2), which is then evaluated [6].

$$Sg_1 \equiv \left(c_1 \quad c_2 \quad c_3 \quad c_n\right) \tag{1}$$

$$M_{Sv} \equiv \left(c_{i,k}\right) = \begin{pmatrix} c_{1,1} & c_{1,2} & c_{1,3} & c_{1,n} \\ c_{2,1} & c_{2,2} & c_{2,3} & c_{2,n} \\ c_{3,1} & c_{3,2} & c_{3,3} & c_{3,n} \\ c_{m,1} & c_{m,2} & c_{m,3} & c_{m,n} \end{pmatrix} \tag{2}$$

$$Pc_k = \frac{\overline{\sum_{ij}} Sv_{ijk}^E}{\left(Sv_{\max} + Sv_{\min}\right) \cdot n_{act,k}^E} \tag{3}$$

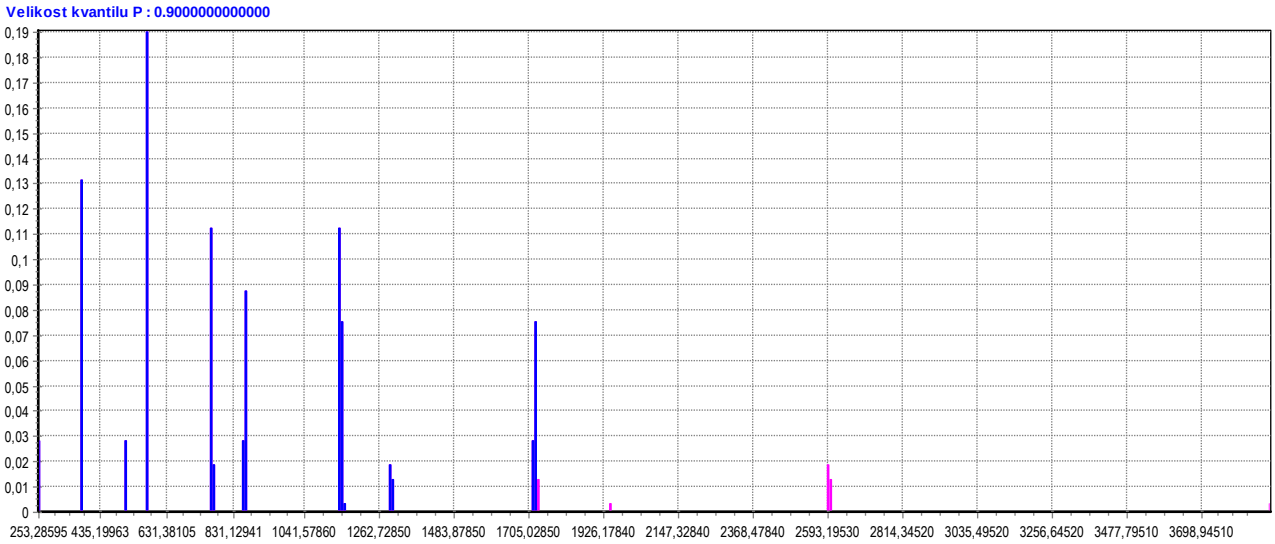

Figure 2. Histogram. [7]

This evaluation method we can choose according to the purpose for which this assessment to serve (3). The most commonly used classical analytical evaluation. It is also possible to use the evaluation using histograms (Figure 2). [7]

Method and its application, i.e., application was also included in the instruction on VSB-Technical University of Ostrava and at the Faculty of Civil Engineering and the Faculty of Safety Engineering.

Because this method of UMRA is a universal method, it is possible to use it in all fields of the construction industry, but also in all spheres of human activity.

The method of universal matrix of risk analysis (UMRA) is based upon the comparative logic-numerical analysis of risk severity level for the given problem being resolved (project or its part) by an expert team.

The method of universal matrix of risk analysis has two stages:

- word phase – it is focussed on identification of project segment exposed to danger, sources of dangers endangering the segments. This phase is realised by an expert team. A matrix form which is further worked with in the numerical phase is the result.
- The numerical phase includes:
  - estimation of risk severity level using the UMRA matrix;
  - qualification of the risk according to estimated severity levels. [6]

Other Variants and Options

The paper presents a universal method applicable in the field of environment and its forensic evaluation. [8, 9] Method of UMRA works with constant sizes rated factors. With this method it is necessary to evaluate comparable structures or processes. In practice, this restriction is not a negative consideration for using this method.

If we badly needed work processes or structures of different importance, we must use the RPN index [*Risk priority number*] or use a completely different method - such as FMEA method [*Failure Mode and Effect Analysis*].

As it turned out it is very interesting to use in the evaluation of the technical areas for the construction of buildings or to determine the suitability of foundations SWOT method. This method was previously used exclusively in the field of management to assess the status and condition of the company. This method is for use in construction suitable for relatively large range of data that is able to evaluate and also for the ability to interact with different aspects of importance evaluated.

Summary

Using of risk analysis methods is useful as an alternative method for forensic engineering field. Practice has proved that the methods which are designed for management or designed for the others non-technical field can be used also in forensic field very effectively. The risk analysis methods provide additional decision-making forensic tool in the area where doesn´t exist any other relevant instrument.

Acknowledgements

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References

[1] M. Tichý. Risk Control: Analysis and Management. 1st edition.: C.H. Beck, XXVI,. Beck's edition economics, Praha 2006.

[2] K. Kubečka, Methodology for evaluation of structures and buildings in the form of risk analysis, certified metodology, First edition Ostrava, 2010.

[3] J. Fridrich, K. Kubečka, Fire Risk in Relation to BIM, Advanced Materials Research, vol. 899 (2014), pp. 552-555.

[4] K. Kubečka, P. Vlček, D. Kubečková and D. Pieszka, Utilization of Risk Analysis Methods in Decision-Making Process on Fitness of Rehabilitation, Advanced Materials Research, vol. 899 (2014), pp. 568-571.

[5] M. Marschalko, I. Yilmaz, M. Bednárik and K. Kubečka, Variations in the building site categories in the underground mining region of Doubrava (Czech Republic) for land use planning, Engineering Geology. 122 (2011), pp. 169-178.

[6] K. Kubečka, P. Vlček and D. Kubečková, Assessment and Damage for Building Structures Risk Analysis Methods, Advanced Materials Research, vol. 899 (2014), pp. 535-538.

[7] P. Janas, M. Krejsa, Simulation of Structural Reliability direct probabilistic calculation, International conference: „New trends in statics and dynamics of buildings“, Bratislava, 2002.

[8] P. Oravec, Windows in Buildings - Diagnostics of Selected Properties after Time of Using. Advanced Materials Research, vol. 899 (2014), pp. 184 - 187.

[9] B. Hrubá, M. Černíková, L. Kučerová, L. Martiník, The Importance of a Fan Location in the Front Door in Measuring of the Air Permeability by the Blower Door Test, Advanced Materials Research, vol. 649 (2013), pp. 125-128.

Environmental Benefits of Elementary School's Renovation

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Keywords: Building Renovation, Energy Performance, Environment, Life Cycle Assessment, Low-Energy Buildings

Abstract. This paper shows partial results of IEA ECBCS Annex 56 which deals with energy-, economically- and environmentally-efficient renovations of buildings. It describes one of the assessed case studies - renovation of elementary school Kamínky 5 in Brno-Nový Lískovec, Czech Republic into low-energy standard. The school was built in 1987 and renovated in 2009 and 2010. The renovation significantly reduced energy consumption of the school. The energy consumption (heat, electricity) as well as environmental performance (represented by CO_2 emissions, non-renewable and cumulative energy demand) of the school, both before and after the renovation, is described in detail in the paper. Data about the energy consumption are based on audits and financial reports that has been provided by the Borough Office Brno – Nový Lískovec. Data for the environmental assessment are taken from renovation's designs (provided by design office Menhir project s. r. o.) and in-situ inspection.

The Evaluation of Non-Renewable Primary Energy as Part of Energy Performance Certificates

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Keywords: Energy Performance, Primary Energy, Non–Renewable Energy, Energy Carriers

Abstract. The evaluation of non-renewable primary energy expressing the impact of the environment is part of the energy performance certificate. The evaluation is based on factors of primary energy. New buildings or larger modifications of existing buildings must meet the legislative requirements in the Czech Republic, which are consistent with the requirements of the European Union. On the basis of modeling of different energy sources and different number of energy sources for the selected building are set values of non-renewable primary energy.

Emissions of Nanoparticles from Small Combustion Equipment with Regard to the Combustion Mode and Wood Humidity

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Keywords: Nanoparticles, DLPI, Combustion,

Abstract. Contamination of air by solid particles is serious problem for human health and also environment, especially in certain regions of the Czech Republic and Poland. Small particles in nano-sizes are more dangerous than same weight of larger size. Negative effect namely of the solid particles depends on number, specific surface area, respirability and bonding of others substances (e.g. PAH, As, Cd, Zn, Cu etc.) which are higher for smaller (nano-sizes) particles compared to larger one. With the approaching winter, yearly problems with distribution of particles from small combustion equipments arise. The annual emission balance indicate that the proportion of small sources to total air pollution (PAH, dust) is surprisingly expressive [1]. For this reason mentioned above this contribution deals with measuring of amount, and distribution of nanoparticles produced form combustion of wood in small combustion unit.
For combustion test in grave-free stoves were used three samples of wood (wet spruce, dry spruce and raw spruce) and two combustion modes. Nanoparticles from flue gas were characterized by the aperture low-pressure cascade impactor DLPI (separation and weighing of particles in sizes 30 ηm ÷ 10 μm). Wood were combusted in the form of ¼ logs.

Sustainable Construction Technology Based on Building Modules

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Keywords: Sustainable Building Technology, Modular Construction, Structure, Cost, Construction Time

Abstract. The aim of the paper is to demonstrate the widely presented benefits of modular construction as compared with traditional construction method. A case study of family house construction by modular building method and traditional method is used to examine the structural, economic and time indicators of individual construction methods. The results are presented in tabular and graphical outputs and are compared each other in regard to different technological parts of the building. The paper provides the comparison of economic and time indicators resulting from budgets and time schedules of construction that are executed for different variants. Such comparison demonstrates exactly the benefits of modular construction. The building based on building modules consisted of steel bearing structure and enveloped by sandwich panels is adopted as the selected

modular construction technology. The different variant, applied for comparison of modular and traditional construction, is represented by the building with comparable thermo-technical characteristics, constructed by traditional masonry method.

Multi-criteria evaluation of two passive houses in terms of sustainability

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Keywords: Multi-Criteria Evaluation of Buildings, Passive House, Total Delivered Energy, SBToolCZ.

Abstract. Assessment of building objects including the ones which are referred to as passive, is done solely on the basis of the total energy delivered coming from primary non-renewable energy sources but only for the time being when the evaluated building object is utilized.
The article aims to point out the possibility of a multi-criteria evaluation model while comparing two already functioning passive houses, constructed in the same vicinity. The houses are different in each and every aspect. Are constructed from different building materials and both of them do utilize different types of energy required for their operation.

Roof Structure Evaluation in Climatic Chamber Module

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Keywords: Buildings Materials, Roof In Situ Measurements, Laboratory Measurements.

Abstract. The paper focuses on the assembly of equipment in experimental climatic chambers with their respective sample envelopes and fenestration systems, which are involved in a measuring experiment. The prime aim is to design a logical and transparent system for gathering, evaluating and storing hygrothermal related data. This contribution further illustrates the installation of measurement points in test samples, the system of monitoring their physical properties, measurement results of roof system of the climatic chamber module and vapour barrier influence in roof structure on temperature damping phase shift.

Additional Insulation of Detached Dwelling Houses with Straw-bale Elements

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Keywords: Straw-Bale, Refurbishment, Energy Efficiency, Insulation.

Abstract. The paper introduces the planning and construction experiences and development ideas of additional insulation of walls made from straw-bale. The energetic refurbishment of existing building is an important priority in the action plan of the EU dealing with the energy efficiency. The additional insulation of walls reduces significantly the energy demand of building but the effectiveness of the insulation has economic and environmental limits. According to our previous research we introduced that the additional insulation of walls made from straw has significant advantages.

The application of straw-bale insulation has large potential in the case of detached dwelling houses in rural environment. The paper introduces through two ready buildings the most important negative and positive experiences of straw-bale insulation. The paper also makes proposals for the development of the technology.

The use of Probability in Risk Assessment

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Keywords: Forensic Science, Forensic Engineering, Risk, Risk Analysis, Risk Management, Damage, Defect, Failure

Abstract. For a correct interpretation of the results of the risk analysis are necessary correct input data. Acquisition of data can be different. For logical and numerical methods the expert risk analysis can we ensure data through questionnaires. This can serve as questionnaires for experts. Acquisition of data can also be combined with methods for probabilistic analysis.

Condensation of Water Vapour on External Claddings of Prefabricated Apartment Buildings

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Keywords: Building, Cladding, Insulation, Composition, Materials, Condensation.

Abstract. Water vapour can condense in the structure or on its surface. The condensation of steam on the surface of the structure towards the interior cannot lead only to the deterioration of aesthetic properties, but also it can lead to the deterioration of the room habitability especially in terms of health. Therefore, it is necessary that any condensation has been as close to an outdoor area and no-threatening the owner of the apartment. The paper deals with the issue of the condensing zones of external claddings in the selected prefabricated buildings with external thermal insulation composite system (ETICS). The aim of the paper is to demonstrate the influence of the thickness and type of insulation material on the condensation of water vapour.

Introduction

The considerable development of additional contact insulation of blocks of flats built in between 1960 and 1990 was achieved in recent years. The additional insulation is done to reduce the energy intensity of the objects with which the thermal comfort of residents is closely connected. These objects now no longer correspond to standard values of thermal technical requirements [1, 2] such as a temperature factor of the internal surface, heat transfer coefficient or the requirement for humidity diffusion in a construction, which results in a possible condensation in the construction in comparison of the construction time. It is important that any condensation was as far as possible from the inner surface of the structure.

When performing an additional contact insulation is important to select the material and thickness of the insulating material so that the condition of the heat transfer coefficient was met and there has not been water vapour condensation in the structure because with increasing thickness of the insulating material may come to pass the condensation inside an envelope of a building. The beginning of any condensation can nowadays locate using software support, such as software TEPLO [3], in which the following results were calculated and modelled.

The partial pressure of water vapour at the saturation may not achieve a lower value than the value of the partial pressure of water at the same spot of the wall [4]. Otherwise it will cause condensation of water vapour in the structure. This usually happens in the winter.

The following three examples illustrate the problems of condensation in the envelope of the building. Three types of insulators were selected and afterwards assessed - mineral wool (TF Profi), graphite polystyrene (EPS GreyWall), foam polystyrene (EPS 70 F) - with three different thicknesses of insulators - 80 mm, 120 mm, 160 mm- at three different thicknesses of insulator - 80 mm, 120 mm, 160 mm - with three different structural systems implemented in the Ostrava-Karvina region which has over other sites in the Czech Republic its own specific conditions such as the protection of buildings against mining impacts due to underground mining, material reuse, etc.

The Building in the Structural System of T02B-3B

The selected object was implemented in the system T02B-3B and is located in Havirov. The building was built in 1962 and it is a detached residential building consisting of three interconnecting sections when each section includes 4 floors and one basement.

Table 1, 2. Original composition of the envelope of the object and the composition with an insulation.

Material	Thickness [mm]
Internal lime plaster	10
Slag- pumice- concrete panel	300
Outdoor lime-cement plaster	10

Material	Thickness [mm]
Internal lime plaster	10
Slag- pumice- concrete panel	300
Insulation (mineral wool, graphite polystyrene, foam polystyrene)	80 (120, 160)
Outdoor silicone plaster	5

The building in the structural system of OP 1. 11

The selected object was implemented in the OP 1. 11 in Ostrava. The building was built in the 80s of the 20th century. It is an apartment building with 8 floors and an basement.

Table 3, 4. Original composition of the envelope of the object and the composition with an insulation.

Material	Thickness [mm]
Internal lime plaster	10
Reinforced concrete	150
Foam polystyrene	80
Reinforced concrete	70
Outdoor lime-cement plaster	20

Material	Thickness [mm]
Internal lime plaster	10
Reinforced concrete	150
Foam polystyrene	80
Reinforced concrete	70
Insulation (mineral wool, graphite polystyrene, foam polystyrene)	80 (120, 160)
Outdoor silicone plaster	5

The building in the structural system of T02B

The selected object was implemented in the T02B system and is located in Ostrava - Mariánské Hory. The building was built in the late 60s of the 20th century. This is a residential house with 3 floors and one basement.

Table 5, 6. Original composition of the envelope of the object and the composition with an insulation.

Material	Thickness [mm]
Internal lime plaster	10
Hollow brick masonry	300 (375)
Outdoor lime-cement plaster	20

Material	Thickness [mm]
Internal lime plaster	10
Hollow brick masonry	300 (375)
Insulation (mineral wool, graphite polystyrene, foam polystyrene)	80 (120, 160)
Outdoor silicone plaster	5

The boundary conditions of the calculation

Making the calculations the ambient temperatures were entered as follows: For an object implemented in a system T02B-3B, the internal design temperature for the original composition of the envelope θ_{ai} = 22 ° C, in the system OP 1. 11 θ_{ai} = 21 ° C and for an object in the system T02B θ_{ai} = 22 ° C because of the realization of the object. Internal design temperature θ_{ai}= 20 ° C was applied when the calculation was considered with the thermal insulation. For the Ostrava-Karvina region was taken as the value of the outdoor temperature in winter θ_e = -15 ° C.

Evaluation of condensation zones

Individual parameters were evaluated by using a computer program TEPLO [3]. Collected data are presented in the following table.

Table 7. Location of the condensation zone for the systems, the type and thickness of the insulation.

