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## ENERGY EFFICIENT BUILDINGS – LOWER STRUCTURE

### BUDYNKI ENERGOOSZCZĘDNE – STREFA KONTAKTU Z GRUNTEM

#### Abstract

Part of the package of low-energy and passive houses is the basement and foundation too. A correct proposal of construction detail of buildings that lying on the soil is one of the steps that contribute to reducing energy requirements for heating and operation of building. At the same time increase the quality of the indoor environment as well as performance at work. In the construction of the lower structure, the most delicate point is the contact of walls, foundations and floor structure with the soil and subsoil, this frequently leads to inconsistent solutions of the design detail, resulting in the formation of thermal bridges with subsequent condensation

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

#### Streszczenie

Poprawne rozwiązanie szczegółów budynku będących w kontakcie z ziemią jest jednym z istotnych kroków, które przyczyniają się do zmniejszenia zapotrzebowania na energię do ogrzewania i eksploatacji budynku. Jednocześnie poprawie ulega jakość środowiska wewnętrznego i wydajności pracy. W dolnej części budynku najbardziej wrażliwe są miejsca styku ścian, fundamentów oraz podłogi z gruntem i podłożem, są one często niewłaściwie rozwiązywane, powodując powstawanie mostków termicznych i dalej kondensację pary wodnej.

*Słowa kluczowe: konstrukcja budynku, podłoga na gruncie, izolacja termiczna, budynki na terenie*

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## 1. Introduction

The correct proposal of construction details is one of the steps which will contribute to reducing energy requirements for the heating and operation of the buildings which are situated on the terrain whilst at the same time, increasing the quality of the indoor environment as well as performance at work.

In our case within the construction solution of a detail where the wall, foundation and floor are in contact we must consider many requirements. In addition to the structure and thermal protection must be taken into account requirements as follow as: waterproofing, fire safety, antiradon measures, statics, economy and impact of outdoor and indoor environment.

The quantity and type of thermal insulation material is very important too. Compliance with this requirements is the deciding factor that contributes to the optimization of the construction details.

### 1.1. The design possibilities of a new generation of ground floors for energy efficient buildings

#### 1.1.1. Boundary conditions for the calculation

Outside winter air temperature shall designate the location of the building, depending on the geographic location according to maps of temperature fields and, depending on altitude **Košice 297 m above sea level** (2. temperature region),  $\theta_e = -13^\circ\text{C}$ . The relative humidity of ambient air is determined by the ambient temperature as calculated:  $\varphi_e = 84\%$ . Calculation of the internal air temperature for the residential part of the building:  $\theta_i = 20^\circ\text{C}$ . Relative humidity of indoor air:  $\varphi_i = 50\%$ . Surcharge for heating temperatures dipped to decrease indoor air: **to 5 K**.

### 1.2. Results of 2D modeling of details for new generation of the lower structure for energy efficient buildings

Distribution of temperatures and heat flows under the buildings (as you can see below) and its immediate vicinity is closely linked with the correct calculation of the total heat loss of assessed buildings. The detailed analysis of the building structure show us what impact the location of insulation has and its mutual combination as well as the overall solution of the detail. In our case we're speaking about the detail where are external wall, basement and floor in contact with a soil as yiu see below.

Here are the following variants:

- establishment with thermal insulation of basis and external wall,
- establishment with special block and plinth insulation,
- establishment on block of foam glass and plinth insulation,
- establishment on brash of foam glass,

**Variant 1:** Establishment with thermal insulation of basis and external wall. This method (Fig. 1) is the most used in Slovakia for ordinary houses in the energy standard. Thermal insulation of the external wall continues up to the lower edge of the base strip. Thermal

