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STUDY OF THERMOPHYSICAL PROPERTIES OF BUILDING ENVELOPES IN THE MONOLITH-BRICK HOUSES OF ST.-PETERSBURG

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Abstract: *This article describes the issues related to climatic conditions that occurred in Saint Petersburg for the last 100 years. Presented some types of building envelope with the heat engineering defects. The recommendations for improving the thermal qualities of walling.*
Key words: *climate, construction, ceiling, building envelope, building thermal physics, heat engineering of defect.*

INTRODUCTION

Over the past century the average annual temperature of the globe has risen by 0.6^0 C. [1] . During this time, and changed climatic characteristics in St. Petersburg. Since the 1980s there actively increasing the average global air temperature. This to reduce to the fact that the duration of the winter period, for a specified period of time was reduced by 13 days compared with the first half of the 20th century. Mainly due to an earlier onset of spring. The shift of the end of winter has shifted to a cooler part of the year. Beginning of the winter period remains unchanged. Winters in St. Petersburg become much colder. [2].

In this regard, the question of energy efficiency of housing erected in the city of St. Petersburg since the late 1990s. with cast-frame technology. Houses of that type of usually construction system is cross-wall. Multivariate design solutions walling in such buildings [3], and the complex of the research suggests that it is not always maintained the required level of temperature and humidity, which has a substantial impact in creating comfortable living conditions. In St. Petersburg, widespread homes made of brick-monolithic technique. Modern approach is the construction of such buildings can significantly improve the space-planning decisions [3,6] and improve the quality of work. However, using a constructive solution walling of buildings is not always possible to provide the necessary temperature and humidity conditions, which has a significant influence on the creation of comfortable living conditions. In some homes, noted complaints of residents on low temperature in living rooms during the cold season, which makes it necessary to use additional electric heating housing. In this connection, there is need to conduct research aimed at increasing thermal protection in buildings of this type.

STAGES OF THE FULL-SCALE SURVEY (этапы выполнения натурных обследований)

The studies involved two stages. The first step is live-examination of certain types of walling in the monolith-brick apartment buildings. In the second phase was carried out computational and theoretical analysis of the considered types of walling.

Shown in fig. 1 building envelope cladding, includes reinforced concrete is a monolithic slab 200 mm thick. At a distance of 200 mm from the outer end of the plate, its thicker is perforated, extruded polystyrene to fit into insulation material, dimensions 150h300h200 mm. Exterior walls building are sample multilayered construction , consisting: of masonry 120 mm thick, insulating layer - foam concrete 300 mm and the inner layer of plaster 20 mm thick.

The study was conducted as follows: the top (floor) and lower (ceiling) face of the slab, were divided into a series of vertical and horizontal lines, the grid was adopted by the size 100x100 mm. At the points of intersection of these lines were measured by a special instrument by which to determine temperature, thermal flow and humidity. After processing, the digital readings obtained during full-scale survey was determined by the temperature field slabs. The numerical values of measured quantities are summarized in table 1,2. Built on the results of the experiment schedules are shown in fig. 2, 3.

The studies were conducted in the morning time period for the following parameters of external and internal environment: $t_{ext} = -18^{\circ} C$, $t_{\text{int}}^{\text{ñðåä.}} = 18.2^{\circ} C$, $\varphi_{\text{int}} = 19.7\%$. In this case, heating the premises of its central heating system. Daily temperature fluctuations ranged from - 14.6^{0} to -19.6^{0} C.

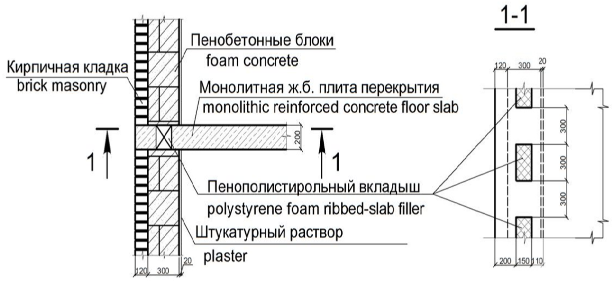

Fig. 1. *Fragment building envelope*

On the surface slab, where it is the ceiling temperature variation in the first row is: 10.75^{0}C minimum, maximum 11.5^{0}C, a temperature drop Δt at the same time was equal to 9.25^{0} C and 8.5^{0} C respectively.