System	Insulation	Condensation zone	
		Left boundary	Right boundary
T02B-3B	No insulation	0.0 m	0.2174 m
T02B-3B	Foam polystyrene – 80 mm	0.39 m	0.39 m
T02B-3B	Foam polystyrene – 120 mm	0.43 m	0.43 m
T02B-3B	Foam polystyrene – 160 mm	0.47 m	0.47 m
T02B-3B	Mineral wool – 80 mm	0.39 m	0.39 m
T02B-3B	Mineral wool – 120 mm	0.43 m	0.43 m
T02B-3B	Mineral wool – 160 mm	0.47 m	0.47 m
T02B-3B	Graphite polystyrene – 80 mm	-	-
T02B-3B	Graphite polystyrene – 120 mm	-	-
T02B-3B	Graphite polystyrene – 160 mm	0.4525 m	0.4525 m
OP 1. 11.	No insulation	0.24 m	0.24 m
OP 1. 11.	Foam polystyrene – 80 mm	-	-
OP 1. 11.	Foam polystyrene – 120 mm	-	-
OP 1. 11.	Foam polystyrene – 160 mm	-	-
OP 1. 11.	Mineral wool – 80 mm	-	-
OP 1. 11.	Mineral wool – 120 mm	-	-
OP 1. 11.	Mineral wool – 160 mm	-	-
OP 1. 11.	Graphite polystyrene – 80 mm	-	-
OP 1. 11.	Graphite polystyrene – 120 mm	-	-
OP 1. 11.	Graphite polystyrene – 160 mm	-	-
T02B	Wall thickness 300 - no insulation	0.0 m	0.2238 m
T02B	Wall thickness 300 - Foam polystyrene – 80 mm	0.3858 m	0.39 m
T02B	Wall thickness 300 - Foam polystyrene – 120 mm	0.4144 m	0.43 m
T02B	Wall thickness 300 - Foam polystyrene – 160 mm	0.4468 m	0.47 m
T02B	Wall thickness 300 – Mineral wool – 80 mm	0.39 m	0.39 m
T02B	Wall thickness 300 – Mineral wool – 120 mm	0.43 m	0.43 m
T02B	Wall thickness 300 – Mineral wool – 160 mm	0.47 m	0.47 m
T02B	Wall thickness 300 – Graphite polystyrene – 80 mm	0.3716 m	0.39 m
T02B	Wall thickness 300 – Graphite polystyrene – 120 mm	0.4040 m	0.4196 m
T02B	Wall thickness 300 – Graphite polystyrene – 160 mm	0.4297 m	0.4525 m
T02B	Wall thickness 375 - no insulation	0.0 m	0.2870 m
T02B	Wall thickness 375 - Foam polystyrene – 80 mm	0.4640 m	0.4650 m
T02B	Wall thickness 375 - Foam polystyrene – 120 mm	0.4952 m	0.5050 m
T02B	Wall thickness 375 - Foam polystyrene – 160 mm	0.5236 m	0.5450 m
T02B	Wall thickness 375 – Mineral wool – 80 mm	0.4650 m	0.4650 m
T02B	Wall thickness 375 – Mineral wool – 120 mm	0.5050 m	0.5050 m
T02B	Wall thickness 375 – Mineral wool – 160 mm	0.5450 m	0.5450 m
T02B	Wall thickness 375 – Graphite polystyrene – 80 mm	0.4527 m	0.4640 m
T02B	Wall thickness 375 – Graphite polystyrene – 120 mm	0.4768 m	0.4952 m
T02B	Wall thickness 375 – Graphite polystyrene – 160 mm	0.5104 m	0.5302 m

The table shows the location of the condensation zone for individual systems and the type and thickness of insulation. The left boundary is the distance from the edge of the inner surface where is the condensation of water vapour. Right border indicates the maximum distance where the water vapour can condense in the structure.

There is not a single condition met on the distribution of moisture in the original state of the system T02B T02B-3B with a wall thickness 300 mm. It is a condition which must be the vaporizable amount of water vapour higher than the condensed amount of water vapour. And another condition is that the annual amount of condensate must be lower than the percentage of the surface density of the material in which the condensation is.

The system T02B with wall thickness of 300 mm and with the mineral wool insulation does not meet the conditions under which the annual amount of condensate is lower than the percentage of the surface density of the material in which condensation occurs. The same condition is not met for the original state of the system OP 1. 11. and the original state of the system T02B with wall thickness of 375 mm.

Conclusion

It was found that the zone of condensation of water vapour thanks to insulation either disappears completely (prefabricated apartment block in the construction OP 1. 11.) or will be moved closer to the exterior into the insulation and its length is significantly reduced. The best material in terms of the condensation zone at three selected panel systems appear to be mineral wool as its condensing zone is always, except for OP 1. 11., on the border with outdoor insulator plaster. Other location of the condensation zone and its size varies according to the thickness and type of insulation and cladding.

Acknowledgment

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References

[1] ČSN 73 0540 – 2 Thermal protection of buildings – Part 2: Requirements. Praha: Český normalizační institut, 2011

[2] ČSN 73 0540 – 4 Thermal protection of buildings – Part 4: Calculation methods. Praha: Český normalizační institut, 2011

[3] Z. Svoboda, TEPLO 2011 for Windows

[4] Information on http://stavba.tzb-info.cz/vlhkost-a-kondenzace-v-konstrukcich/6771-difuzni-tok-a-kondenzace-vodni-pary-v-konstrukci-steny-cast-1-vlhky-vzduch-a-vznik-difuzniho-toku

Humidity and Temperature in Mouldy Homes with Thermal Insulation

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Keywords: Mould, Ventilation, Humidity, Insulation, Moisture Damage, User Behaviour,

Abstract. Aim of this research was to find out, if highly insulated, airtight buildings tend to an increased mould growth. Basis of the valuation was a variety of measures in buildings in Austria. In the recent years moisture respectively mould damages in building constructions increased significantly. The number of dwellings with mould has been growing continuously, in spite of better thermal insulation. Scientifically, many questions of mould in buildings are not sufficient explained yet. The high thermal insulation standard is politically important and ecologically useful for the reduction of energy consumption. If the air tightness of the windows is improved, thermal transmission and ventilation losses can be lowered. The consequences of a lowered air change rate leads to an increased concentration of air pollutant and a raised air humidity. Not only in renovated buildings, a raised air humidity associated with an increased concentration of air pollutant effects mould. It has been noticed in new buildings too. However, the fact that a enhanced inside surface temperature as a result of a increased insulation is contradicts the increase of the mould damages. Correct constructed buildings and user behaviours have to combine in order to keep an apartment free of mould.

Introduction

Moisture damage accompanied by mould growth has especially increased in importance in recent years. The number of homes affected by mould growth continues to rise steadily despite better thermally insulated components. This damage often is the results of several interrelated causes. The main, but not sole cause of mould growth in residences is the presence of moisture, which can be attributed to structural defects or bad user behaviour. The high level of insulation is installed partly due to political commitments to reduce energy consumption and also for environmental considerations. In addition to transmission losses, draughts are reduced by improved window air tightness. As a consequence, the reduced air ex-change leads to an increased concentration of indoor air pollutants and indoor humidity. Mould growth occurs not only in renovated buildings, but also in insulated new construction. However, the presence of increased damage due to mould contradicts the correlation that more insulation and higher indoor surface temperatures lead to a reduction in mould growth. Due to the large number of homes with mould, it can be concluded that there is an increase in damage caused by mould in insulated housing. Measures must be taken during construction, and user behaviour during occupancy must work together to keep a home mould free.

Humidity and Temperature Measurements in Living Spaces

This paper includes the preliminary results as the investigation is ongoing and will take several years until completion. A study was sought to have a broad overview of mould infestation simultaneously in multiple living spaces. This study includes measurements taken from actual conditions in populated areas to understand the resulting damage. The data is focuses upon the problem of mould stains in rooms and buildings that are naturally ventilated through windows and doors. In many cases, where mould is detected, multiple sources act together, and a clear separation between the different causes is impossible. The usual solution is often not justified and carried out with insufficient examination into the cause. A damage assessment must consider the construction

material, its installation during construction, and the occupant's behaviour. Only by making an investigation using humid-thermal measurements can it be objectively determined. Errors made during construction such as improper installation and user influences are much more noticeable than before due to the advancements in the thermal insulation standard and increasing building air tightness. Previously, excess humidity could be released to the exterior through cracks around poorly sealed components (windows, doors). The purpose of this study is to illustrate the extent and causes of mould in residences. All types of apartments, including both existing and new developments were studied (Fig. 1). The analyzed apartments had low occupancy. With fewer people per dwelling, high humidity levels are naturally not expected. The studied homes are typically furnished. 182 apartment buildings with 182 apartments were investigated and detailed measurements were taken. Mould was found both locally and covering large surfaces (Fig. 1).

Figure 1. Two investigated homes.

For the investigations, the ambient temperature, relative humidity, surface temperature, and dew point were measured in multiple buildings for the minimum duration of two weeks along with the accompanying theoretical investigations. Occupants were not informed about the measurement parameters before the measurement period. The investigations of heating, ventilation and use patterns could therefore be recorded on the spot. An important objective of this study is to measure and record the behaviour of people in the real world. The mould formations are not uniformly distributed in the investigated homes. Mould growth most typically occurred in the bedroom (approximately 40 %). In the living room, the incidence of mould growth is about 20 % less. In the kitchen, mould frequency was 15 %. In the children's bedrooms and other rooms, the mould growth frequency is about 15 %; and in the bathroom is about 10 %. The ambient temperature, relative humidity, surface temperature, and dew point temperature were determined from the measurements (see Fig. 2). It is clearly seen how long and when the rooms were aired. Many apartment users know very little about the causes of mould growth, and suspect that by ventilating through open windows for 5 minutes a lot of heat will be lost. Tenants opened their windows very rarely for longer than recommended. In the measurements carried out in the 182 dwellings, the factors were analyzed which could have led to the mould growth. The results show that mould growth caused by users is mainly due to lack of ventilation. In this study, mould damage caused by rising damp was of minor importance, since such losses are mainly related to the apartments on the ground floor.

Moisture Balance of a Room

The moisture balance of a room can be shown (not used in analysis) using a simple model. The relative humidity in a room under steady state conditions can be determined using a balanced approach. The amount of humidity in a room depends on the amount of vapour produced m_{pr}, (e.g. by breathing, cooking, drying clothes, potted plants, etc.), the amount contained of condensation in the outside air m_{ou}, and the humidity by ventilation released to the outside m_{ve}. The balanced method is performed for a specific period, usually for an hour. Therefore, it is advisable to work not

only with measured values of relative humidity, but also with calculated humidity values from the moisture balance. The water vapour that diffuses through the components, the water vapour from installation, and moisture within components are neglected in such calculations. This makes it clear that air exchange in the form of intentional ventilation, can have a much larger influence on the transport of water vapour than by diffusion or absorption of moisture through building components [4]. The amount of water vapour released through ventilation is calculated with the following equation (1).

$$m_{ve\ per\ hour} = n \cdot V_{Room} \cdot f_i \quad (1)$$

n - Number of air changes per hour in $1 \cdot h^{-1}$

V_{Room} - Air volume of the room in m^3

f_i - absolute humidity of indoor air in $g \cdot m^{-3}$

The amount of supplied water vapour can be obtained from the following equation:

$$m_{ou\ per\ hour} = n \cdot V_{Room} \cdot f_e \quad (2)$$

f_e - absolute humidity of outside air in $g \cdot m^{-3}$

The three moisture flows m_{ve}, m_{ou} and m_{pr} are interrelated through the following mass flow balance:

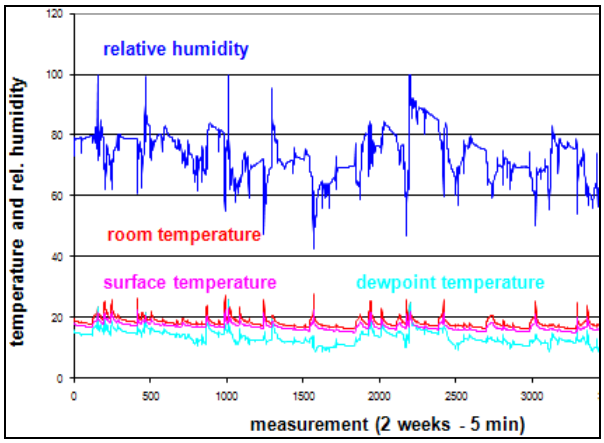
$$m_{ve} = m_{ou} + m_{pr} \quad (3)$$

Substituting the equations for m_{ve} (1), m_{ou} (2) gives:

$$n \cdot V_{Room} \cdot f_i = n \cdot V_{Room} \cdot f_e + m_{pr} \quad (4)$$

This results in the possibility to determine the self-adjusted absolute indoor humidity f_i:

$$f_i = f_e + m_{pr} / n \cdot V_{Room} \quad (5)$$



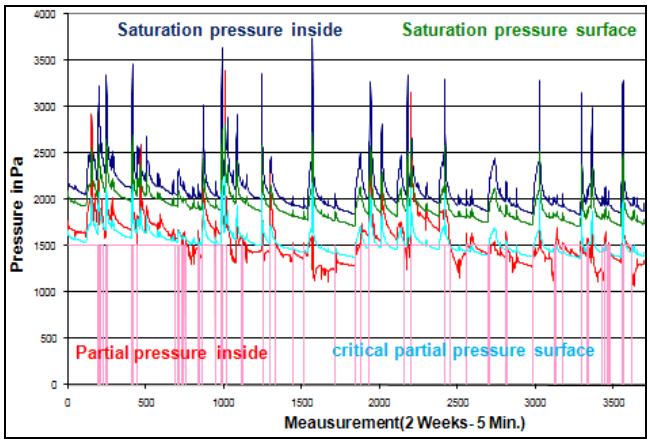
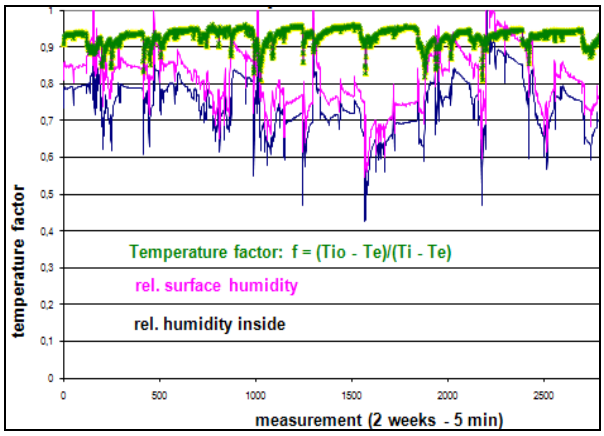


Figure 2. (left) Measured air temperature, relative humidity, surface temperature, dew point temperature (one dwelling).
Figure 3. (right) Calculated partial pressures from measured - parameters (one dwelling).



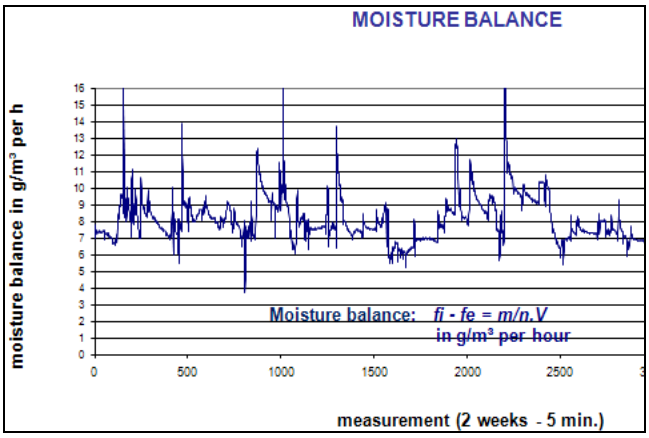


Figure 4: Calculated temperature and humidity factor from measured parameters (one dwelling).
Figure 5: Moisture production in $g \cdot m^{-3}$ per hour (one dwelling).

In these equations, the quantity of produced water vapour, m_{pr}, and ventilation rate are unknown. These two parameters show the dependence between moisture production and ventilation. This ratio means: "If a large quantity of moisture is produced, (m_{pr}), a large quantity must also be discharged, (n), and vice versa."

Correct Ventilation and Heating Behaviours

Natural ventilation in residential properties continues to decrease. The fact is that in recent times well sealed windows are being installed for purposes of energy conservation in new and existing buildings. Thus, the gaps which acted as moisture paths between joints are sealed. This increases humidity in the home, bringing with it the consequential condensation and mould growth. The reduction of ventilation heat loss is desirable but unfavourable as it increases humidity, and the required minimum air exchange is often not reached. The moisture is trapped in the room causing the level of indoor humidity to rise which easily leads to condensation and mould growth. The moisture load may be limited through proper ventilation and heating. Correct ventilation can be achieved by fully opening windows for short periods of time to allow for complete air exchange. The resident can then find that mould cannot find favourable growing conditions in the apartment. Using window ventilation, the warm moist air flows out and cold dry air comes in from the outside. [1].The main purpose of ventilation is to reduce humidity. It seems that habitual airing by opening windows is burdensome and difficult for the resident. Many occupants do not trust that ventilation is necessary even at low outdoor temperatures, and believe that a lot of heat is lost by airing. By transverse ventilation or fully opening windows for short periods of time, the warm air that is exhausted. The air actually contains a small amount of heat, because the heat is stored in the thermal mass of the building components.

Domestic Hygiene and Growth Media for Moulds

Moulds are a natural part of our environment and therefore, also exist in building interiors. Mould spores range in size from 3 to 20 microns. Their small size allows the spores to be inhaled and float in the air over long distances when blown in the wind [2]. Indoor mould growth is mainly determined by three factors: humidity, temperature and availability of a growth medium [2]. In addition to humidity and temperature, the nutrients for mould growth are of particular importance. Moulds may also grow on materials that contain no nutrients if they have organic particles and dust from the air on their surfaces. Therefore, it is very important to have complete home hygiene against mould growth. Even though favourable temperatures for mould growth usually exist in damp unheated basements, it is relatively rare for mould to appear. In the cellar, the concentration of airborne organic particles and dust is much lower than the concentration in apartments, and thus

basement environments lack the nutrients for mould. This assertion can easily be confirmed by the comparison of basements in buildings with mouldy apartments. Moulds are the result of the decomposition of organic material and thus are more readily available in an apartment than in a basement.