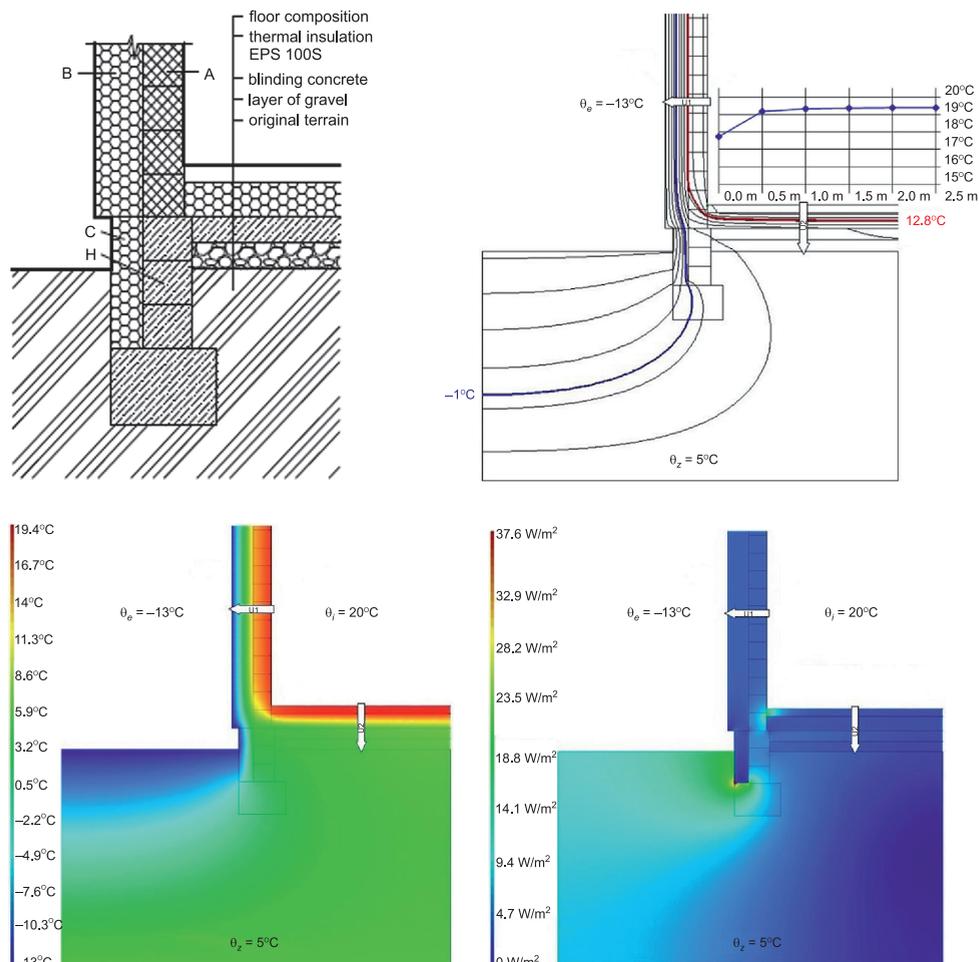


Fig. 1. Establishment with thermal insulation of basis and external wall (A – Ytong P2-400, B – expanded polystyrene EPS 70F, C – extruded polystyrene Styrodur 2800C, H – form block DT30) – results of 2D modeling of detail and cours of temperature

insulation in the floor is laid on the upper surface of the base plate (slab). Thermal insulation of external walls and in the floor is separated by external construction.

**Variant 2:** Establishment with special block, with plinth insulation. The thermal bridge, which forms the cladding in contact with the base plate (slab) can be interrupted by polystyreneconcrete shapes KS-ISO KIMMSTEIN. This method can be still combined with plinth insulation or without this insulation (Fig. 2).

**Variant 3:** Establishment with special block, with plinth insulation. The thermal bridge, which forms the cladding in contact with the base plate (slab) can be interrupted by block of foam glass PERINSUL. This method can be still combined with plinth insulation or without this insulation (Fig. 3).

**Variant 4:** Establishment on brash of foam glass. Establishment on brash of foam glass is a relatively new solution. Brash of foam glass is poured into the tub which is lined with extruded polystyrene boards. Backfill is compacted at a ratio of 1:1.25. Thereafter is situated reinforced concrete base plate (slab) on backfill of foam glass (Fig. 4).

