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A BUILDING MADE OF POLYSTYRENE PREFABRICATES FROM THE PERSPECTIVE OF NEW TECHNICAL CONDITIONS AND STANDARDS OF NF15 AND NF40

BUDYNEK Z PREFABRYKATÓW POLISTYRENOWYCH W ŚWIETLE NOWYCH WARUNKÓW TECHNICZNYCH ORAZ STANDARDÓW NF15 I NF40

Abstract

The article describes the results of performed calculations of heat transfer through the divisions of buildings designed in the technology of polystyrene prefabricates. All results were referred to the values contained in the new Technical Conditions. The article also contains the results of linear simulations of thermal bridges in the cited technology.

Keywords: *heat transfer coefficient, thermal bridges, technical conditions, polystyrene prefabricates*

Streszczenie

Artykuł opisuje wyniki przeprowadzonych obliczeń przenikania ciepła przez przegrody budynku zaprojektowanego w technologii prefabrykatów polistyrenowych. Wszystkie wyniki odniesiono do wartości zawartych w nowych Warunkach Technicznych. Artykuł zawiera również wyniki symulacji liniowych mostków termicznych w przytoczonej technologii.

Słowa kluczowe: *współczynnik przenikania ciepła, mostki termiczne, warunki techniczne, prefabrykaty polistyrenowe*

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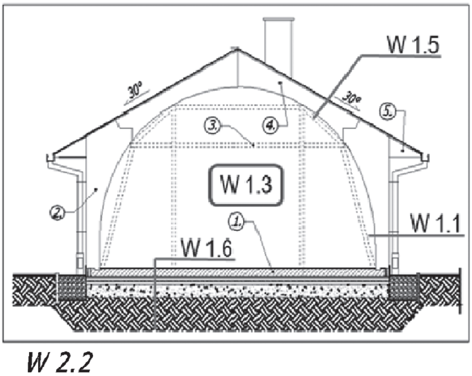
1. Introduction

New law regulation have been implemented in Europe. They improve energy efficiency of buildings and new initiatives are created to support low-energy and passive building engineering. Currently in Poland the new Technical Conditions are in force, which brings more changes in the years 2014, 2017 and 2021. Deciding to build a low-energy house, investors must take into account the higher cost of erecting these houses. However, the buildings meeting the relevant standards can be partially financed by the support from the National Fund for Environmental Protection and Water Management (NFOŚiGW). Subsidies are divided into two categories, closely linked to the categories of buildings: NF15 and NF40.

The technical Conditions adopted in 2014 and subsidies from the National Fund for Environmental Protection and Water Management steer the development of building engineering onto the area of Poland in the nearest years. The analysis of current technologies of erecting buildings designed to compare the ownership of the buildings with the requirements of the adopted changes in regulations becomes important. The article describes the analysis of meeting the chosen building parameters that were compared with the values required by the Technical Conditions and by the guidelines for subsidies to the standards of NF15 and NF40.The single-family house built in the technology of the M3 System was subjected to the analysis. Parameters included in the analysis are: heat transfer coefficients and coefficients for linear thermal bridges.

2. Short description of the M3 System technology



W 2.2

1.	Reiforced-concrete column 14cm x 24cm	

W 2.4

1.	Reiforced-concrete beam 16cm x 22cm	

W 1.1

1.	Mineral plaster+fiberglass mesh	1,0cm
2.	Self-supporting polystyrene monoblocks	30,0cm
3.	Cement-limestone plaster+fiberglass mesh	1,5cm

W 1.3

1.	Mineral plaster+fiberglass mesh	1,5cm
2.	Foamed polystytene	15,0cm
3.	Cellular concretet tile	24,0cm
4.	Cement-limestone plaster+fiberglass mesh	1,5cm

W 1.5

1.	Tin plate with glue	0,6cm
2.	Fiberglass meshand glue dedicated to polystyrene	1,0cm
3.	Self-supporting polystyrene monoblocks	30,0cm
4.	Cement-limestone plaster+fiberglass mesh	1,5cm