Outlook and Conclusion

The occupant may minimize favourable growing conditions for mould in an apartment by their behaviour. Moisture may be limited in the apartment by proper ventilation and heating. The relative humidity of the air in the apartment should not exceed 70-75 % for prolonged periods of time [3]. The better the insulation of a building, the more unfavourable is the ratio of the ventilation heat losses to the total heat loss. Thus, it is worth little to reduce the U-value of the building below the required values for new buildings without decisively minimizing ventilation heat loss at the same time. Overall, the natural ventilation rate has become much lower due to the improved tightness of the building envelope, especially windows. Total heat losses are not allowed to be reduced by minimizing ventilation. For hygienic reasons, the air change rate cannot fall below 0.5 /h Preventative measures should be taken to avoid mould damage to health and the building construction. This should be ensured through proper construction and limited moisture exposure. Planning, proper execution, and continuous maintenance during occupancy can ensure that the causes are minimized. The moisture load limitation is currently left up to the residents. With sufficient air exchange, relative humidity within a room can be maintained at a level where no condensation forms or already existing condensation dries out. When the occupant does not air the apartment frequently enough, the existing humidity cannot be released to the outdoors, and the resident is mostly to blame for mould formation. It follows that the air change rate must change according to the moisture content in the indoor air. This can be done using ventilation with humidity-based controls. By installing a ventilation system with a humidity monitor, humidity levels in homes can be controlled by simple means without increased heat loss. Rational energy use should never be ignored.

References

[1] A. Antonyova, A. Korjenic, P. Antony, S. Korjenic, E. Pavlusova, M. Pavlus, T. Bednar: "Hygrothermal properties of building envelopes: Reliability of the effectiveness of energy saving"; Energy and Buildings, 2013

[2] Lietfaden zur Vorbeugung, Untersuchung, Bewertung und Sanierung von Schimmelpilzwachstum in Innenräumen, Erstellt durch die Innenraumluft - Hygienekommission des Umweltbundesamtes Vorsitz: Dr. Bernd Seifert, Umweltbundesamt 2002 Berlin

[3] U. Jaroch, Institut für angewandte Bauphysik, Physik am Bau, Hermsdorf : Feuchtigkeit in Gebäuden – Ursachen und Nachweisverfahren

[4] J. Drayer, Institut für Hochbau und Technologie, TU Wien: Bauphysikalische Schadenprozesse

[5] E. Litavcova, A. Korjenic, S. Korjenic, M. Pavlus, I. Sarhadov, J. Seman, T. Bednar: "Diffusion of moisture into building materials: A model for moisture transport"; Energy and Buildings, 2014

The Analysis of the Humidity Transit through Wood Wall Depending on the Quality and Performance of the Diffusion Retarder

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Keywords: Transition of the Water Steam, Diffusive Closed Circumferential Wall, Diffusion Retarder, Humidity Probe, Temperature-humidity Sensor

Abstract. The research is going to be focused on the comparison of the transport of the moisture by composition of two diffusive different types of circumferential walls of the wooden house. The first wall is the diffusive closed wall and the second wall is the diffusive opened wall. The measurement of the diffusion of the moisture with proper and improper realization of the diffusion retarder is going to be under way in these walls. The measured values of humidity probes are going to be used for the comparison. These humidity probes are going to be located in the place of a wooden post and in the field between the posts and the temperature-humidity sensors that are going to be installed only in the field between the posts. The probes and the sensors are realized in the diffusive opened wall from earlier research [1].

Introduction

The humidity is one of the most important factors that have an influence over the indoor environment. The moisture transport through the wooden wall is very significant for the efficiency and durability of the load bearing wooden wall.

In the internal environment of building there is an air humidity with which is needed to deal for the draft of a building envelope. In the draft of diffusive closed system there is a diffusion retarder which transmits air humidity in a certain amount but in diffusive opened system there is diffusion retarder which doesn't transmit air humidity and the question which type of barrier for the transmission humidity is on the structural engineer.

The full-scale test house for the research

The data for this research are going to be acquired from the experimental wooden house EXDR1 (Fig. 1), located in the south-east of Czech Republic in a city called Brno. The test house was constructed for monitoring of the wooden construction. To regulate internal conditions (temperature, relative humidity, pressure change) the experimental wooden house is equipped with technical equipment such as ultrasonic humidifier, electrical heaters with heat dirty socket for automatic control of heating and electric axial fan with external supply / exhaust air on the façade [2].

The walls, which are going to be focused on the comparison of the transport of the moisture by composition of two diffusive different types of circumferential walls of the wooden house, are designed as a diffusive closed and a diffusive opened.

Figure 1. The experimental wooden house EXDR1 and its insulation of façade.

Figure 1 shows the building insulation for different types of walls. On the first floor, which is designed as diffusive closed construction, is used on the exterior side the polystyrene and the second floor is constructed from the diffusive opened mineral wool.

The measurement is going to take place on the wall E3 with the diffusive closed composition and on the wall E5 with the diffusive opened composition (Fig. 2). The wall E3 is located on the first floor and the wall E5 on the second floor, both at the entrance to each floor and two above him.

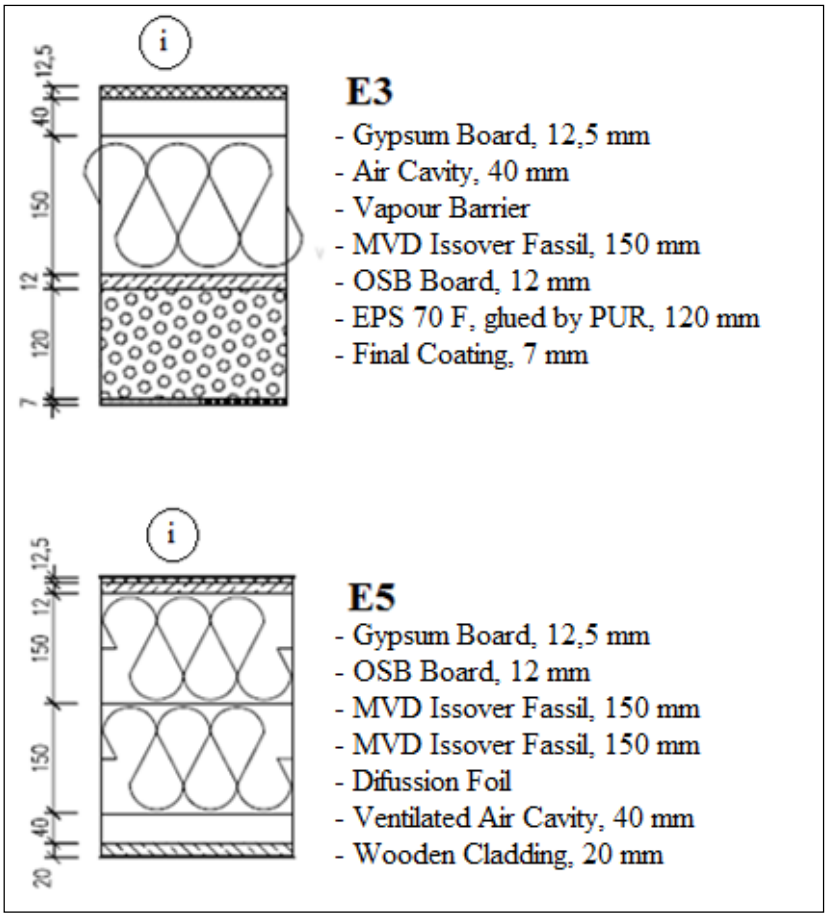

Figure 2. The wall's composition.

On the first floor (in the wall E3) the ELBEZ probes with temperature compensation WS-16 / T for the measuring wood moisture [3] and the BRESET – HONEYWELL HIH6131 sensors which

measure the humidity and the temperature [4] are installed from previous research and therefore are fully prepared for the measurement but the same probes and sensors are going to be installed in the wall E5 on the second floor. The placement for probes and sensors in the wall E5 would be the same as the wall E3, the probes are placed at the post and the sensors in the field between the posts (Fig. 3).

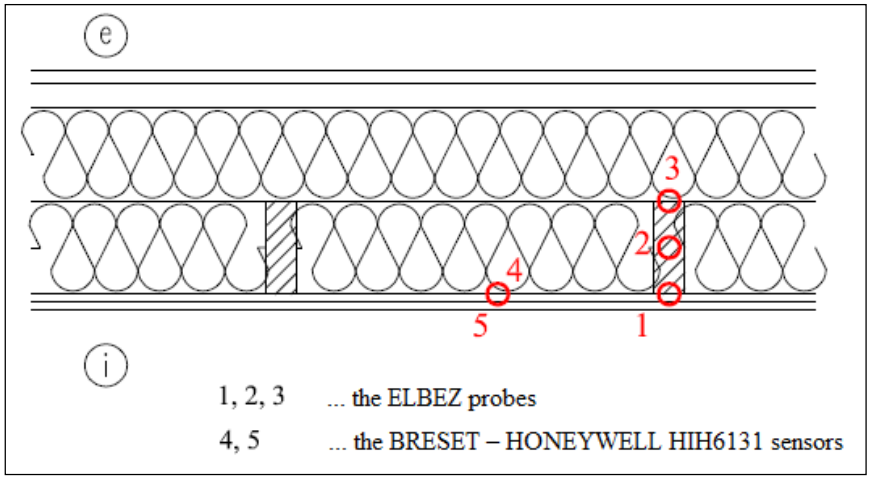

Figure 3. The placement of the probes and the sensors in the diffusive open wall E5.

Diffusion retarders – the vapor barrier for diffusive closed wall and the OSB board for diffusive opened wall – are going to be properly performed on one part of the wall and on the another part of the wall (rest of the wall) diffusion retarders are going to be poorly performed. The proper realization of the OSB board is going to made with close connections OSB boards or sealed joints and it is going to be located over two fields and improper realization of the OSB board is going to be without taped. Properly implemented diffusion retarder is going to be in the rest of the wall and in the place where the probes are going to be placed there is going to be made the leaking diffusion retarder. The process of the implementation diffusion retarder is going to be the same as the wall with vapor barrier which is implemented (the diffusive closed wall).

Figure 4. The realized placement of the probes in the wall E3.

Measurements are going to be performed in the regulation of the internal environment to match the already ongoing measurement of the diffusion of the water vapor:

– the temperature is sets for the normal use in the interval 20-22 ° C,

- parameters of relative humidity during the measurement are going to reflect variations interior boundary conditions in residential buildings: 30 % - dry air , 50% - living room , 80 % - bathroom,
- comparison of water vapor diffusion in two distinct types of exterior walls wooden houses (diffusion and diffusion- closed piece wooden walls),
- The analysis of the impact of ventilation - natural or artificial (HVAC),
- The comparison of moisture transport in the correct and incorrect implementation of the diffusion retarder - a vapor barrier (foil) in diffuse closed wall and vapor barrier (OSB board) for diffuse closed wall.

In this experimental analysis there is also going to be monitored phase shift vapor diffusion for both types of structures.

It is necessity suppose that the normal or regulated internal condition could be influenced by an external wall envelope. The external wall envelope (it is meant mainly insulation) isn´t absolutely airtight. The airtightness of wooden walls is about 0,8 h^{-1}.

An influence of the external condition is represented on figure 5.

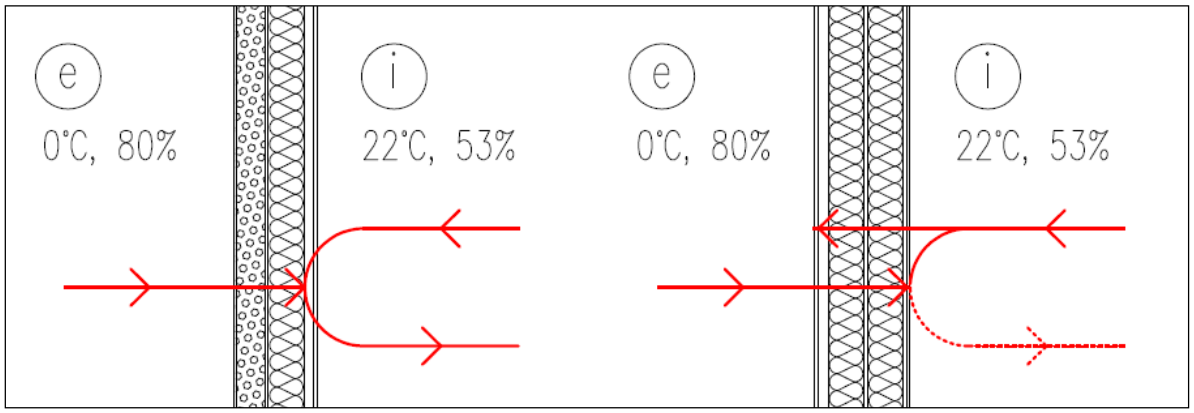

Figure 5. The moisture transport through wooden walls (first wall – diffusive closed, second wall – diffusive opened). [2]

Conclusion

The significant effect on the diffusion of water vapor has an airtight implementation of the wooden walls and that in the entire of the profile (the resistance to climatic conditions in the construction of the wooden wall).

Acknowledgment

The paper was supported by the following research project FAST-J-14-2404.

References

[1] M. Uvizlová, T. Bečkovská, The transition of the water steam through the composition of the diffusive closed circumferential wall of the wooden house with the proper and improper realization of vapor barrier, Advanced Materials Research 899 (2014). Switzerland: Trans Tech Publications, 2014.

[2] Information on http://www.upst.cz/

[3] Information on http://www.elbez.cz

[4] Information on http://honeywell.com

Thermal and Technical Evaluation of Details of Wooden Buildings which are Established Over an Air Gap

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Keywords: Air Gap, Crawl Space, Foundation Engineering

Abstract. Foundation of the low-energy house and passive house is important not only for statics but also in thermal technical aspect. Wooden buildings are susceptible to faults resulting from increased humidity, so it is essential to emphasize the details of construction. The article deals with the setting up of wooden buildings over an air gap - Crawl Space. This foundation is used in American countries and we want to verify using in climatic condition of the Czech Republic. This method of establishment has advantages such as ventilation of water vapor and accessible technical networks. In this paper there are designed several details of foundation. These models differ mainly in the height of the air gap and the type of the substructure. Construction details are analyzed and evaluated in available software. Main parameter for evaluation is thermal technical aspect.

Introduction

Demands on the energy performance of buildings [1], which is also influenced by the quality of the foundation of the building, are still increased. Wooden structures are possible to establish in the traditional way, or using the air gap without direct contact with the soil [2].

Establishment of wooden structures with crawl space level from a technical point of view brings certain advantages. These include some possibility of control and easier repairing technical distribution, which led to the house, there is a possibility of ventilation water vapor and radon [3,4]. The basement of floor construction is designed wooden frame, which saves concrete and limited wet processes [3]. For this reason are construction wooden structures even faster.

Air gap height should be at least 600 mm, preferably 900 mm [4]. In the air gap is air temperature corresponding approximately to the outside air. For this reason, it is necessary to ensure the technical solution of the floor. It is also necessary to deal with a solution that would avoid increasing air humidity in the crawl space or water vapor in the floor structure. If the base structure made using strip foundations, then suggest sufficiently large venting holes to seal out the cold [3].

Wooden family house in the village Kramolna (region Náchod) is based above the ground using the footings with dimensions 500 x 500 mm. The air gap between the ground floor and the ground and has a range of 350 to 750 mm (from north to south). The supporting structure of the house is built by the system STEICO with supporting wooden pillars in size 140 x 140 mm. On the load-bearing wall were used beams STEICO wall SW45 and the supporting joist floor construction STEICO joist SJ60. Thermal insulation of the whole house will be done using blown insulation CLIMATIZER Plus, which is made from natural cellulose fibers. Circumferential wall of the house has two kinds of finishes from the outside - wooden siding and a clay plaster. Compositions circumferential walls and floor are shown in Table 1 and 2.

Table 1. The composition floor from the interior.

Material	thickness [mm]
Linoleum	4
Mirelon	2
OSB board 3 SUPERFINISH ECO	18
OSB board 3 SUPERFINISH ECO	25
beams STEICO joist SJ60 + Thermal insulation CLIMATIZER Plus	300
OSB board 3	12

Table 2. The composition external walls from the interior.

Material (wall 1)	thickness [mm]
Clay plaster	10
OSB board 3 SUPERFINISH ECO	18
beams STEICO wall SW45 + thermal insulation CLIMATIZER Plus	300
Diffusion foil JUTADACH 115	-
Wooden siding	19

Material (wall 2)	thickness [mm]
Clay plaster	10
OSB board 3 SUPERFINISH ECO	18
beams STEICO wall SW45 + thermal insulation CLIMATIZER Plus	300
OSB board 3 SUPERFINISH ECO perforated	18
Reed mat	-
Clay plaster	30

As regards the details of the lower corner listed here two solutions which differ in surface finish of circumferential wall, the height of the air gap and the guidance of cut for details on the floor. Detail no. 1 is the air gap 350 mm high, with wooden siding the peripheral wall (wall 1) and a sectional view running parallel to the floor beams STEICO deposition. Detail no. 2 with an air gap, which having a variable height in the range from 750 to 350 mm, with clay plaster on wall (wall 2). The cut perpendicular to the beams STEICO. Wiring details are shown Fig. 1.

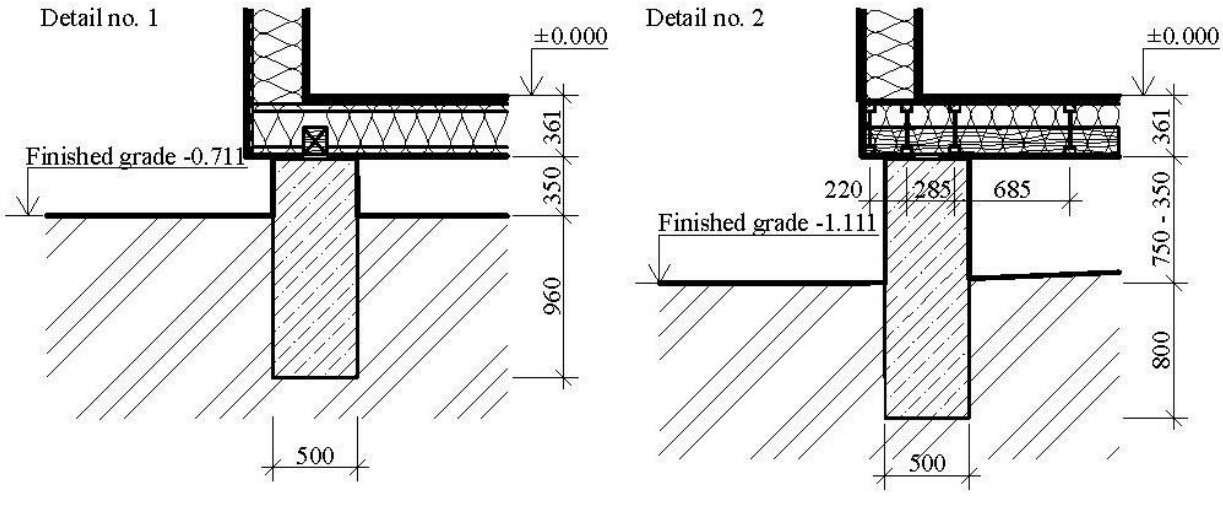

Figure 1. Schemes of solved details.