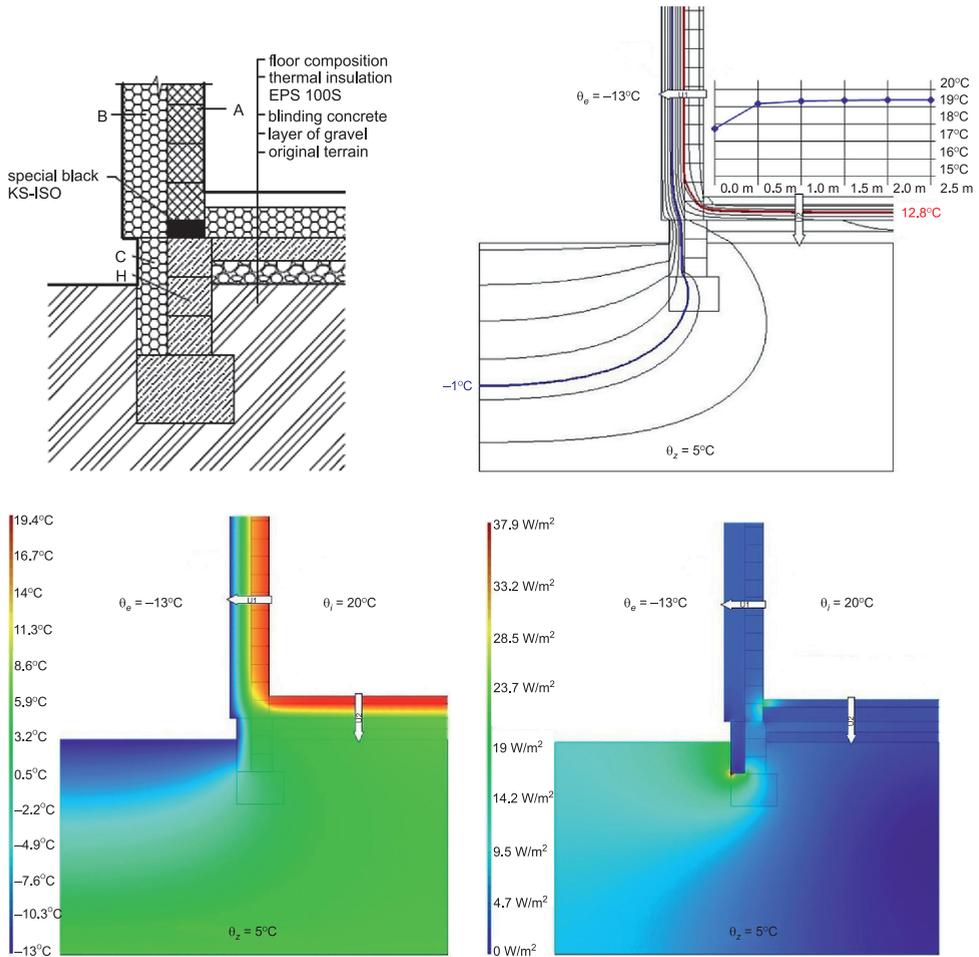


Fig. 2. Establishment with special block – KS-ISO, with plinth insulation (A – Ytong P2-400, B – expanded polystyren EPS 70F, C – extruded polystyren Styrodur 2800C, H – form block DT30,) – results of 2D modeling of detail and course of temperature