In the next series, a tendency to increase the growth temperature is retained. The temperature increment for each row of the average fluctuated and ranged from 1.3^{0} C to 0.15^{0} C.

In depth study area monolithic reinforced concrete slab, a zone of low temperature has not changed, has not reached its maximum to the normalized values [3,4].

On the surface slab, where it is a the floor, wide differences in temperature in the first row is: 9.75^{0}C, a minimum value and maximum 10.75^{0}C, the temperature drop Δt at the same time was equal to 10.25^{0} C and 9.25^{0} C , respectively.

In the second row, the minimum and maximum temperatures were equal 9.25^{0}C and 10^{0}C. The temperature drop at the same time was 10.25^{0} C and 10^{0} C.

In the next series, the trend towards an increase in temperature rise is insignificant. The temperature increment for each row of the average fluctuated and ranged from 0.2^{0} to 0.35^{0} C.

In depth study area monolithic reinforced concrete slab (floor), low temperature zone preserved, without reaching the normalized values was 13.9^{0} C.

Table 1

№ series	The length of the test area floor slab (ceiling), mm						
	0	100	200	300	400	500	600
	The temperature at the nodal points, ^{0}C						
1	11	11,5	12,25	13,5	14,25	15,25	16,25
2	10,75	11,5	12,5	13,3	14,25	15,3	16,0
3	11,0	12,0	12,75	13,55	14,55	15,35	16,1
4	11,15	12,15	12,7	14	14,75	15,3	16,15
5	11,25	12,25	13,3	14,25	14,75	15,3	16,25

№ series	The length of the test area floor slab (ceiling), mm					
	700	800	900	1000	1100	1200
	The temperature at the nodal points, ^{0}C					
1	16,25	16,75	17,5	17,55	17,6	17,55
2	16,3	16,8	17,55	17,60	17,65	17,65
3	16,35	16,85	17,6	17,7	17,75	17,7
4	17,0	17,25	17,65	17,7	17,5	17,6
5	17	17	17,75	17,75	17,8	17,75

Table 2

№ series	The length of the test area floor slab (ceiling), mm						
	0	100	200	300	400	500	600
	The temperature at the nodal points, ^{0}C						
1	10,75	9,25	10,5	11,5	11	11,1	11,25
2	9,25	9,5	10,75	11,25	11	11,1	11,25
3	9,0	9,75	11	11	11	11,1	11,25
4	9,75	10	11	11,5	11	11,25	11,6
5	9,75	10	11	11,5	11	11,25	11,6

№ series	The length of the test area floor slab (ceiling), mm					
	700	800	900	1000	1100	1200
	The temperature at the nodal points, 0C					
1	11,5	11,75	12	12,25	14	13,9
2	11,5	11,75	12,1	12,2	13,9	13,9
3	11,5	11,8	12,9	12,2	13,5	13,6
4	12,5	12	11,8	12,1	12,8	12,9
5	11,5	12	11,8	12,1	12,8	12,85