Heat-Technical Assessment of the Structures in the Software

Each house construction must be comply with the requirements specified ČSN 73 0540-2 [5]. These requirements include the heat transfer coefficient and the condensation of water vapor, on which also were assessed walls and floor of the house using software Teplo 2011.

Boundary conditions for the assessment of structures in the program according to ČSN 730540 - 3 [6] are: design internal temperature θ_i = 20 °C, Internal air temperature θ_{ai} = 20.6 °C is design internal temperature increased by a surcharge according to Table [6], the design external temperature in winter θ_e = -17 °C (region Náchod), internal resistance of heat transfer of the building wall construction R_{si} = 0.13 $m^2 \cdot K^1 \cdot W^{-1}$, external resistance of heat transfer of the building floor construction R_{si} = 0.17 $m^2 \cdot K \cdot W^{-1}$, resisting transfer to the outside of the building structure R_{se} = 0.04 $m^2 \cdot K \cdot W^{-1}$.

The heat thermal transmittance must satisfy the condition [5]:

$$U \leq U_N \ [W \cdot m^{-2} K^{-1}] \quad (1)$$

Where:

U_N $[W \cdot m^{-2} K^{-1}]$ – is the required heat thermal transmittance

U $[W \cdot m^{-2} K^{-1}]$ - is the heat thermal transmittance

Assessment of condensation of water vapor, where for building structure comprising wood element is determined by the condition [5]:

$$M_c = 0 \ [kg \cdot m^{-2} a^{-1}] \quad (2)$$

Where:

M_c $[kg \cdot m^{-2}]$ - the annual amount of condensed water vapor

Assessment 2D temperature field was done in Area 2011. Details differ only in the air gap height and depth of establishing the foundation structure. Type of the foundation structure of this assessment is not affected. In the modeling situations with the same boundary conditions, the forms height of the air gap does not affect the temperature in the inner corner.

The boundary conditions corresponding to the climatic conditions in the Czech Republic. Detail was been modeled in the Area 2011 software. According to ČSN 73 0540 - 3 [6] boundary conditions are: design internal temperature θ_i = 20 °C, internal air temperature θ_{ai} = 20.6 °C, the design external temperature in winter θ_e = - 17 °C (region Náchod), external temperature in winter in the soil θ_e = + 5 °C is located at a depth of 3 m below finished grade, resistance to transfer to the inside of the building structure R_{si} = 0.25 $m^2 \cdot K \cdot W^{-1}$, resistance to transfer to the outdoor of the building structure R_{se} = 0.04 $m^2 \cdot K \cdot W^{-1}$, resistance in soil R_{se} = 0 $m^2 \cdot K \cdot W^{-1}$.

The assessment and evaluation of detail was performed according to requirements ČSN 73 0540 - 2 [5].

$$f_{Rsi} > f_{Rsi,N} \ [\ -\ ] \quad (3)$$

Where:

$f_{Rsi,N}$ [-] – is lowest required temperature factor of the inner surface

f_{Rsi} [-] – is determined temperature factor of the inner surface

Summary

The results of the evaluation according to requirements ČSN 730540 - 2 [5] are shown in Table 3 and 4. M_{ev} [kg·m^{-2}rok^{-1}] is the annual amount of the evaporated water vapor.

Table 3. Evaluation of the construction of the software Teplo 2011.

Name construction	Determined value U [W·m^{-2}K^{-1}]	Required value U_N [W·m^{-2}K^{-1}]	Evaluation $U \leq U_N$	M_c [kg·m^{-2}rok^{-1}]	$M_c < M_{ev}$ [kg·m^{-2}rok^{-1}]
Wall 1	0.13	0.30	fulfilled	0.257	0.257 < 0.593
Wall 2	0.13	0.30	fulfilled	0.026	0.026 < 3.765
Floor	0.13	0.24	fulfilled	0.002	0.002 < 2.810

Table 4. Evaluation of details of the software Area 2011.

Name	The temperature factor of the inner surface f_{Rsi} [-]	Required lowest temperature factor $f_{Rsi,N}$ [-]	Evaluation $f_{Rsi} > f_{Rsi,N}$
Detail no. 1	0.896	0.760	Fulfilled
Detail no. 2	0.902	0.760	Fulfilled

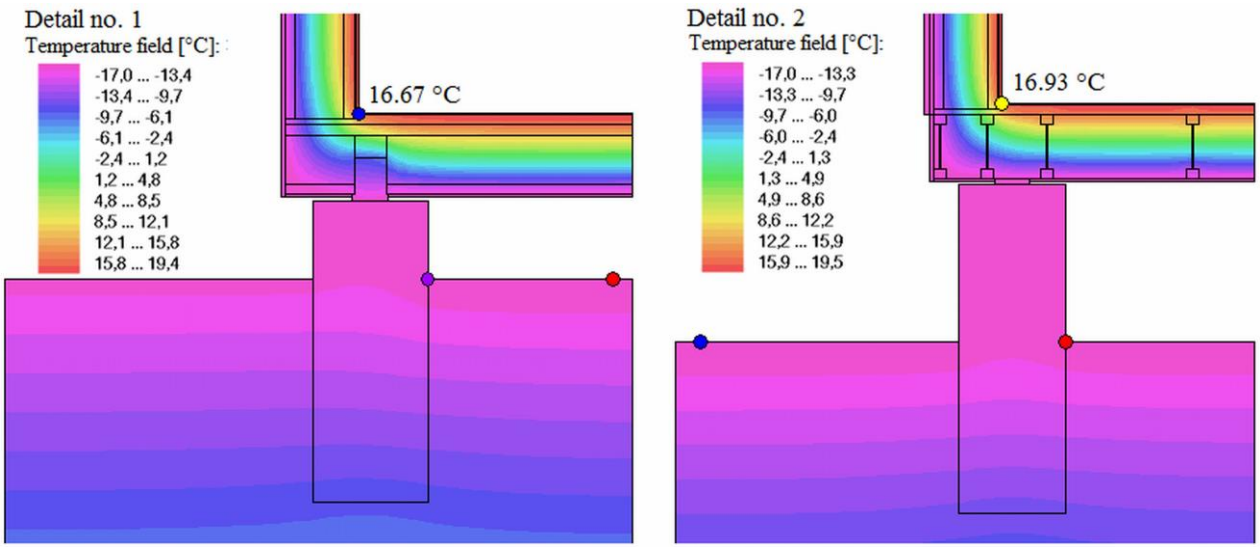

Figure 2. Illustration temperatures process, software Area 2011.

According to the assessment using Teplo 2011 software in the wall with wooden siding (wall 1) occurs condensation of water vapor. It is necessary to verify this effect in actually measurement and using eventual measure. The second wall (wall 2) has to contain perforated OSB board with very low diffusion resistance to protect wall from condensation. This OSB board is located closer to the outer side of the wall.

For more information about the temperature and humidity in the Crawl Space is a necessary long-term measurement and evaluation which is our future work.

Acknowledgment

The work was supported by the Student Grant Competition VSB-TUO. Project registration number is SGS SP2014/167.

References

[1] Directive of the European Parliament and of the Council 2010/31/EU on the energy performance of buildings

[2] Information on http://www.drevostavby-usa.cz/domy-na-klic/

[3] Information on http://www.prirodnibydleni.cz/crawl-space/

[4] J. Šála, J. Smola, Foundation of wooden structures above aired crawl space, in: Thermal protecting of buildings no.3, CZB - Cech for thermal insulation of buildings, Prague, 2013, pp. 49-52.

[5] ČSN 73 0540 – 2, Thermal protecting of buildings – part 2: Requirements, The Office for Standards, Metrology and Testing, Prague, 2011, including changes Z1: 2012.

[6] ČSN 73 0540 – 3, Thermal protecting of buildings – part 3: Design value quantities, The Office for Standards, Metrology and Testing, Prague, 2005.

Analysis of the Icelandic Modified Pitched Green Roof

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Keywords: Pitched Green Roof, Ventilated Air Gap, Unventilated Air Gap, Turf, Condensation

Abstract. In Iceland appears historically proven construction of the pitched green roof. The material composition and methods of technological implementation create a unique comprehensive bond, which is resistant to frequent changes and fluctuations of the extreme climate conditions. Nowadays, the design of the construction is not being further developed, it does not use modern construction methods, knowledge, materials and also the construction does not meet the requirements of the building legislation in the European Union and in the Czech Republic.

The article is an analysis of structural and material design of the original concept of the pitched turf roof originated from Iceland and particularly the theoretical design solution its modernized modification, which is adapted to suit the requirements of the building codes and laws in the European Union and in the Czech Republic. Another discussed problem is the assessment of the impacts of climate phenomena and its effect on the overall stability and behaviour of building physics of the roof structure and the individual layers captures possible utilization of this construction. The grass mats that create the casing of the pitched green roof affect the physical behaviour of the structure, which is discussed on a theoretical basis.

Research of the Temperature Field Process in the Soil for a Home - Founded on a Foam Glass Granulate

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Keywords: founding passive houses, foam glass, simulation of a temperature field.

Abstract. Foam glass granulate is environmentally friendly, heat-insulating building material which is made from recycled glass waste. It is a very porous material with low density, with good thermal insulation properties, high static load capacity and almost zero water absorption. The paper deals with the research of the temperature field process in the soil under the floor of a passive house built on a reinforced concrete slab foundation with a layer of compacted subsoil using raw materials friendly to the environment in the form of granules of foamed glass. This method of progressive foundation of the building addresses the elimination of thermal bridges at the base and establish a continuous thermal insulating of the building envelope without thermal bridges.

The Presence of Microscopic Algae and Funguses on the Facades of Buildings Equipped with Thermal Insulation Composite System (ETICS)

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Keywords: Biotic Attack, ETICS, Degradation, Algae, Fungi, Green Facade

Abstract. In the last decade we have been confronted with problems with biotic infestation of facades in engineering practice. The presence of microscopic algae and funguses on the facades of thermal insulation buildings distorts the appearance of buildings with green, brown or black coating. The reason for biotic pests beginning to appear on the facades of buildings very often is mainly the enlargement of thickness of thermal insulator ETICS. Thanks to the thermal insulation of facades with large thickness less thermal energy penetrates into the surface or plaster surface. The outer side is warmed up less and therefore it has lower outer surface temperature. Lower outer surface temperatures enable hypothermia of the surface of facades. The hypothermia of facades appears especially at night. The resulting aqueous film is the basic source of the necessary damp needed for the life of algae and funguses on facades of buildings. The presence of damp on the outer surfaces rises significantly depending on the better thermal insulation of walls.

Measurement and CFD Simulation of Wind-Driven Rain Using Eulerian Multiphase Model

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Keywords: Wind-Driven Rain, CFD, Precipitation, Rainfall, Measurement, Eulerian Multiphase Model

Abstract. This paper deals with measurements of wind-driven rain intensity in Meteorological garden of Slovak Hydrometeorological Institute and subsequent modelling of free standing wind-driven rain gauge in OpenFoam CFD simulation tool using Eulerian multiphase model instead of common used Langrangian particle tracking model.

Hygrothermal Loads of Building Components in Bathroom of Dwellings

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Keywords: Bathroom, Hygrothermal Assessment, Moisture

Abstract. The paper presents an analysis of indoor temperature and relative humidity measurements in dwelling's bathroom. Obtained data are compared with those defined in technical standards and applied for assessment of building component from building physics point of view. These parameters are used for boundary condition at the evaluation level of building components and their values have significant influence on hygrothermal assessment. The example of building's component demonstrates analysis magnitude of differences between the calculation results applying standardized boundaries condition and monitored data based on in-situ measurements. Temperature and humidity measurements are applied for prediction of hygrothermal behaviour of building's component by HAM algorithm. Finally, results from analysis presents the penetration depth of moisture increasing at surface caused by moisture peaks in internal environment of bathroom.

Hygrothermal Assessment of Timber Elements in Truss with Above-rafter Thermal Insulation

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Keywords: Equilibrium Moisture Content, Truss with Above-rafter Thermal Insulation, Roof Overhang, Hailwood-Horrobin Equation, Cube3D, Wood Moisture Measuring, Resistance Method.

Abstract. This paper focuses on the analysis of the roof overhang detail performed by using rafter within above-rafter thermal insulation system. Close attention is paid especially to course of temperatures and the moisture condition of the rafter which goes continuously through the building envelope from interior to exterior. Both simplified thermo-technical calculations results and the results from long-term experimental measuring performed on a real building are presented and compared here.

Transient Numerical Simulation of Linear Thermal Transmittance in Software CalA

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Keywords: Transient Numerical Simulation; Linear Thermal Transmittance; Software CalA

Abstract. Calculation of heat losses of buildings according to European standard EN ISO 10211 and Czech standard ČSN 73 0540 is simplified to one-dimensional time-steady heat conduction through the building construction in direction of the largest temperature gradient. This simplification of the calculation is incorrect in case of complex geometry. Calculation according to norm takes into account this inaccuracy and uses Linear Thermal Transmittance in 2D geometry or Point Thermal Transmittance in the 3D geometry as a calculation correction. This contribution is focused on detailed calculation of linear thermal transmittance in case of contact external peripheral wall and plastic window frame. Results of two-dimensional transient numerical simulation show unsteady linear thermal transmittance in time and dependence on solar radiation. All of these variable boundary conditions can be easily simulated in the software CalA as well as complex geometry.

Comparison of Approximate Soil Thermal Conductivity Calculations with Laboratory Measurements and New Estimation Methods for Sandy Clayey Silt

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Keywords: Thermal Conductivity, Soil Thermal Properties, Hygrothermal Performance, Thermal Conductivity Estimation, Building Physics, Soil Mechanics

Abstract. In this paper, the most common approximate thermal conductivity calculation methods were compared through Hungarian soil samples with laboratory measurement results and the representative values of EN ISO 13370:2007. Based on the results, the soil's thermal conductivity can be estimated using the modified Johansen method for higher sand containing samples, and de Vries's method for the high silt and clay containing samples. In the light of the test results, two new methods were developed, which can be used for sandy clay silt samples. These gave almost identical results compared to the measured values and were also more accurate than the other estimations in the analysed situations.

Design Properties of Log Walls with Respect to Building Physics

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Keywords: Massive Log Wood, Temperature Fields, Surface Temperature, Thermally Insulating Material.

Abstract. The paper deals with the construction of walls of log wood houses of Canadian type in terms of thermal insulation, with the focus shifted onto the comparison of alternative structural solutions of such walls. The main aim of the research done was to assess the different Canadian type massive log wood walls, with various thermally insulating materials placed between the logs. The computer simulations of wall models did include a Final Element Method analysis in ANSYS software. Massive wooden walls unfortunately do hardly meet today's ever increasing requirements given for thermal resistance, heat conductivity and heat losses of a building, since the bed joints are weakened and also because of the thermal conductivity of wood itself. Thus, mainly the contact surface temperature was observed, which also became one of the evaluation factors describing the quality of construction. The main benefits of the paper is the list of surface temperatures (within the joint and on the logs) coming from simulations of joint solutions and insulating materials.

Experimentally Measured Boundary and Initial Conditions for Simulations

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Keywords: Water Profile, Air Temperature, Relative Humidity, Measurement, Numerical Analyses

Abstract. Real dynamic boundary conditions and initial condition has to be taken into an account when simulations need to be done. The most helpful are in situ measurement facilities with climate monitoring. Indoor environment operation modes with different air temperature and relative humidity made indoor boundary conditions. Measured weather data are used to create complete boundary conditions for the research locality. Initial condition of masonry water profile is set up. The initial and boundary conditions are considered for an individual locality simulation proposes.

Use of EMW Radiation in the Building Industry

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Keywords: Wood, Remediation, Microwave Radiation, Wooden Construction, Mould, Wood Moisture, Wood-Destroying Insects

Abstract. This paper discusses theory and application of microwave radiation and experimental optimization of microwave radiation to eliminate moisture content in wood elements. Owing to its properties, microwave radiation has been used in the construction industry in modern times, in particular to dry wet masonry of buildings. Effects of electromagnetic radiation on building structures lead to relatively sharp decreases in moisture content from damp building structures or elements. The influence of electromagnetic radiation on building structures lead to oscillation of water molecules contained in the material, which cause a phase transformation of water into vapour. Consequently, the vapour evaporates from the moist material, thereby drying the element exposed to radiation.

The article describes experiments carried out at the Faculty of Civil Engineering of the Faculty of Technology in Brno that demonstrate successful decrease of water content in building materials using microwave radiation. First, the understanding of microwave radiation will be discussed.

Following an analysis of research results an optimum intensity of microwave radiation sources as well as the necessary length of the irradiation of microwave radiation have been determined with respect to the particular type of building material and the success rate of elimination of moisture.

Maximum Temperatures of Roof Tiles during the Summer Period

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Keywords: Thermal Emittance, Solar Reflectance, Cool Roof, Numerical Calculation

Abstract. Solar radiation is the main source of heat gains during the summer period. The most exposed non-translucent structure of the building is the roof. Material characteristics of roof tiles are able to influence the upper surface temperature and also the thermal performance of the whole roof structure. The aim of this article is comparison of the highest temperatures of roofing tiles reached by a summer day in accordance to their material characteristics. Data obtained from an in-situ measurement are compared with the values obtained by numerical calculation. The temperatures obtained by in-situ measurement are higher than thus earned by numerical calculation.

Hygrothermal Microclimate of Reconstructed Residential Building

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Keywords: Hygrothermal Microclimate, Relative Humidity, Ventilation in Residential Interiors.