W 1.6

1.	Parquet	2,0cm
2.	Lean concrete	5,0cm
3.	Foamed polystytene	5,0cm
4.	Reiforced-concrete slab	18,0cm
5.	Foamed polystytene	15,0cm

Fig. 1. Constructional scheme. Description in the text

The examined technology is based on the use of foamed polystyrene monoblocks in form of large-scale prefabricates. Building elements are placed onto the foundation plate. They are attached to the foundation plate using a proper solution based on fiberglass mesh and glue dedicated to polystyrene. Polystyrene elements are constructed in the shape of arc which allows to perform a very thermally tight building envelope. Technology is complemented with gable ends made in any technology. In the analyzed building, there is a gable end made of cellular concrete with a thickness of 24 cm. More about the technology can be found on the website of the M3 System company and in the article [1]. Fig. 1 shows the scheme of prefabricated elements arrangement. Where: 1 is the floor on the ground, 2 – wall element of the monoblock, 3 – beam of the gable end, 4 – prefabricated roof component, 5 – finishing element.

3. The coefficient of heat transfer through the basic divisions in the building and the requirements contained in the Technical Conditions

Building divisions were marked and described in (Fig. 1). According to the Polish standards, the heat transfer coefficients for individual partitions were determined. It should be noted, that for the purpose of the calculation and subsequent simulation, the least favorable options of partitions were assumed. For partitions at the variable thickness, the narrowest variants of a constant thickness were assumed. The results of calculations combined with the requirements of the Technical Conditions are shown in (Table 1).

Table 1

Heat transfer coefficient

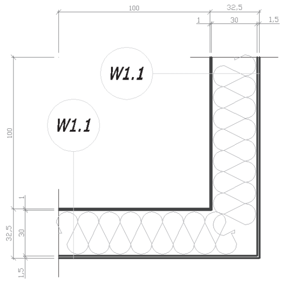
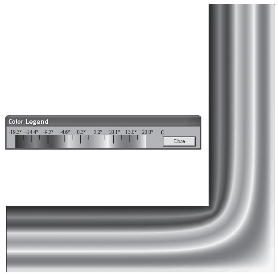
Division type	U [W/m^{2}K]			
	Designated	Requirements of Technical Conditions		
		2014	2017	2021
Floor on the ground	0.184	0.30	0.30	0.30
Roofs	0.129	0.20	0.18	0.15
External walls – made of prefabricates	0.128	0.25	0.23	0.20
External walls – gable ends, cellular concrete	0.160	0.25	0.23	0.20

4. Thermal bridges

The article uses the method of simulating the flow of heat flux available in the Therm program. Bridges from a) to f) were determined using data from the Polish standards, and [2]. For bridges of g) and h), the requirements and calculation algorithms like in [3] were applied. Schemes of analyzed thermal bridges, and the distribution of heat flow is shown in (Tab. 2) and the values of linear coefficients of thermal bridges can be found in (Tab. 3).