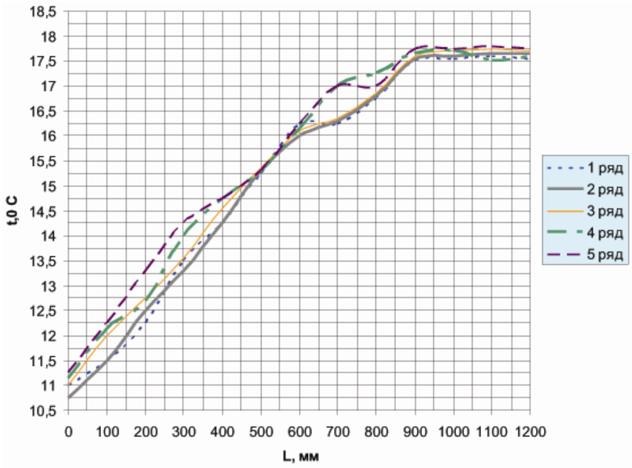

Fig. 2 *The temperature distribution on the surface of the slab ceiling*

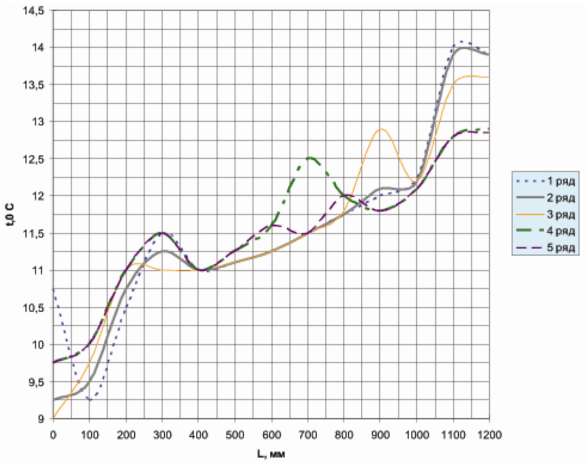

Fig. 3 *The temperature distribution along the slab-floor*

1. THE CALCULATION RESULTS IN A PROGRAM COSMOS

The purpose of computational and theoretical studies was to compare the results of calculations with experimental data obtained during field tests. The studies were conducted using the software package COSMOS.

The temperature of interior and exterior wall cladding layer was calculated in addition, values of which were $\tau_{\text{int}} = 16.64^0 C$, $\tau_{ext} = -17.4^0 C$. In addition, the varied outdoor and indoor air temperature. The design scheme of the investigated site is presented in fig. 4.

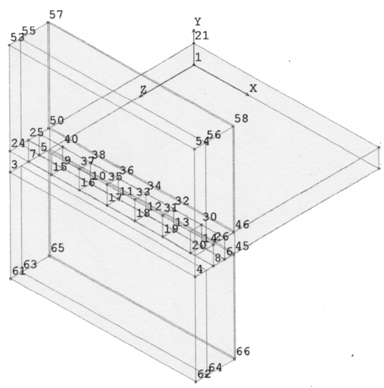

Fig. 4 *Diagram of study design*

When the computational and theoretical studies varied parameters:

- α - heat transfer coefficient at the outer and inner surface; α =4.5-8.7 W/m^2 ^{0}K .
- λ - thermal conductivity for insulation, these values vary from 0.038 to 0.038 to 0,043 W/m^2 C;
- δ - thickness of the monolithic concrete slab wondered equal 160, 180, 200 mm. Some results of calculations of the study design are shown in figure 5.

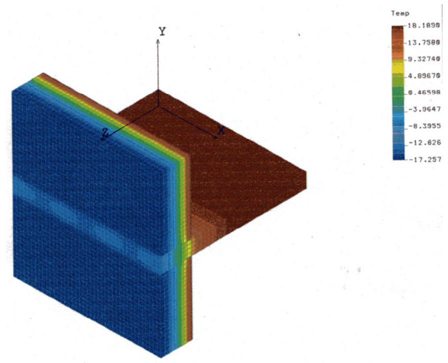

Fig. 5. The results of calculation at a temperature equal to

$$t_{ext} = -18^{\circ} C,\ t_{\text{int}}^{\tilde{n}\eth\hat{a}\ddot{a}} = 18.2^{\circ} C,\ \varphi_{\text{int}} = 19.7\,\%$$

2. CONCLUSION

Analysis of the research shows that the zone of low temperatures on the surface slab has the same temperature fluctuations as in the experiment. Meanwhile, the process of their distribution in the computational model differs in length and less than 500 mm. The reason lies in a number of assumptions made in this case, in particular the not possible to take into account all factors affecting the heat transfer in buildings.

As evidenced by the results of the investigations, the application of the considered types of frame structures with modern materials can not fully ensure comfortable living conditions. It is recommended to improve thermal properties of building envelopes in the nodal connections by constructing additional heat protection.

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ИЗСЛЕДВАНЕ НА ТЕРМОДИНАМИЧНИТЕ СВОЙСТВА НА СТРОИТЕЛНИТЕ ПАКЕТИ В МОНОЛИТНО БЛОКОВИ СГРАДИ В САНКТ ПЕТЕРБУРГ

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Ключови думи: *климат, строителство, таван, строителен пакет, строителна термофизика, , дефект на топлинното инженерство..*

Резюме: *В този доклад се описват проблеми, свързани с климатичните условия, които са възниквали в Санкт Петербург през последните сто години. Представени са някои нидове строителни пакети с топлинни инженерни дефекти. Направени са препоръки за подобряване на термичните качества на облицоването на стени.*