Abstract. The paper is oriented on the hygrothermal microclimate of residential interiors in reconstructed building. The questionnaire survey has showed significant increase in number of allergies, respiratory diseases and occurrence of fungi after reconstruction. In order to find causes, experimental measurements of hygrothermal microclimate were carried out. The long term high values of relative humidity were found out and the link with number of efficient natural ventilation was searched for. Ventilation once a day was usual, what was proved as insufficient. Dwellers were informed about right way and number of ventilation. Furthermore, measurements proved decrease of air humidity, but not sufficiently. It was proved that nobody was able to achieve recommended number of ventilation and almost all of them considered it annoying and unreal to sustain. The biggest problem was proved night 7 hour interval. Therefore allergic and respiratory problems were significant in the morning. In conclusions of paper is suggestion for solution of researched problem.

Analysis of the Hygrothermal Performance of the Lightweight External Cladding

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Keywords: Hygrothermal Performance, Timber-Frame External Cladding, Passive House, Experimental Measurement, Simulation Methods.

Abstract. This paper deals with the hygrothermal performance of timber-frame external cladding in a passive house. The wall and roof assemblies were simulated and analyzed with regard to hygrothermal performance. Different boundary conditions and methods were used for the simulation calculations. The results of the simulations were compared with in-situ measurements, which were carried out at an experimental passive house at East Czech Republic. Due to the results of simulations and measurements, it should be possible to evaluate accuracy of simulation methods for prediction of the hygrothermal performance of the lightweight external cladding.

Monitoring Thermal Parameters of Lightweight Wood-Based Perimeter Walls

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Keywords: Coefficient of Thermal Conductivity, Solar Radiation, Long-Time Testing

Abstract. Based on initial measurements that have been performed on a sample wall, partial results of long time monitoring are presented. The wall was lightweight timber-frame construction built in a climate chamber in the laboratory pavilion type Department of Building Constructions and Urban Planning Faculty of Civil Engineering, University of Žilina. Article is focused on changes of thermal properties of insulations during day affected by actual weather condition.

Building Envelope Analysis in Terms of Thermal Stability in Summer

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Keywords: Lightweight Construction, Thermal Stability, Thermal Inertia, Time Shift, Thermal (heat) Damping, Decrement Factor, Numerical Modeling.

Abstract. Energy building design concept consists in controlling the thermo physical characteristics of the building envelope such as thermal transmittance (U-value) to name one example. However, besides the U-value, the envelope thermal inertia should also be considered because it helps to create indoor thermal comfort. Therefore, in situ measuring and dynamic thermal simulation was made. Simulated calculation results were validated by measuring. In the same model were created cases. These cases varied building envelope constructions, which had different materials and thickness, but they had the same U-value. The aim of this work was to compare simulated cases and to understand, how it works. It was found that the variation of outside temperature have no significant influence. Different performance of the building envelope constructions was seen only when heat gains were considered.

Introduction

For the last years building concept has been improving in terms of energy efficiency. Energy efficiency and return on investment of a building is the reason why low energy houses have become increasingly common. Saving energy during the winter season creates higher demands on the insulation thickness and design with high solar heat gains by a glazed pane. Of course, the thickness of insulation goes hand in hand with mass of construction. In buildings made of lightweight constructions with heat gains there appears to be a high level of environmental discomfort in summer and the problem has to be solved.

Thermal behavior of buildings in summer is a complex issue. All thermal processes within a building can be handled by indoor temperature or energy consumption. For thermal stability of buildings it is the best to use calculations where indoor temperature is monitored. Time course of indoor temperature directly says how thermal stability of a building is.

In Situ Measuring

Measuring was carried out for validation results of theoretical dynamic simulations. There were several reasons for a choice of the building for measuring. There was information that a building has thermal indoor environmental discomfort in summer, it has a lightweight construction and there is a weather station at close range to measure global and diffuse solar irradiance.

The building was a one storey office building made of a container construction used as office premises, for small business meetings and, in addition, there was a shop. Measured building is shown in Fig. 1. External walls and roof were made of steel structure insulated by mineral wool. They were coated by gypsum plasterboard from interior and grey steel sheet from exterior. Specific constructions compositions are available in Table 1.

Table 1. Composition of envelope constructions measured building.

Name	Layers (internal – external)
External wall	gypsum plasterboard 13 mm, mineral wool 30 mm, air gap 100 mm, mineral wool 100 mm, steel sheet 2 mm
Flat roof	gypsum plasterboard 13 mm, mineral wool 30 mm, air gap 150 mm, mineral wool 150 mm, steel sheet 2 mm
Ground floor	carpet 4 mm, oriented strand board 25 mm, extruded polystyrene 110 mm, concrete 100 mm
Partitions	gypsum plasterboard 13 mm, air gap 80 mm, gypsum plasterboard 13 mm,

The measuring was being carried out from 23rd August to 19th September 2013. Outdoor temperature and indoor temperature in all rooms were measured every 15 minutes by resistive temperature sensors for air (Pt 1000 / 6180 ppm). Global and diffuse solar irradiance were provided by the Czech Hydrometeorological Institute (CHMI) every 60 minutes. The maximal global irradiance was 800 $W \cdot m^{-2}$. The data was processed, then solar irradiance and outdoor temperature were used as simulation weather data and indoor temperature was used for validation purposes.

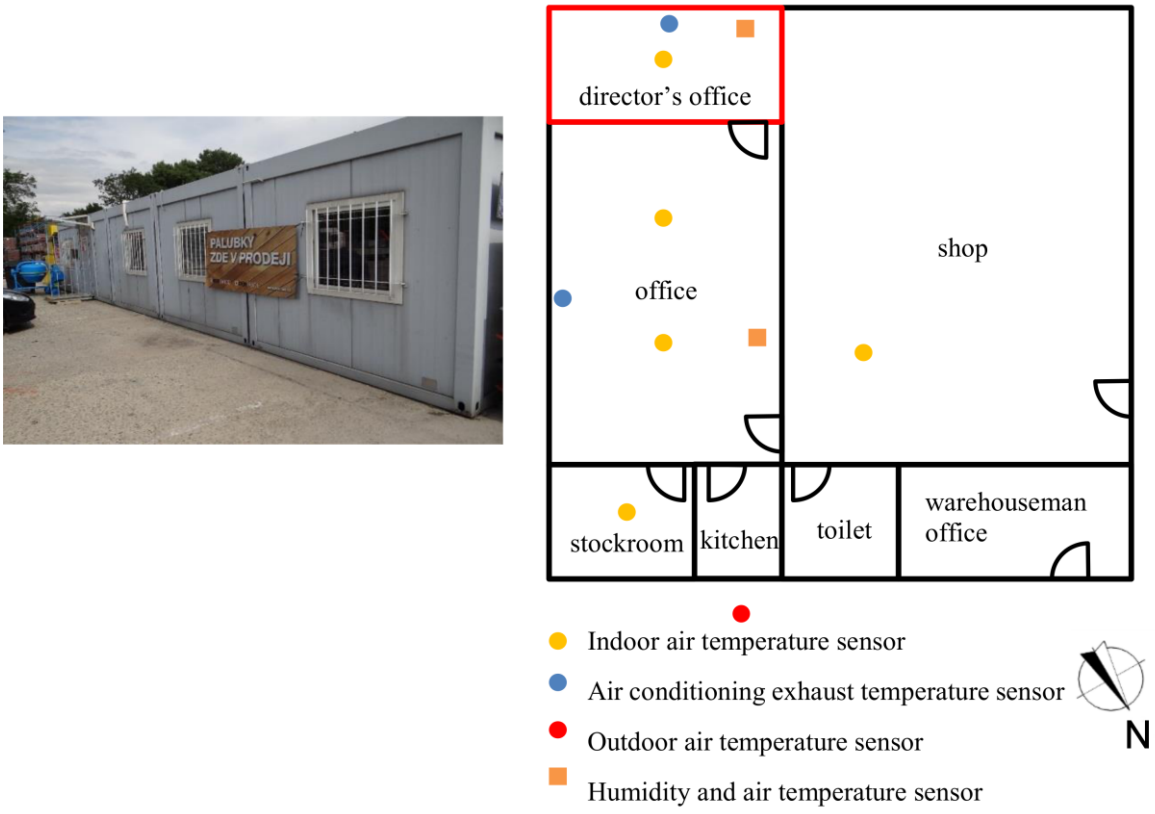

Figure 1. Photo and floor plan of measured building.

Dynamic Simulation of Base Case

The measured building was modeled in software for dynamic simulations with an hour calculation step. For simulation was used software was Design Builder. The entire building was simulated as a whole, but it was also divided into zones. Every zone consisted of one room. All possible parameters were considered to obtain the best results. Time-dependent parameters were controlled by schedules, for example, occupancy, office equipment and lighting gains, window shading and natural ventilation. Stored material near the building was modeled as shading component block same size as on the real site.

Base Case Results Verification by Measuring

The results for the director's office were analyzed and compared. There was a very good equivalence between simulation results and experimental measuring. The deviation between the temperature of the simulation and the measurement was almost all the time less than the accuracy of the measuring device as shown in Fig. 2.

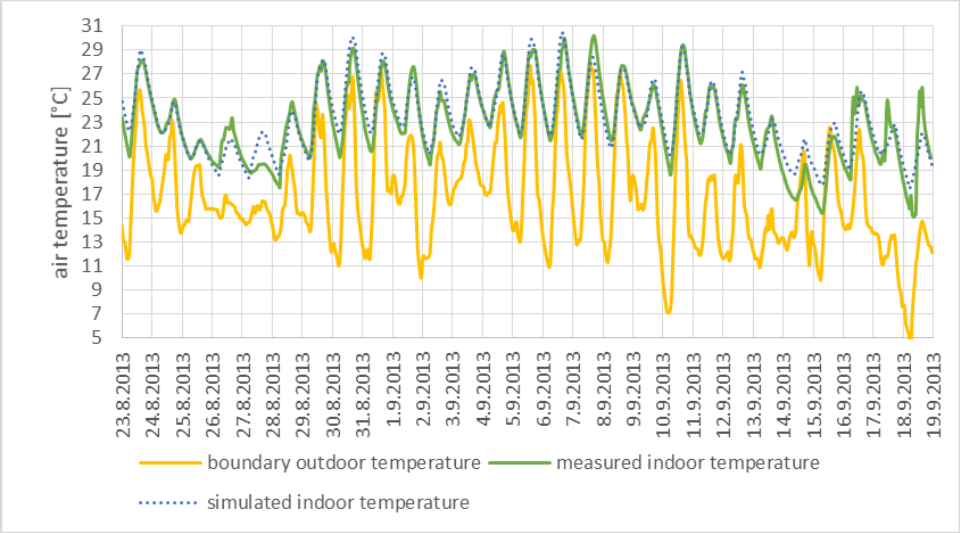

Figure 2. Course of simulated indoor air temperature in the director's office validated by measuring.

Dynamic Simulation of Other Cases

As shown in the previous section, dynamic simulation model results correspond to real building. Now it is able to create other cases by changing external wall construction and these are compared with the base case and in between. All the walls have same U-value of 0.20 $W \cdot m^{-2} \cdot K^{-1}$. Compositions of external wall for all cases are in Table 2.

Table 2. Composition of tested external walls.

Name	Layers (internal – external)
Base case	gypsum plasterboard 13 mm, mineral wool 30 mm, air gap 100 mm, mineral wool 100 mm, steel sheet 2 mm
Case 1	gypsum plasterboard 13 mm, resinous woods (spruce) 81 mm, fiberboard insulation 160 mm
Case 2	cement-lime plaster 10 mm, ceramic hollow block 300 mm, expanded polystyrene 110 mm
Case 3	expanded polystyrene 110 mm, ceramic hollow block 300 mm, cement-lime plaster 10 mm
Case 4	cement-lime plaster 10 mm, heavy bricks 600 mm, cement-lime plaster 10 mm

Dynamic simulations were made in two variants. In the first variant all heat gains and solar passive heat gains by glazing were considered. In the second one no heat gains were considered.

Considering Heat Gains. This variant corresponds very well to the real-life situation. The course of simulated air temperature in cases is as expected. The time course of indoor temperature indicates that the best wall construction in terms of thermal stability is made of heavy bricks. The worst is the base case wall construction made mainly of insulation and air gap. Results are available in Fig. 3.

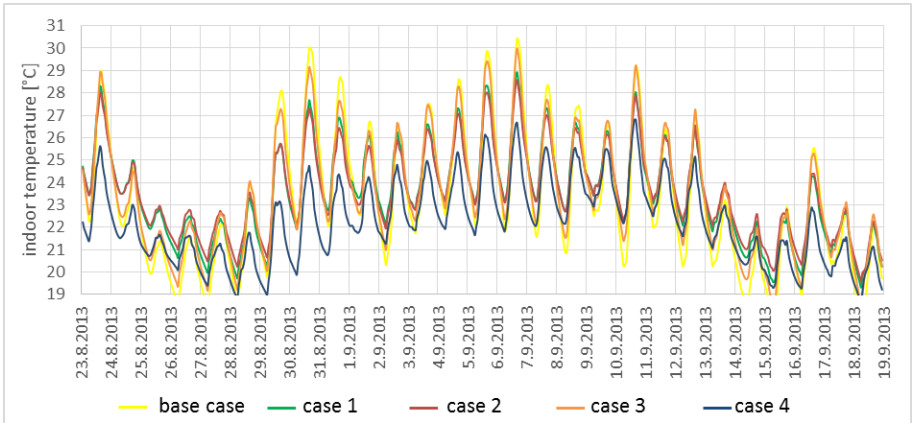

Figure 3. Course of indoor air temperature considering heat gain.

Not Considering Heat Gains. Most of the methods used in the national standards do not consider heat gain. The international standard ČSN EN ISO 13786 mentioned in article [2] uses time shift and decrement factor for evaluation of constructions. Similar model was created as it is said in standard [1]. That was the reason why the variant without gains was simulated. The results were surprising because the best construction seemed wooden construction with fiberboard insulation and the worst the construction made of heavy bricks. Results are available in Fig. 4.

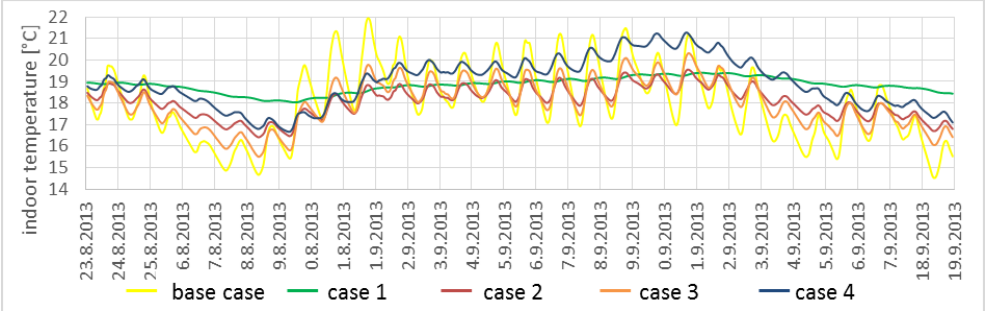

Figure 4. Course of indoor air temperature without heat gains.

Summary

Thermal stability of building depends on constructions and zone activity. Well known fact was confirmed by dynamic simulation with heat gains that heavy constructions are the best in terms of thermal stability. In comparison maximal indoor temperature in tested cases, lightweight construction made of steel external performs 3 K warmer than heavy wall construction made of bricks.

Calculation method [1] and comparison of the constructions without considering heat gains is not correct and gives wrong results. Computational model considering heat gains describes the thermal behavior the most precisely. The correct results may be get by detailed dynamic simulation.

References

[1] ČSN EN ISO 13 786, Thermal performance of building components - Dynamic thermal characteristics - Calculation methods, Prague: Czech Standards Institute, 2008. Sorting sign 13786.

[2] N. Aste, A. Angelotti, M. Buzzetti, The influence of the external walls thermal inertia on the energy performance of well insulated buildings, Energy and Buildings, Volume 41, Issue 11, November 2009, pp 1181-1187

The Issue of Wooden Buildings Made of Natural Building Materials

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Keywords: Wooden Building, Wooden House, Condensation of Water Vapour, Cellulose.

Abstract. The article points out the problems of critical points in the construction of wooden house whose the thermal layer is made of natural materials. The construction details such as the bottom corner at the connection of the foundation and the external wall or corners at the level of spatial bracing are very risky in terms of the condensation of water vapour. They are also crucial for ensuring of the mechanical resistance and stability of the entire building. The degradation of load bearing timber elements in these details which was caused by condensation of water vapour can cause serious structural defects.

Introduction

There is a significant development in some fields of civil engineering, especially in sector of new structural systems and building materials. Wood constructions are not a phenomenon of our time. Stone and wood materials have been used since time immemorial, but with the development of thermal insulation materials the wooden houses show big shift. Big boom also achieves return to the nature and materials that are related with nature such as straw, clay or cellulose [3].

Compared to the past also other criteria must be taken into account, not just the fact that it is a renewable resource of nature. Particular the fact that the criterion for energy saving is still tighter. Therefore, increasing attention is directed to construction components and especially their implementation. Incorrect implementation of the details may cause not only the deterioration of the thermal properties of the object but can also affect the stability of the entire building.

One of the main reasons which can affect negatively natural materials is water vapour. Among its key agent in the buildings are human activities. Other agents may be plants or chemical processes. All these factors contribute to the fact that moisture in the house increases and this leads to penetration of water vapour through the wall from the environment with a higher partial pressure to the environment with lower partial pressure [2]. The specific humidity of the outdoors air changes during the season, so the rate of condensation of water vapour which could be reached is not constant during the year. For detection of temperature and humidity in the construction and their potential impact on the entire object has been selected reference building were some temperature and humidity sensors were installed. The aim is to verify the correctness and functionality of the structural design and construction details of wooden houses made of natural materials. Proper design of construction and details is crucial to ensure the long life and reliability of all structures.

Reference Wooden House

The building is located in the village Kramolná, near the town of Náchod. The house is one-storey wooden house with a saddle roof. It is based on concrete footings with air gap between the floor and ground (Fig. 2). The supporting structure is made of oak squared timbers. The floors, walls and roof are made of a beam STEICO, 300 mm thick and OSB boards. The thermal insulation of the building consists of blown insulation Climatizer PLUS. Doors and windows with triple glazing are made of plastic. The facade is partially clad with timber cladding and clay plaster which is also used in the interior. The house is going to be ready for measurements during the summer months.

Figure 1. The wooden house in Kramolna during construction.