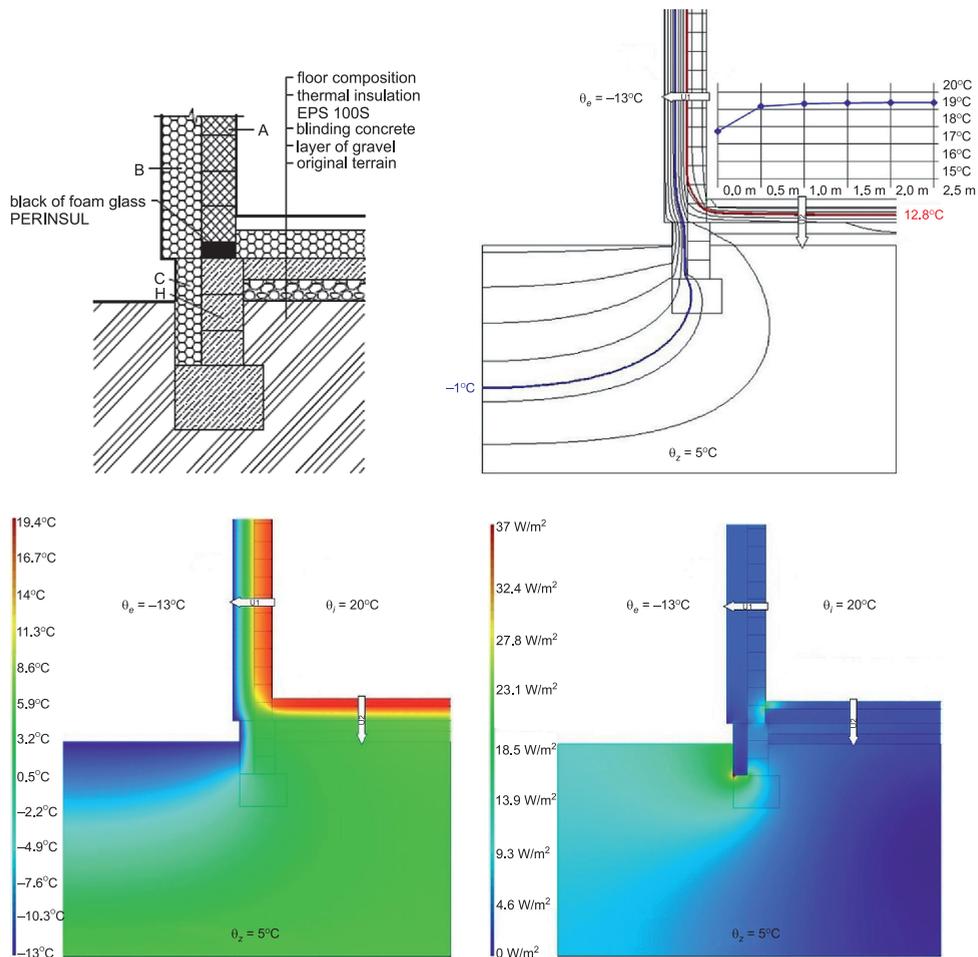


Fig. 3. Establishment with special block – PERINSUL, with plinth insulation (A– Ytong P2-400, B – expanded polystyren EPS 70F, C – extruded polystyren Styrodur 2800C) – results of 2D modeling of detail and course of temperature

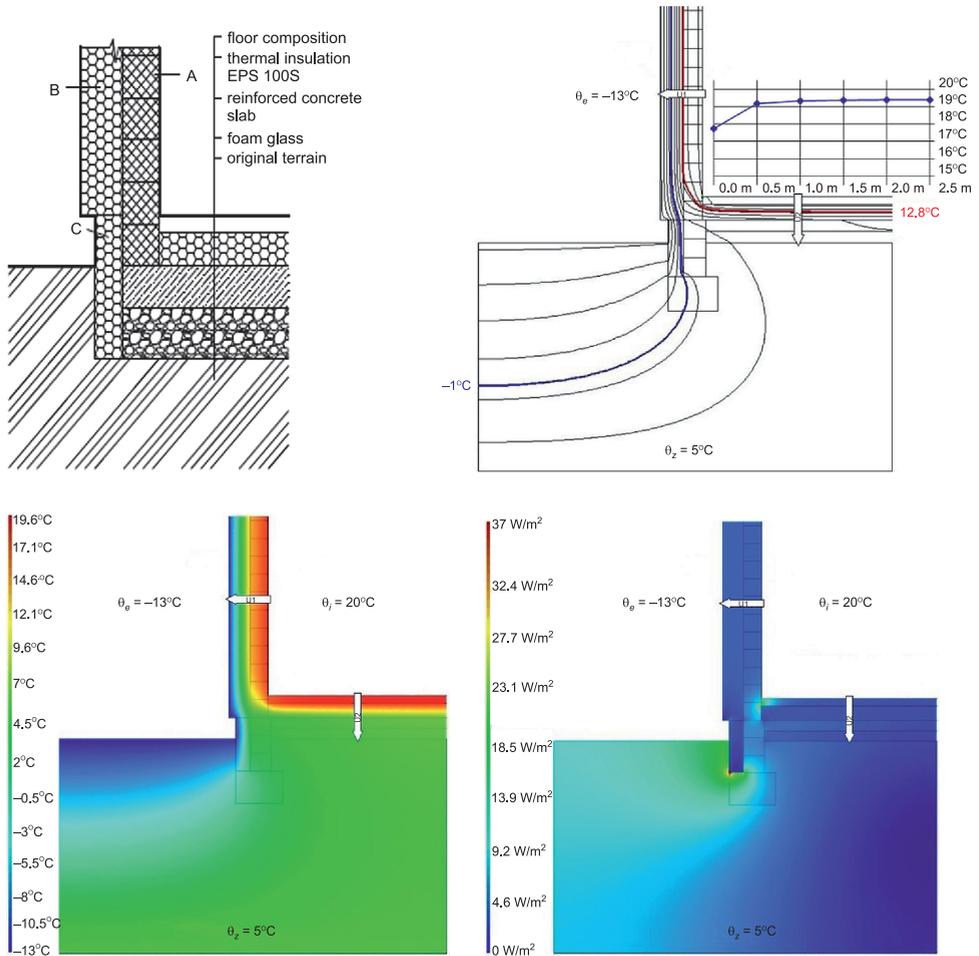


Fig. 4. Establishment on brush of foam glass (A – Ytong P2-400, B – expanded polystyren EPS 70F, H – form block DT30) – results of 2D modeling of detail and course of temperature