Table 2

Distribution of heat flux flow

<table>
<tr><td>a)
</td><td></td></tr>
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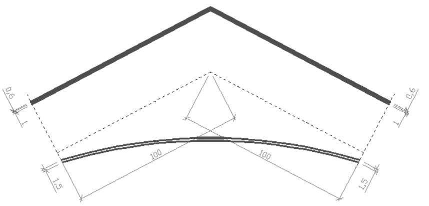
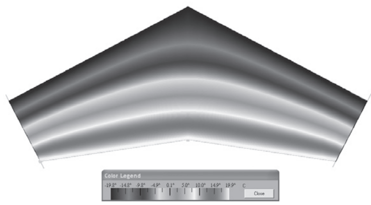
</td><td></td></tr>
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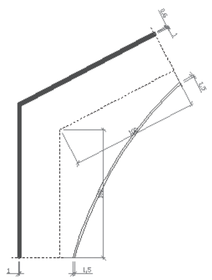
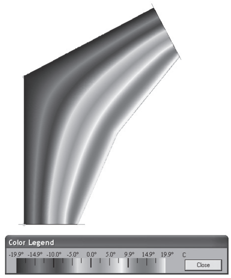
</td><td></td></tr>
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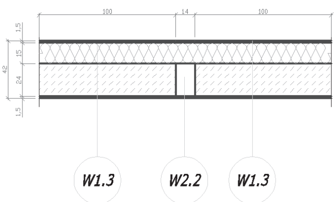</td><td></td></tr>
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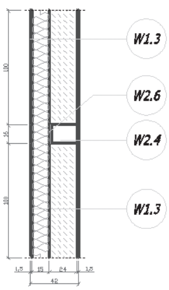</td><td></td></tr>
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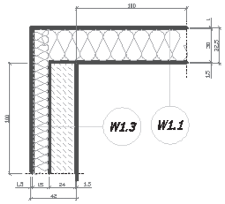
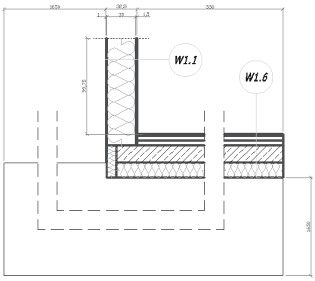
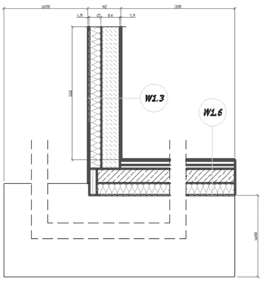
f)



g)



h)



T a b l e 3

Coefficients of the linear thermal bridges

Designation	Bridges presence location	Ψ_e [W/mK]
a)	Connection of two walls – M3 System	0.023
b)	Connection of system elements in the roof ridge	–0.105
c)	Connection of wall and roof system elements	–0.129
d)	Reinforcement of the gable end made with the reinforced concrete pole	0.115
e)	Reinforcement of the gable end made with the reinforced concrete beam	0.117
f)	Connection of the M3 System wall with the gable end made of cellular concrete	0.078
g)	Connection of the M3 System wall with the floor on the ground	–0.119
h)	Connection of the gable end with the floor on the ground	0.037

5. Conclusions

Simulations and comparative analysis indicate that the M3 System technology already meets the requirements of the Technical Conditions that will be in force from 2021 (in 2021 TC will best ricter than they are today).

The designated values of linear thermal bridges in the analyzed technology show that the M3 system technology fits in a NF15 standard. The only location that should be slightly improved are bridges in the gable end made of cellular concrete. Without changing anything in the solutions of divisions, the conditions of NF40 are met. It should be noted that the presented parameters constitute only a part of the requirements that must be met when seeking for the subsidies from the National Fund for Environmental Protection and Water Management.

M3 System is one of the few technologies in Poland which meet the conditions of NF15 and TC of 2021. The thermal insulation of these buildings is at the level of high energy-efficient constructions. Referring to the article [4] M3 System technology is prepared for the changes that the New Thermal Conditions will bring into Poland. This readiness can contribute to dominate the low-energy construction sector in Poland.

References

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[3] Olszar P., Pawłowski K., *Analiza parametrów fizykalnych przegród budowlanych stykających się z gruntem*, Izolacje, 5/2011.

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[6] PN-EN ISO 6946:2008 Komponenty budowlane i elementy budynku. Opór cieplny i współczynnik przenikania ciepła. Metoda obliczania.

[7] PN-EN ISO 13370:2008 Cieplne właściwości użytkowe budynków. Wymiana ciepła przez grunt. Metody obliczania.

[8] PN-EN ISO 10456:2009 Materiały i wyroby budowlane – Właściwości cieplno-wilgotnościowe – Tabelaryczne wartości obliczeniowe i procedury określania deklarowanych i obliczeniowych wartości cieplnych.

[9] TECHNICAL CONDITIONS – Rozporządzenie Ministra infrastruktury z dnia 12 kwietnia 2002 r. w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie (wraz ze zmianami do 2014 r.).