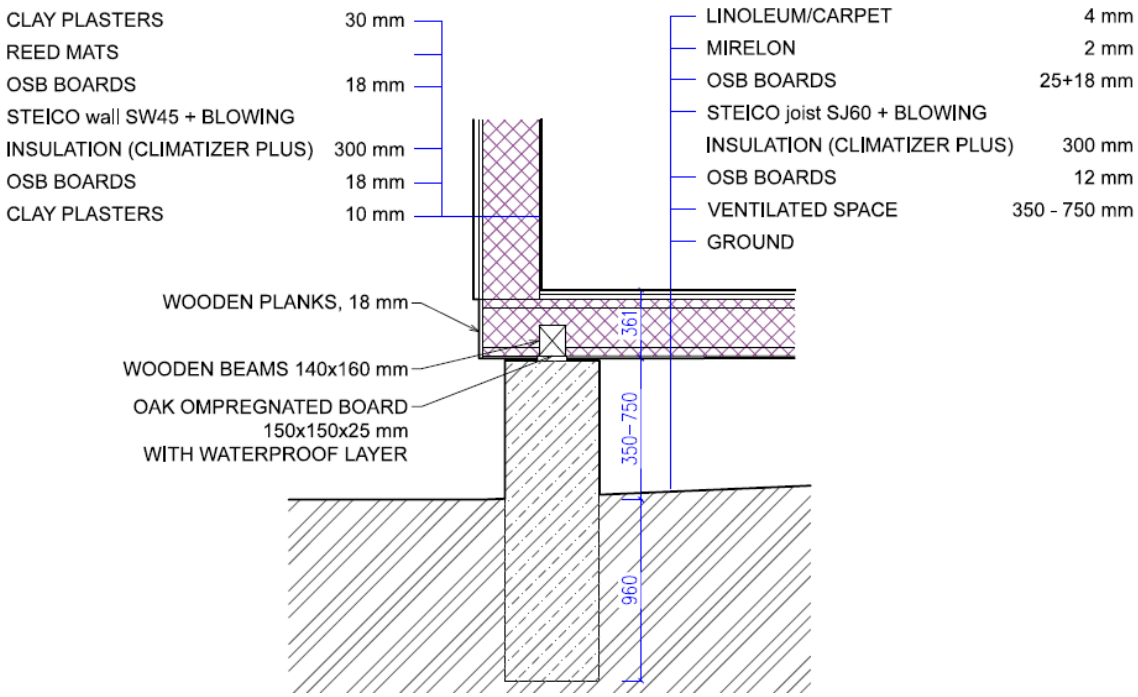

Figure 2. The detail of the building foundation.

The assessment of the real state-measurement assumptions

The verification of the correctness of the structural design and construction details of wooden house (Fig. 1, 2) will be done by long-term monitoring and subsequent evaluation of selected thermal and technical parameters. Based on consultations with experts [4] was the sensor Papouch installed in the wooden house (Fig. 3).

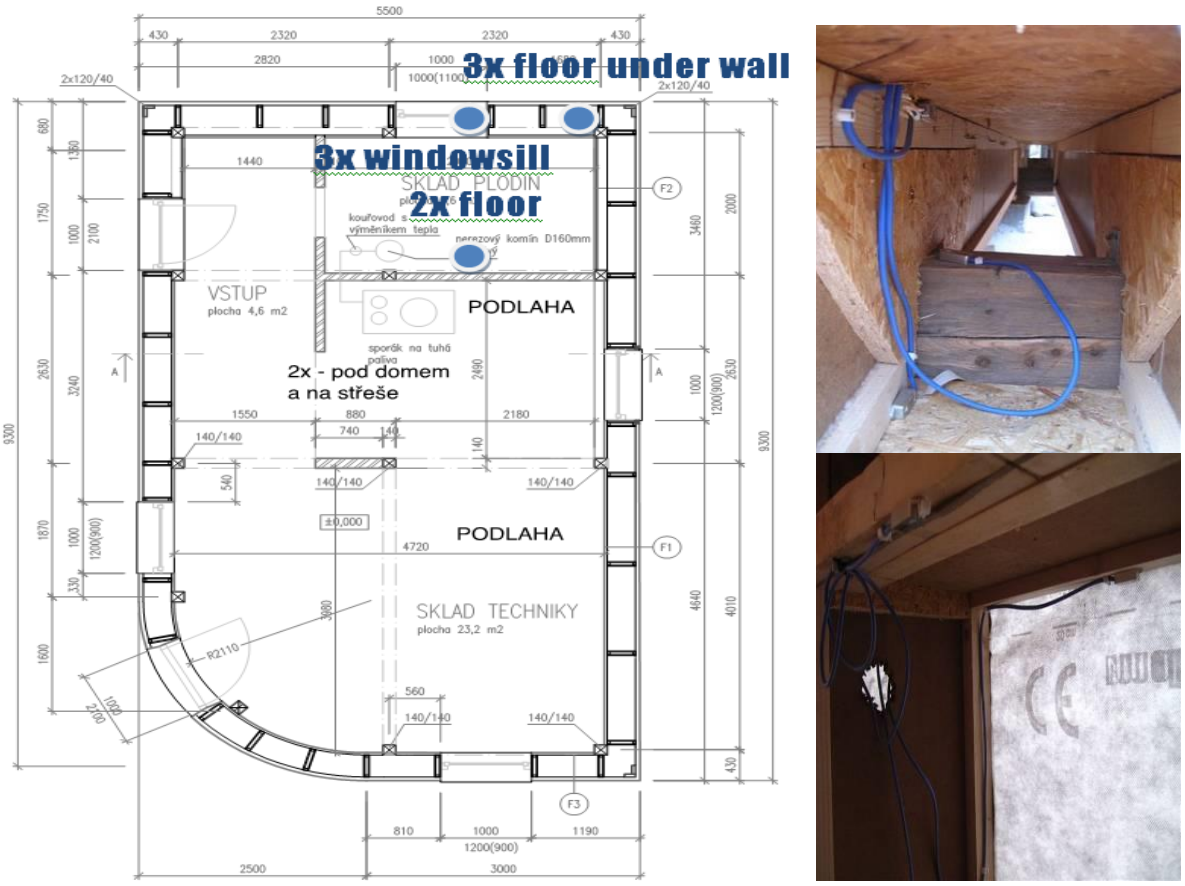

Figure 3. The location of the sensors in the construction.

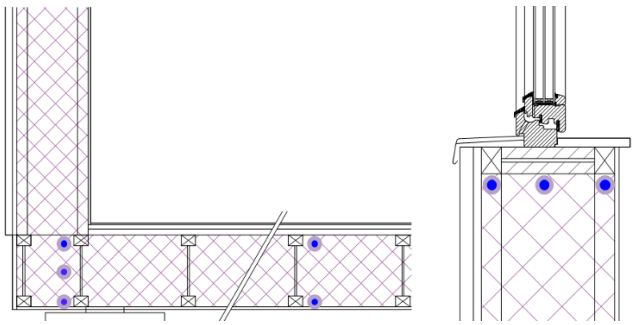

Figure 4. The location of the sensors in the wall and in the window sill.

The sensors will record temperature and relative humidity inside each construction of the wooden house. Other sensors will record the boundary conditions in the interior and exterior of the building. The arrangement and location of sensors allow the evaluation of the thermal insulation properties in detail of the building (Fig. 4).

Critical details

When evaluating the structures from the area of Náchod the boundary condition will be θ_e = -17°C for outside air temperature and θ_{ai} = 20 °C for indoor air temperature [2]. The resistance to heat transfer inside the building structure according to CSN 13 788 (2002) [1] specify a value of R_{si} = 0.25 $m^2 \cdot K \cdot W^{-1}$ which corresponds to the slower air flow in a corner or behind furniture. The transfer resistance at the temperature on the outside of R_{se} = 0.04 $m^2 \cdot K \cdot W^{-1}$ is valid for outdoor use.

The simulation of the temperature and the water vapour condensation was made in solved details by using software Area 2011 (Fig. 5).

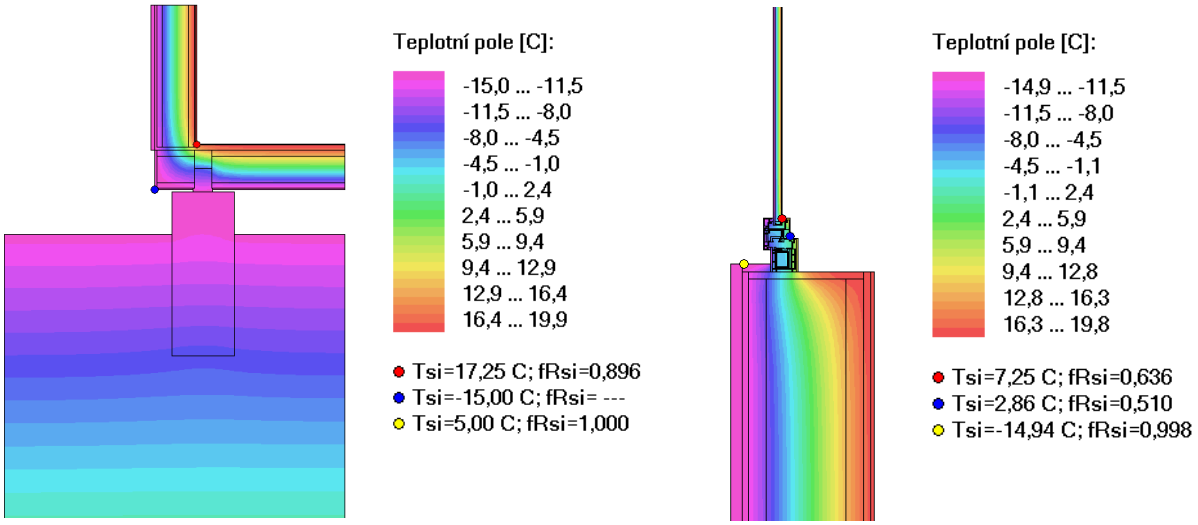

Figure 5. Output of Program Area 2011 - temperature field (A. the construction detail of the contact of the floor with perimeter wall, B. the construction detail of windowsill).

Table 1: The values of thermal resistance R, heat transfer coefficient U and water vapour condensation M_c as calculated by the computer software TEPLO 2011.

Construction	R [$m^2 \cdot K \cdot W^{-1}$]	U [$W \cdot m^{-2} \cdot K$]	M_c [$kg \cdot m^{-2} \cdot a$]
Floor	7.41	0.131	0.031
Wall with cladding	7.23	0.135	0.026
Wall with plaster	7.17	0.136	0.026

Summary

By evaluating and comparing the measured data with the calculated values will be possible find out how much the in situ measurement differs from the simulated conditions. By measuring in situ will also possible to evaluate if the structural design is correct. The construction of the measured object allows partial disassembly of selected details and optical control as well. This will make it possible to precisely assess whether there is the condensation of water vapour in the detail and what is its rate of importance.

Acknowledgement

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References

[1] ČSN 13788 Hydrothermal performance of building components and building elements- Internal surface temperature to avoid critical surface humidity and interstitial condensation- Calculation metods. Prague: Czech Standards Institute, 2002.

[2] ČSN 730540-2 Thermal protection of buildings- Part 2: Requirements. Prague: Czech Standards Institute, 2002.

[3] J. Chybík, Natural building materials, Grada, Prague, 2009.

[4] J. Teslík et al., 2013, Advanced Materials Research, Volumes 860-863, Airtightness and acoustic properties of family house from straw,1215-1218, 2013.

[5] J. Vaverka, Wooden residential buildings. 1. ed., Grada, Prague, 2008.

Measurement and Calculation of Ventilation in the Floor of the Brewery Žirovnice

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Keywords: Air Insulations, CFD Programs, Ventilation System, Designing, Measurements

Abstract. The article discusses how to test the functionality of air insulations designed for the floor ventilation in historic buildings and follows on from the previously published articles. A flow analysis is being performed on an object of the City of Žirovnice which has been registered in the list of cultural monuments and was built as a brewery in the years 1589 - 1592 on the site of an older medieval building. The foundations and external brickwork consist mostly of stone. This article brings new air flow readings. The aim of the article is to analyse in detail the air flow in a specific floor void with the aid of modern CFD programs and experimental measurements using the ALMEMO device.

Impact of Building Refurbishment on the Operative Temperature and PMV

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Keywords: Building Refurbishment, Operative Temperature, PMV, Thermal Comfort

Abstract. Energy saving is one of the main priorities in the building sector. In the last years in Hungary different national programs were launched in order to improve the thermal properties of residential buildings. In case of building refurbishment 40-60% heating energy savings were expected. There were cases when the expected energy savings have not been met. The aim of this research was to see which the refurbishment impact is on the thermal comfort in a residential building. It was found the mean radiant temperature, the operative temperature and the predicted mean vote (PMV) decrease after building refurbishment.

Development and Experimental Verification of Ventilation Units for Under Pressure Ventilation System

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Keywords: Ventilation unit, under pressure ventilation system, development.

Abstract. Task of controlled ventilation in modern residential buildings is to ensure optimum quality of interior environment and fulfill hygienic and thermal technical requirements guaranteeing comfort of user. The paper discusses development and experimental verification of atypical vertical ventilation units of under pressure controlled ventilation system for residential high-rise building. Recommended concept of solution to façade detail in relation to ventilation system. Conceptual designs of alternatives of air inlet openings of under pressure controlled ventilation system for apartments of atypical vertical geometry. Optimized alternative of air inlet openings in the bottom level of vertical pilaster with function of air distribution channel for ventilation system. Laboratory experimental verification of physical properties of optimized alternative of ventilation units of under pressure controlled ventilation system in their development cycle. Hydrodynamic regime of air inlet openings of controlled ventilation system – laboratory experimental research in large rain chamber. Aerodynamic regime of natural controlled ventilation system – laboratory experimental research in large pressure chamber. Acoustic properties of natural controlled ventilation system – laboratory experimental research in acoustic chambers. Comparison by the experiment of verified parameters of ventilation units of under pressure controlled ventilation with design parameters.

Design Issues of the Airconditioning Systems in the Spaces of Swimming Pool Halls

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Keywords: air conditioning, humidity balance, air flow, humidity, trichloramine, swimming pool hall

Abstract. The main requirements of designing the internal microclimate in swimming pool halls include removing evaporating water vapor and trichloramine (NCL_3) from occurrence area of swimmers. As it is apparent from the differential equation of the mass transfer over the water surface, so with increasing speed above the water level there is increasing evaporation of water vapor at the same time. This is undesirable in view of the requirement to maintaining humidity below the upper limit of recommended limits. The article aims to point out the problem with the releasing trichloramines from the water surface and thus point to a potential increase in water vapor evaporated from the water.

Microbes in the Interior of Schools

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Keywords: School Buildings, Microbial Microclimate, Viruses, Bacteria, Colony Forming Units.

Abstract. Article is focused on the concept of microbial microclimate, and microorganisms. Further described herein are sources of microorganisms. More details in the incidence of building structures. Hereinafter, the way the samples were taken for evaluation of microorganisms on building structures, notably the floors and walls. The comparison was also sampled benches. Samples were evaluated in the laboratory. The Petri dish is clearly shown which microorganisms are present; they are mostly mould and species Penicillium. Overall, they found any major threats of structures which have been taken.

Analysis of Damage to the Historic Roof Truss in Terms of Internal Environment

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Keywords: Relative Humidity, Wood Moisture, Fungal Occurrence, Structural Damage, Spreading of Insect

Abstract. The main threats that endanger the historical roof trusses in our geographical conditions are wood decaying fungi and wood destroying insects. For these threats to occur and spread across the historical roof truss, several criteria have to be fulfilled within the indoor environment. These critical criteria include wood moisture, relative humidity, amount of daylight and airflow. In addition to these monitored parameters and their critical values, we must not forget the impact of local geographical specifications and wider dependencies. This article is focuses on comparison of theoretical knowledge in this area with in-situ measurements of historical roof trusses on several reference buildings – churches and chapels in Southern Moravia. These were chosen due to their long-lasting nature and circumstances of the construction. The influence of specific local conditions (especially indoor environment) on the extent of damage is also examined in addition to general comparison.

Issues of Indoor Climate Discomfort in Light Wooden Low-Energy Houses

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Keywords: Wooden Building, Energy Performance, Indoor Climate, Passive Houses

Abstract. The paper presents the results of in-situ measurements (temperature and CO_2 concentration) carried out on several family houses built in a low-energy, passive or nearly zero standard. Factors of potential discomfort of wooden low-energy houses such as light good-insulated envelope constructions, solar passive gains, air tightness, sensibility of ventilation system and others are analyzed. Results of measurements are confronted with computer simulations and results based on normative methods.

Integration of PCMs and Capillary Radiant Cooling / Heating to Ensure of Thermal Comfort

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Keywords: Phase Change Material (PCM), Radiant Cooling, Capillary Tubes, Latent Heat

Abstract. The thermal comfort of buildings occupants depends on the physical properties of applied building materials, on the solar heat gains through the transparent part of the external envelope and the mode of heating/cooling and ventilation. Capillary radiant cooling / heating can maintain a state of indoor environment in the required temperature range in accordance with legislative framework. The paper shows possibility how to improve thermal comfort and thermal stability in summer.

Presented system uses phase change materials as a latent heat storage medium for better absorption of heat. Microencapsulated phase change materials Micronal® DS 5040 X and DS 5008X were used as latent heat storage medium in combination with gypsum plaster. Activation of phase change materials is carried out by capillary tubes with cooled / heated water circuit. At Institute of Building Structures at Faculty of Civil Engineering are located two rooms for comparative measurements. There were located thermal storage modules in the experimental room.

Low- temperature radiant cooling and heating with phase change materials are one of the ways to reduce energy consumption and operating cost for cooling / heating. The paper presents the results of measurements for different modes of operation of cooling and heating.

Microbiological Aspects of Energy-Efficient HVAC (Ventilation) Systems Houses

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Keywords: Internal Microclimate, Microbiological Analyzes, Microorganisms, Moulds, Germs.

Abstract. Currently it is under pressure to reduce the energy consumption of the buildings. The pressure is noticeably reflected in the current way of building designing, in general. Therefore, essential part of these objects become air-conditioning (ventilation) systems, mainly due to possibilities of heat recovery and controlled ventilation. This contribution focuses on ventilation systems, low energy houses, which aims to highlight the issue of purity of these systems on the microbial level. Evaluate the impact of external and internal environment following the condition of HVAC systems in time, in the real objects. The purpose (aim) of this all is to remind that there are other aspects that have to be considered in the design and subsequently, in the use of the systems, such as the impact of the nature of the building use on the purity of air-conditioning systems. It is necessary to point out that the presented ventilation systems have a significant impact on the creation of the internal environment, and equally they can harm, instead to be beneficial.