## 2. Conclusion

Thermal insulation is now a word that we hear all around, particularly with respect to rising energy prices in line with the long-term strategic goals of reducing emissions and improving energy efficiency in buildings. This is the subject of European Parliament and Council 2013/31/EU of 19<sup>th</sup> May 2010 on the energy performance of buildings. The European Union has committed to reduce overall greenhouse gas emissions by 20% of what it was in 1990 by 2020. By the same date, to reduce energy consumption in EU countries by 20% and to achieve 20% share of renewable energy sources of total energy consumption. This can also contribute to solving the lower structure for a new generation of energy efficient buildings. The simulation model will be compare with measurement in situ [2]. Based on the results of measurements and after fine-tuning simulations of the experimental building will be to obtain relevant results applicable in practice for the design of passive buildings. It will be in compliance with basic hygienic requirements in terms of structures, indoor environment and in terms of design and use of heating or ventilation systems.

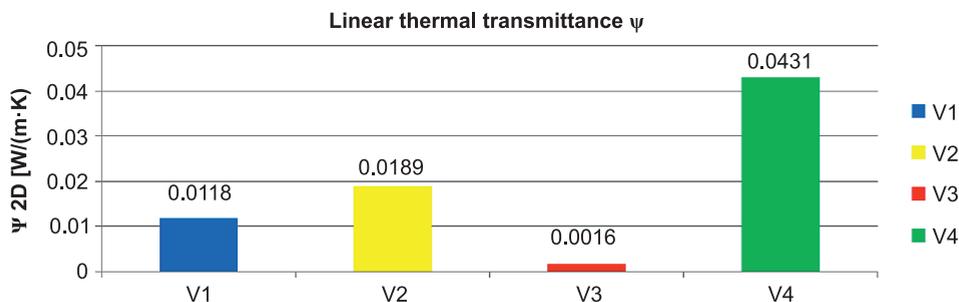


Fig. 5. Linear thermal transmittance

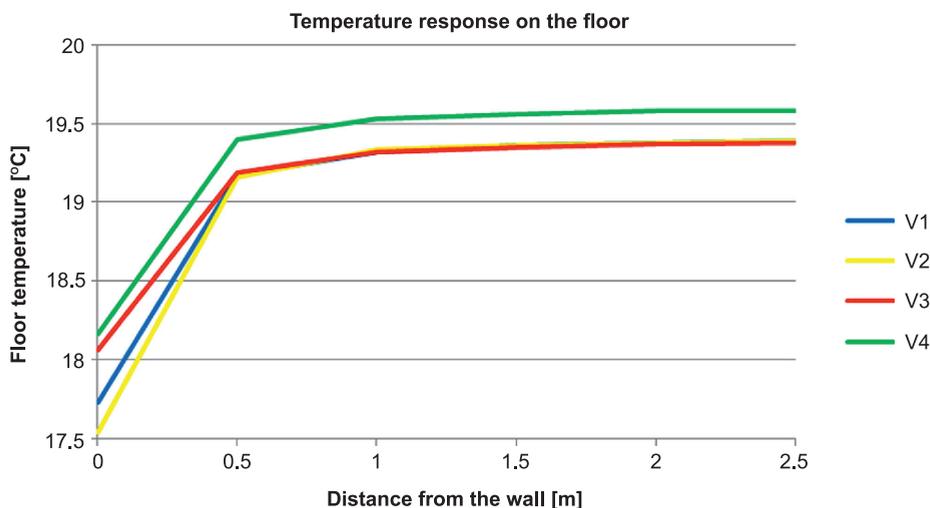


Fig. 6. Temperature response on the floor of variant 1–4

**Representation of the structural modifications for each variants detail**

Sign	$U_{\text{wall}}$ [W/(m <sup>2</sup> ·K)]	$U_{\text{floor}}$ [W/(m <sup>2</sup> ·K)]	$\theta_{si}$ [°C]	$f_{Rsi}$ [-]	$L_{2D}$ [W/(m·K)]	$L_{2D,wall}$ [W/(m·K)]	$L_{2D,floor}$ [W/(m·K)]	$\Psi_{2D}$ [W/(m·K)]
Variant 1	0.104	0.17	17.73	0.93	0.527	-0.26	-0.256	0.0118
Variant 2	0.104	0.17	17.54	0.93	0.534	-0.26	-0.256	0.0189
Variant 3	0.104	0.17	18.06	0.94	0.514	-0.26	-0.256	0.0016
Variant 4	0.104	0.099	18.16	0.94	0.452	-0.26	-0.149	0.0431

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