Influence of the Indoor Environment Quality on the Market Value of the Buildings

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Keywords: Indoor Environment Quality, Appraisal of Real Estate, Market Value of the Building, Real Estate Market.

Abstract. The modern buildings are becoming more and more different from the traditional buildings, especially regarding their parameters of the indoor environment and low energy performance. For this reason, the real estate market has been looking for new criteria to estimate their market value and to distinguish them one from another. As they are trying to find the most objective parameters for establishing the market value of the buildings on the real estate market their attention focuses also on the quality of the indoor environment. The real estate market perceives a building with high quality of the indoor environment traditionally in the context of the technical, economic and energetic parameters but with higher and higher emphasis also put on social and environmental connections. This paper is focused on the analysis of how much the quality of the indoor environment is taken into account in the process of the market valuation of the buildings in modern context.

Wood as Material Suitable for Health Care and Therapeutic Facilities

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Keywords: Wood, Health Care Facilities, Comfort, Maintenance, Surface Finishing, Roughness,

Abstract. Paper deals with features important for creating healthy microclimate in health care and therapeutic facilities. It presents basic facts about visual, tactile, behavioural, somatic, acoustic and socio-cultural comfort particularly important for spatial design of these facilities.

It focuses especially on choice of materials and their surfaces for built-in elements and furnishings which plays crucial role for well-being - comfort. It sets hypotheses that by using wood as phenomena by humanization of microenvironment, it is possible to reach high level of complex comfort.

It also shows main disadvantages of using wood in the healthcare and wellness facilities, where belongs particularly more demanding maintenance to keep the surfaces clean and disinfected and water resistant. To prevent these problems, the high resistant chemical /artificial finishing is needed. But with chemical finishing there are lost many positive effects of wood on healthy microclimate.

Despite of it there are two hypotheses that are contributing to the statements that wood is suitable for the healthcare facilities. First is that natural wood without additional chemical finishing has antibacterial (antimicrobial) effect. And second is that it is possible to provide a surface modification with the aim to reach the state that wood can be hydrophobic or even super hydrophobic and thus easy to maintain such as adjustment by plasma or by finings based on nanotechnologies and bio mimetic. The paper presents examples and own tests supporting these hypotheses.

Indoor Climate of Residential Interiors and Asymmetry of Radiation

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Keywords: Indoor Climate, Local Thermal Discomfort, Asymmetry of Radiation

Abstract. The paper is oriented on the indoor climate of residential interiors. Questionnaire survey in new residential building has showed problems with securing quality of indoor climate. In smaller residential interiors with large glazed surface was this problem bigger. Cause of problems was formation of local thermal discomfort. One of the most serious area of local thermal discomfort is asymmetry of radiation. To clarify asymmetry of radiation, there were carried out experimental measurements in a special microclimatic laboratory for convective heating. In this paper, there is presented the scientific analysis and the outputs from measurements. In the conclusion of this paper are introduced principals for designing the residential interiors without local thermal discomfort.

Wood-burning Stoves in Well-Insulated Dwellings

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Keywords: Wood-Burning Stoves, Thermal Insulation, Heat Loss, Dwellings, Thermal Performance.

Abstract. New requirements for the thermal performance of building structures also affect heating equipment solutions. A specific problem is the future of the local heaters in the following well-insulated houses in terms of overheating. This paper discussed some results of the dry bulb air temperature measurement in one of these houses. The article further reported list of the local wood-burning stoves with respect to the calculated heat loss in these houses isolated on the requirements of the standard in 2016 and in 2021.

Daylight as a Core Attribute of the Architectural Concept of the Modern Shopping Centre

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Keywords: Daylight, Indoor Environment, Rooflights, Electrochromic Glazing, Thin Glass, Photochromic Devices, Innovative Design.

Abstract. Modern shopping centres became a very popular in our society because of a comfort and pleasant atmosphere in indoor illuminated spaces. Daylight from skylights and large-scaled glazed roofs allow better perception of architectural elements and details. This aspect brought trends of using daylight as powerful visual information medium in maximum possible scale, creating variety of large-spaced solutions for a good quality indoor shopping environment. Optimal forms of roof structure, together with modern materials and construction solutions have significant influence on saving energy consumption. Daylight became determinant factor in a process of basic disposition and operational framework of shopping centre, and also has overall influence on architectural style of designed buildings.

Introduction

Construction industry in recent years is marked by a major boom of building shopping centres. Fertile soil of investor‘s activities is due to the integration tendencies of individual countries as well as globalization and internationalization of trade. The architectural concept of shopping centres is based on the principles of the architect Victor Gruen author of 1950 [1]. His idea was to create a single structure building with many indoor pedestrian corridors, plazas and galleries designed not only for the business, does not lose to its updated. Popularity of the shopping centre of the general public is not only linked to the purchase itself, but also to the possibility of using many services and facilities for leisure under one roof. Magnet for visitors is not only a good service facilities but also comfortable environment created by spacious, airy and richly illuminated spaces which provides comfortable conditions in a case of bad weather. Air-conditioned indoor spaces in a summer and heated in a winter are suitable for visitors of all ages. However uppermost aspect of the internal environment is daylight.

Daylight and Shopping Mall

Daylight in an interior represents the direct input of the solar rays through the glazing. Perception of the human eye begins with the brightness intensity of 100 lux. Amount of brightness in an enclosed space affects light climate, dependent on the size of the illuminating openings. To ensure a visual comfort, means to allow entering of natural daylight in sufficient quantity and quality. Achieving this goal in different circumstances of the external lighting (during cloudy, sunny sky, even in direct sunlight) is one of the most difficult problems of a designing the daylight. Daylight used in a store’s interiors helps to create a visually stimulating and productive environment for buyers. It allows reducing 1/3 of the total cost of operating power [2].

For an architect is the daylight a significant component of the creative architectural process in the designing of the future architecture. Author of the shopping centre by using a natural light, creates a space, enhances dominants in interior and defines an overall lighting concept. Lighting concept is an important factor in the process of architectural design - from a functional and compositional point of view. This concept contributes also to the dispositional and spatial resolution of the building. In the compositional and aesthetic proposal allow to shape and decorate the space,

determine coloured climate, accentuate objects and constructional and architectural elements, to limit spaces and to separate them with one another and lead the visitor through the space.

Skylight – the Dominant Architectural Element

Light enters into the interior of the shopping passage through the roof openings, which has to be glazed for visitors comfort. The glazing is part of the envelope of the building structure on which are placed energy saving requirements. Meet the minimum requirements on the energy intensity is an obligation under the Act. [3] Sufficient thermal insulation, acoustic and mechanical resistance of the glazing is part of regulations for a glazing. Regulations pay great attention to a safety of a glazing. Skylight proposal must be assessed on a load: own weight glass, load the barometric pressure in the cavity insulating glass, load the altitude changes the place of manufacture and installation location, wind load and snow load on the lower pane of glass from the snow, wind and weight glass.

A building receives not only light through skylights into the interior, but also solar radiation, which causes undesirable increase of temperature. Daily air rise of temperature must satisfy the boundary conditions given by the standards of the country.

Requirement of thermal stability is in contrary to the requirements of daily lighting. Questions required minimum daylight factor values and the values of maximum daily air temperature rise for the summer period must be addressed at the stage of concept formation. These requirements have a major impact on the spatial resolution of commercial arcades, their height, width, length. Affect the proper orientation of these spaces. Affect the size, location, shape and angle of illumination areas. Construction solutions of the shape of the skylights are becoming one of the major architectural compositional elements in the design of the shopping centre.

Glazing Skylights

Glazing for skylights is used in different materials. Their choice depends on the requirements of the author of the building, respectively, of the will of the investor. The most common application is the use of thermal glass panes**.** In addition to glazing glass skylights are also used filler polycarbonate sheets, acrylic sheets, plates Kalwall and others.

In the development of glazing materials has occurred a great progress in the last decade. In practice were found new glazing with more effective results. The goal of its use is to ensure a favourable light comfort and to reduce a consumption of fossil fuels.

These include:

a) electrochromic glazing [4] controlled by a dynamic changes of the glass. Glass consists of two glass panes that have, from the inner side, glued- on transparent conductor. The cavity between the panes is filled with a colourless fusion of electrolyte. Wiring the conductors to a voltage arises through the electrolyte set of reversible electrochemical reactions that stain electrolyte to different colours. After disconnecting the electrical voltage the glass returns to its original colourless state.

b) photochromic glazing [4] controlled by the user. Staining of the glass is managed by keeper through photochromic device. Glazing consists of two, oppositely positioned glass panes. One is coated with a photoconductive electrode deposited on a conductive coating. The second one is provided with a chromogenic electrode. The cavity between them is filled with electrolyte. Wiring the conductors to a voltage arises colouring of glazing in presence of light.

c) gaschromic glazing [4] is also controlled electronically. Also consists of two against each other planted glasses. The cavity between them is filled with a transparent conductor, electrochromic electrode and electrocatalytic layer with hydrogen gas. Connecting the electrocatalytic layer and a transparent conductor to a voltage arises colouring in the electroc hromic layer. Glazing returns to the colourless state after disconnecting from the electrical voltage.

d) thin glazing of photovoltaic panels [5]. It is formed by two facing to each other safety glass, which is provided from the inside by PVB film. Among the films are equipped photovoltaic modules.

Photovoltaic glazing has a great future. Its advantage is that it permits to illuminate the interior, generates electricity and also shades the interior space. Together with glass forms composite design of the building envelope. Connection of the photovoltaic panels allows you to create translucent shell structure [6]. A wide range of elegant shapes, colours and optical elements, glass and construction profiles encourages creativity in architectural design of roofing.

Design Shopping Centres

The situation of shopping centres, which is day-to-day attacked by online stores, is difficult, teetering on the edge of its existence. Companies, managing retail units, in an effort to retain customers still come up with new innovative ideas, not only in the field of business, functional content and attractiveness of leisure-time activities, but also in technology, dispositional and architectural solutions. Architecture today is directed by computers, the desire to prosper from the opportunities offered by various drawing software. It is faced with the challenge of globalization and internationalization of global trade and influenced by the tremendous rapid development of technology and construction technologies. Beginning of using computers in the process of architectural design initially caused different fantastic shapes. Later, we began to look for the functional content of this form in a synergetic way and we started to call this activity digital architecture [7]. New term began to indicate a range of new architectural forms.

Digital Architecture

It is seen as a free game of nonmaterial forms in cyberspace, which may or may not to be converted into a real physical space [8]. It is created by developed software that allows designing and implementing complicated irregular and curvilinear structures, composed of a big amount of different elements. Digital architecture is understood as a synonym of free non-rectangular shapes, understood as a new spatial thinking of dynamically flowing spaces - previously labelled as elements of organic architecture.

However, digital architecture does not ignore forms using straight lines. Complicated algorithmic practices are working well with the compositions of rectangular shapes, rectangular media facades, complex structures composed of simple bodies, etc. Digital technologies have great influence on architectural life not only because of the broad scope, but also because of high speed. They bring to the creative process of shopping centres many impulses, what authors only gradually align by their absorption possibilities with. The founders of the global architectural competition FEIDAD (Far Eastern International Digital Architectural Design Award - Taiwan) distinguish two uses of this technology:

High-technologies [9], used by fully utilization of possibilities of implementing by digital technologies, leading to a purely aesthetic shape (F.Gehry, Z.Hadid).

Low-technologies [9], where digital processes are used more in the design phase and in the implementation phase are more used traditional construction methods (T. Ito).

The architecture of contemporary shopping centres is slowly abandoning the classical notion of disposition-spatial concepts with insufficient light climate of retail spaces. More and more are beginning to be designed a multi-storey free-flowing spacious places with large glazed areas - mainly in focal positions - pedestrian circulation areas of passages, atriums, and shopping arcades. Their spatial shaping and model roofing is marked by distinctive original artistic expression, for example.: My Zeil Shopping Mall in Frankfurt, Germany (Architects: Massimiliano and Doriana Fuksas) [10].

Summary

New methods of designing and building design by computers in cyberspace offers the designer a wide range of architectural fantasies designing the arcades in shopping centres. The big challenge in implementing them is progressive glazing technology-based on Building Integrated

Photovoltaics. Possibility of producing computer designed and specified components in the production of photovoltaic panels in the hands of the architect gives the opportunity to shape the roofs of malls in different spatial plan-forms. Daylight which illuminates the interior spaces of the arcades is becoming a major means of looking for the concept of modern shopping centres. Application of Photovoltaic panels for roofing and illumination of the interior is the way of fulfilment of EU Regulation No. 347/2013 and Directive EP 010/31 EU Zero Energy Performance of Buildings after 2020.

References

[1] M. Orvell, The Death and Life of Maine Street, in: The University of North Caroline Pres, USA, 2003, ISBN: 978-0-8078-3568-5. – p. 27

[2] G. Loisos, Skylighting and Retail Sales, California 1999

[3] P. Nahálka, Architecture and the Internal Environment, in the Current Office Buildings Environmental Aspects, in: Advanced Materials Research EnviBUILD Buildings and Environment 2013, 273 -276.

[4] J.P. Cronina,b, T.J. Gudgela,b, S.R. Kennedyb, A. Agrawala, D.R. Uhlmann, Electrochromic Glazing, Arizona 1999, http://www.scielo.br/scielo.php? Script=sci_arttext &pid= S1516-14391999000100002, 17.07.2014

[5] Building Integrated Photovoltaics, Information on: file:///C:/Users/Eva/Downloads/ ADDOX%20%20Fotovoltaické %20zasklení%20(10).pdf 18.07.2014

[6] E. Oravcová, Construction in the Trend of Sustainability – Wooden Houses with Integrad Photovoltaic Systems, in: Advanced Materials Research 899, (2014), pp. 209-212.

[7] MITCHELL, William J. 2009: Antitectonics. The Poetics of Virtuality. In: LIU, Yu Tung, LIM, Chor-Kheng., 2009: New Tectonics. Towards a New Theory of Digital Architecture: 7th Feidad Award. Birkhauser Verlag AG, Basel, pp 10 – 18.

[8] V. Šimkvič et al., Digital architecture FA STU 2009, In: Proceedings of research papers. STU Bratislava 2009, pp 9-14.

[9] LIU, Yu-Tung, LIM, Chor-Kheng., 2009: New Tectonics. Towards a New Theory of Digital Architecture:7th Feidad Award. Birkhauser Verlag AG, Basel, p. 190 – 191.

[10] MyZeil Shopping Mall/Studio Fuksas, Frankfurt, 2009, Information on: http://www.archdaily.com/243128/myzeil-shopping-mall-studio-fuksas/ 15.07.2014

Simple Conversion Method for Determination of the Global Illuminance from Satellite Images

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Keywords: Global Horizontal Irradiance, Remote Sensing, Global Horizontal Illuminance, Satellite Images

Abstract. To better utilize natural sources in the performance of buildings during whole year the availability of detail data in time and for specific location plays key role. Such data offers ground measurements or databases of satellite images. Establishment and operation of CIE IDMP ground stations is quite expensive and there are a few active stations on the ground at this time. To study of irradiance availability in specific locality the data describing relevant local radiative conditions are needed. For this reason the satellite images offer sufficient information. The first part of this paper is focused on short introduction to the remote sensing and the Heliosat method. In the second part are presented results of the solar irradiance availability on the horizontal plane and their time changes based on the processing satellite images. The illuminance and irradiance data obtained at ground CIE IDMP station in Bratislava were used to proposed verify model for estimation of the global illuminance from irradiance. Cities Bratislava and Brno are relative close with distance 130 km and similar daylight climate of Central European climatic zone, therefore can be assumed that data from CIE IDMP station Bratislava can represent relation between photometric and radiometric variables and daylighting changes in Brno.

Investigation of Useful Daylighting during a Day

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Keywords: Daylighting, supplementary lighting, illumination of classrooms, illuminance sequences

Abstract. Annual availability of daylight depends on exterior luminous conditions. If sunny sky is presented the interiors are illuminated by direct sunlight and diffuse skylight or only by skylight in dependence on the orientation and cloudiness. Under sunless situations only skylight is source of daylighting. The minimum illuminance expressed by Daylight Factor is required for performance of visual tasks by the Slovak standards. Traditionally, the overcast situation with exterior illuminance 5000 lx represents this condition. According to recent studies the occurrence of overcast sky in a year is not dominant in Europe and new metrics are looking for. It was published that minimum 100 lx and adequate of 300 – 500 lx is sufficient for the healthy and comfortable indoor environment. Direct sunlight can produce glare and visual discomfort. Bratislava daylight measurements show that such situations can occur often during a year.

The typical daily diffuse and global illuminance courses were selected from Bratislava measurements. The periods in the day of useful daylighting, periods of exterior illuminance below 5000 lx and direct

irradiance above 120 $W \cdot m^{-2}$ when sunshine can cause glare and overheating were identified in a classroom. Paper presents achieved results, their evaluation and discussion.

Daylighting: Prediction of Circadian Effects of Different Spectral Filters

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Keywords: Daylighting, Light Spectrum, Reflectance, Circadian Stimulus.

Abstract. The study presented in this article aims to evaluate in which extent the interior colour surfaces affects human circadian stimulus. Experimental measurements in model rooms were evaluated by methods presented in studies by Rea et al. [1-3]. Even by high levels of daylight illuminances the colour of interior surfaces influences circadian stimulus, but this effect is not significant. Diminishing of circadian efficacy increases with application of dark blue-deficient colours of interior surfaces and by low intensity of daylight.

Evaluation of illuminance of Rooms Oriented to Different Cardinal Points

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Keywords: Daylighting, Illuminance Distribution, Clear Sky, Overcast Sky, Work Place

Abstract. Daylighting levels in interiors are changed every day since sunrise to sunset in dependence on luminous exterior conditions. Indoors are illuminated by diffuse skylight prevailing time of the year in Central European counties while a lot of sunny situations occur mainly during transitional and summer periods. The later can produce overheating as well as glare or disturbing luminance due to excessive sunlight in the space close to windows. If interiors are designed with screened work places the influence of direct sunlight during working time has to be evaluated.

The article will present results of computer daylight simulations in a side-lit office room oriented to cardinal points. The study is focused on daylighting evaluation of the room orientation influence on levels under clear sky conditions and compared with results achieved for the CIE overcast sky model. The calculations were run in software Daylight Visualizer 2.6.7. The daylight simulation show that applying the clear sky model for illumination of oriented rooms, the substantial different illuminances can be resulted compared to outputs from the common overcast sky daylight metrics.

Relation Between the Light Transmission of the Glazing System and Daylight Factor

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Keywords: Daylight Factor, Light Transmission, Glazing System

Abstract. Windows are one of the most important parts of the building façade. Their main function is to ensure sufficient illumination of interiors and contact with outdoor environment, either directly or indirectly. The optical properties of the glazed part of these window apertures have significant influence on a lot of requirements, which have to be satisfied at the same time. The daylight distribution on the working plane is most affected by the glazing system's light transmission. This study offers a simple method, how to find the appropriate value of the glazing system's light transmission in relation to the Daylight Factor, in order to ensure the required daylight distribution in interior.

Effect of Light Reflectance of External Surfaces on Daylight Factor

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Keywords: Light Reflectance, Vertical Daylight Factor, Continuous Shading Obstacle.

Abstract. Daylighting is one of the important factors in the internal environment of buildings. The quality and quantity of daylighting depends on many factors including distances, heights, shapes and reflectance of surrounding external obstacles and ground reflectance. The quantity of daylighting is evaluated using the Daylight Factor. The case study carried out on a lighting simulation software and presented in this article demonstrates the influence of the light reflectance of external surfaces on the Daylight Factor. The aim of the article is the comparison and evaluation of the impact of the light reflectance of the external surfaces on the Daylight Factor.

Evaluation of Indoor Daylight Parameters during Long–term Observations in the Rooms Equipped with Intensive Coloured Surfaces

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Keywords: Daylight Spectral Characteristics, Experiment In Situ, Colour Rendering Index, Non-Visual Response

Abstract. Examination, design and control of internal light conditions belong to important actual architectural issues. In most cases the reason is increasingly growing interest in non-visual response of human on the ambient light properties. Sick Building Syndrome (SBS) is assumed to be caused by complex of inappropriate indoor environment circumstances. Unsuitable light conditions are regarded to be one of them. This paper deals with comparison of internal light parameters such as photopic illuminance level E_V, Spectral Power Distribution (SPD) and definition of peak wavelength value recorded in tested office rooms, which were scaled down to models for easier handling. Models are equipped with different selected coloured wallpapers and flooring materials, whereby one model remains with all surfaces in neutral colours. The outputs of measured parameters are compared with each other and also with outdoor levels of the same light properties. There is also defined filtration efficacy of blue light component assumed to be most effective for controlling of non-visual sensory system of human body. This observation may provide more complex overview on selection of internal surfaces colours in long-term occupied spaces, taking health and wellbeing into consideration.

Distribution of Daylight Factor in Classrooms

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Keywords: Daylighting, daylight factor, schools, human performance, school desk.

Abstract. The study capability of pupils depends on many factors. One of the factors is the level and the quality of daylighting in classrooms. The daylighting quality is particularly important for very young pupils in primary schools and nurseries. This article deals with natural light in classrooms with different school equipment and furniture and various parameters of window constructions.

Comparison of Two Coating Material Reflections of Hollow Light Guide Tube

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Keywords: Hollow Light Guides, Light Transmission, Luminous Fluxes, Laboratory Measurements

Abstract. This paper discusses tube transmission efficiency of two straight hollow light guides. Two samples with diameter of 530 mm and length 1170 mm were investigated under the artificial sky in the laboratory at ICA SAS in Bratislava. The entering luminous flux was calculated from measured illuminance in the point located on the top of light guide. Below the bottom of the light guide was located a set of measuring points on the special construction in the shape of a cross. In these points, one by one, the elementary illuminances were measured and the luminous fluxes leaving the light guide were calculated. Paper presents methodology for laboratory light transmission measurements and discusses effects of two various coating materials on light transmission efficiency of hollow light guides.

Influence of Roads Renovation in Havlíčkův Brod on Adjacent Housing Development

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Keywords: Noise, Traffic, Building, Acoustic Pressure, Noise Intensity, Building Machines, Machine, Mechanization, Construction, Noise Intensity.

Abstract. The article deals with the influence of the noise of construction and reconstruction of roads per capita adjacent apartment buildings in Havlíčkův Brod. It describes a situation where the noise the existing road body, which is in accordance with the limits nař.vl.č.272/2011 is increased by noise from construction activities. The article analyzes the noise situation in each process of construction and apply their outputs in the form of readable data providing inputs for noise studies. The area is expected noise pollution accumulates in the so called old noise pollution with activities of mechanization involved in the construction activities, all in close proximity to residential buildings downtown. There are numerous complaints from citizens. The aim of this article is to determine the percentage increase in noise pollution in the area, including the possible solutions, which could in this help to avoid sanctions or stop the construction.

Introduction

Influence of traffic noise or noise caused by building activities on housing development is an issue of long-term interest for public health authorities and acoustics laboratories. [1] First it is necessary to define the units, which are used for the calculations. Decibel (dB) is a unit of acoustic pressure. The scale of decibels is logarithmic, the individual numerical values cannot be added up, subtracted, or averaged. In case of two noise sources, of which both of them produce 50 dB of noise, the final effect is not 100, but 53dB. The level 60 dB is ten times the amount and 70dB hundred times the amount of acoustic noise compared to 50 dB. The noise intensity is measured in decibels (dB). The noises start at the level of 0 dB, after that come weak tones, which the human ear can recognize, until the strongest, pain-causing 130dB or 180dB noises created by launching rockets. Decibels are measured logarithmically. It means that if the noise is growing stronger by ten decibels, every degree is ten times stronger than the previous one. L_{Aeq} is so-called equivalent noise level. It expresses by one number the level of irregularly changing noise, for example the noise of road traffic. It expresses the energetic content of changeable noise, which sounded at one time by the value of level of stabilized noise, which would, if lasting at the same time as the measured noise, contain the same amount of acoustic energy. The equivalent level of noise is always in regard to particular time interval marked as L_{AeqT}. Usually for work environment is used the equivalent noise level (L_{Aeq}) of eight hours, for non-work environment for day time (L_D), night time (L_N) or the whole day (L_{DN}, L_{24h}). [3] [4]. The value L_{Aeq} evaluating is used by the authorities of public health for evaluation of acceptability/unacceptability of acoustic situation in protected outdoor areas of the buildings. The health limit of equivalent level of acoustic pressure A is set by adding up the basic level of acoustic pressure A $L_{Aeq,T}$ = 50 dB and corrections regarding the sort of protected environment in day and night time. [2]. Besides systematic and long-term measuring of noise emissions by current use of already built roads (noise from traffic), is often performed irregular measuring of noise. These kinds of measuring are usually performed as a part of building planning preparation and building construction for large investment projects of both building or road constructions. [8] We still call these kinds of measuring irregular, even though they are often performed before and during the construction time. [7] [9] They are basis for acoustic studies and evaluations. [5] Part of these studies is also design of noise barriers and control of their efficiency

by later measuring. In the acoustic studies we usually work with the results of measuring of acoustic pressure performed by the producers of the machines, which are used at the construction site. [6]

Description of measurement case studies

In cooperation with certified testing laboratory no. 1617 Akustika Brod s.r.o. was performed noise measuring in non-work environment – outdoor areas in Havlíčkův Brod. The place of measuring was outdoor area of the apartment building at Pražská Street 2873, Havlíčkův Brod. The objective of the measuring was to set the noise value from construction activities during the renovation of the pavement of I/38 road (Masarykova street) in Havlíčkův Brod; that is, setting the level of noise from the operation of cold milling machine WIRTGEN type W 2000 including its accompanying truck, as shown in Figure 1. [11] The noise study was carried out for specific research entitled Modelling the building operation with regard to the aspect of construction noise. The objective of the measuring was to establish the influence of this construction activity on the nearest protected housing development and evaluation of the machine operation in relation to the health limits for noise from construction activities. In this case was measured the noise from particular building machine – compact cold milling machine on belt chassis of the following parameters: cutting width - 2000 mm, cutting depth - 320 mm, engine gross power - 433 kW, operational power capacity 330 m3/h. Cold milling machine W 2000 shows, according to the produces, very low noisiness; the engine is completely closed and besides this, during low outside temperatures (<20°C) the ventilator idles, so the noise emissions are minimized. The operation of the milling machine was conducted during daytime from 7am to 9pm. During the noise measuring the milling took place on the traffic lane in the direction to Kolín. Other construction activity was not recorded during the measuring time. The closest protected housing estates are seven to eight storey-high apartment buildings situated lengthways to the road. On the other side of the road there are high-rise apartment buildings oriented towards the road perpendicularly or sideways. In accordance with the outdoor noise measurement was elected two measuring points. [5] Measuring place MM1 was chosen in the protected outdoor area of the apartment building no. 2873, measuring place MM2 was situated at the other side approximately 14 meters from the machine's track, as shown in Figure 2. [11]. Convenient device for irregular construction noise measuring is the Brüel&Kjaer 2250 phonometer, which allows data transfer and on-line control of the analyzer through USB interface with the use of BZ-5503 programme, which is used to display the measured data, their archivation and export. Other tools for this measuring are: measuring microphone Brüel&Kjær, acoustic calibrator Brüel&Kjær 4231, wind casing Brüel&Kjær UA-1650, 10 meters long microphone cable, metallic tripod (max. height 4 m), anemometer Testo type 4500 with propeller probe 16 mm, Comet Commeter digital record-keeping thermohydrobarometer, HILTI PD42 laser tachometer, SelfLock PSC59 steel tape measure.

Figure 1. Cold milling machine WIRTGEN type W 2000.

Figure 2. Measuring place MM1 and MM2. [11]

Evaluation of data in the case study

This measuring of changeable noise from construction activity excludes from the evaluation the car traffic noise in the other lane. [10] The noise values measured during operation of the road milling cutters and background noise levels are listed in Table 1. Time records Equivalent noise level during operation of cold milling and third octave band analysis of noise is dealt with in the noise study. For the study was considered with the uncertainty of measurement noise space is 1.8 db. [11]

Table 1. Noise levels measured during the operation of the road cutters and background noise levels.

Source of noise	start measuring	end of measurement	Total time measurement	time undisturbed interval measurement	$L_{Aeq,T}$ [dB]	L_{Amax} [dB]	L_{Amin} [dB]
milling road / Project 069	19.5.2014 10:16:32	19.5.2014 10:19:52	0:03:20	0:03:00	**82.5**	90.3	79.6
background noise / Project 068	19.5.2014 10:15:55	19.5.2014 10:16:12	0:00:31	0:00:17	**68.7**	73.9	65.9

Table 2. Noise levels measured during the operation of the road cutters and background noise levels.

Source of noise	$L_{Aeq,T}$ [dB]	L_{Amax} [dB]	L_{Amin} [dB]	L_{A1} [dB]	L_{A10} [dB]	L_{A50} [dB]	L_{A90} [dB]	L_{A99} [dB]
milling road / Project 069	82.5	90.3	79.6	86.1	83.7	82.4	81.0	80.1
background noise / Project 068	68.7	73.9	65.9	70.9	70.4	68.4	66.6	66.1

The evaluation of the measuring and its comparison with health limits according to amendment NV 272/2011 Sb. has proven that from 7am to 9pm the noise from construction activity does not exceed the health limits and between 6am and 7am, and 9pm and 10pm the noise from the construction site does exceed the health limits [11] [2], therefore the beginning of works at 7am is correctly chosen time. [13]

Figure 3. Brüel&Kjaer 2250 phonometer. [12]

Conclusion

Due to the fact that the level of organism's reaction on the noise load depends on the spectre, tonality, speed, intensity change, dynamics, time history, information content, expectancy, and concurrence of noise load, it is up to professional discussion, whether the separation of construction site noise and noise from the existing traffic is the ideal setting for health limits according to

amendment NV 272/2011 Sb. [2] According to citizens' subjective perception it is not so, the noise is perceived comprehensively, inseparably by sources. Also the quality of paving on the second - used - traffic lane will influence the noise creation, because on different paving surfaces the same traffic generates significantly different noise. The difference between solid surface and very broken surface can under certain circumstances make the difference of more than 10dB. The necessity for paving renovation indicates the bad shape of the roads and, therefore, higher noisiness of the passing cars. The difference lowers when the speed of the cars and number of trucks diminishes. In this case the entrance of trucks was not restricted and the speed limit in this zone was set to 50 kph. As a conclusion we can say that if the buildings close to the construction site are inhabited, their inhabitants must not be exposed to higher noise pollution, the noise limits must be met. Obligatory establishment of health limits, however, falls within the competence of territorial competent authority of public health protection; therefore, the possible changes of legislation must be initiated by them.

References

[1] Law no.258/2000 Sb., about protection of public health, as amended by later regulations

[2] Amendment 272/2011 Sb., about protection of health against adverse influence of noise and vibrations.

[3] Czech Technical Standard ISO 1996 (01 1621): Acoustics – Description, measuring and evaluation of environmental noise – Part 2: Determination of environmental noise levels. Czech Office for Standards, August 2009

[4] Czech Technical Standard ISO 1996-2, which, besides other things, specifies methodology for establishing levels of acoustic pressure made by field of acoustic waves falling on buildings' facades

[5] HH ČR no. 62545/2010-OVZ-32.3-1.11.2010 Methodological instructions for unification of methods for authorities for protection of public health and health care centres at the medical inspection during noise evaluation in protected outdoor areas of buildings, Ministry of Health – main public health officer of the Czech Republic

[6] Government regulation no. 194/2000 Sb., which established the technical requisites for production from point of view of the emissions

[7] Government regulation no. 101/2005 Sb., about more detailed requirements for workplaces

[8] Regulation no. 137/1998 Sb., about general technical requirement for constructions

[9] Law no. 309/2006 Sb., which sets other requirements for safety and health protection at work in labour law relationships and about ensuring safety and health protection in activities or services provided outside labour law relationships (law about securing other conditions and health protection at work)

[10] Czech Technical Standard ISO 6395, measuring of exterior noise emitted by machines for ground works (dozers, loading-machines, excavators)

[11] Testing report no. Z15-14 , testing laboratory no. 1617

[12] Information on http://mereni-a-analyza-signalu-hluku-a-vibraci.spectris.cz/produkty

[13] Information on http://www.muhb.cz/uzavirka-komunikace-masarykova

Construction Site Noise and its Influence on Protected Area of the Existing Buildings

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Keywords: Noise, Traffic, Building, Noise Limits, Acoustic Pressure, Noise Intensity, Building Machines, Machine, Mechanization, Construction, Noise Intensity, Noise and Vibration.

Abstract. The article addresses the problem of noise from the perspective of protected building space near the construction. If they are near a building already populated, the residents should not be exposed to elevated noise burden, and according to Government Regulation No. 272/2011 of 24 August 2011 on health protection before adverse effects of noise and vibrations, which are set noise limits. In the process optimization production planning is therefore necessary to address the areas of in-situ noise, its creation, modelling, design methodologies to assess the overall noise at the site. The Article analyzed the issue introduction of new approaches when optimizing for the site and the necessity aspects of noise pollution site in construction technological preparations for the construction. The article defines in detail the sources of noise during construction, dealing with modelling of site noise sources and the value of the protected space structures. It presents examples of noise studies, where captured effect of noise on the nearest places protected sites and residential areas. It presents the methodology of work with the values of the inputs and outputs when working with software support.

Noise Motor Working Tools and Their Measures for Noise Reduction During Construction of Buildings

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Keywords: Noise, Sound Power Level, Noise Level, Motor Working Tools, Filter.

Abstract. This article seeks to highlight the problem regarding noise emitted by chain saws and then solves the limitation of noise, but also try out the various elements that should prevent the spread of noise from those tools. The issue is solved in terms of the applicable standard requirements. It describes elements that were used as to prevent spreading noise. Finally, results from measurements demonstrate applicability of proposed elements in terms of reduction of sound power level. This article deals with the construction noise and builds on ongoing research in this area. For this research can then make some other experiments, follow up on the results.

Vibro-accoustic Comfort Assessment Methodology of Residential Buildings in Urban Environment

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Keywords: Vibro-Acoustic Comfort, Methodology, Building.

Abstract. Noise in residential buildings should be assessed not only in terms of impact on health, safety and performance of inhabitants, but also for the "value" of the building (apartment) in a certain environment. Building energetic certification implementation is one of the first compulsory legislative evaluation criteria. This paper wants to draw the attention to the need for vibro-accoustic building (apartment) certification. Presented tabular evaluation is an objective evaluation. The reason for that are the tendencies related to noise in environment: increased number and levels of noise sources in buildings' exterior and interior, increasing demands for sound insulation of building structures and growing number of "noise" complaints.

Reducing the Negative Effects of City Railways on Houses in Ostrava

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Keywords: Ostrava, Noise, Vibration, Measurement, Rubber Pads, Anti-Vibration Mats, House, Tram, Urban Line, Wheel, Rails, Sleepers.

Abstract. The paper discusses measures to reduce the negative effects of tram traffic on residential house in Ostrava, where the tram line passes through the street area located under the structure of the house.

The lines of urban railways are often kept at densely built-up areas, often in close proximity to the buildings. It is necessary to put a high emphasis on protection against noise and vibration. In case of structures for residential buildings it has a negative effect on residents. An efficient way to reduce the vibration levels of the protected structure and thus the secondary noise is elastic foundation structure as a whole to its support structure. But in practice, we need to solve the problem of the ex post, i.e. when the structure of a residential building already exists.

To reduce the transmission of vibrations to the structure was carried out technical measures for vibration attenuation along the route of the spread it is the path from the source to the protected structure. Railway track was imposed on rubber anti-vibration mats under gravel bed of tram line. Furthermore, the test sections were established in order to test the application of different materials used as a grout space between the rails and the surrounding environment and the reference section to compare the resulting data.

Subsequently was held the measurement of noise and vibration. Vibrations were measured on the own construction of the house, also on the communication - vertical vibration near the track (30 cm far from the running rail track), these data present the transmission of vibration from the rail and sleepers in the immediate surroundings, measuring the vertical vibrations of the road (150 cm far from the running rail track in place that was not affected by reconstruction), these data present the transmission of vibration to the subsoil neighbourhood.

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