SRO-E-070-024-F-R

Certificate of authorization for works in the area of energy inspection as a member of SRO NP “Centre of New Energy Saving Technologies “ENERGY AUDIT AND ENERGY EFFICIENCY”

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REPORT OF RESEARCH OF ENERGY EFFICIENCY OF BRONYA (BRONYA WINTER) HEAT INSULATION

Thermovision inspection of enclosing structures

Residential apartment building in Saint-Petersburg, Prospekt Solidarnosti, 9/3

Individual entrepreneur
20.10.2013

Candidate of economic sciences
SERGEY IVANOVICH DAVYDOV

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REPORT
OF RESEARCH
OF ENERGY EFFICIENCY
OF BRONYA (BRONYA WINTER)
HEAT INSULATION

Produced according to
TU 2216-006-09560516-2013 by SPA "Bronya"

Thermovision inspection
of enclosing structures

Residential apartment building
in Saint-Petersburg,
Prospekt Solidarnosti, 9/3

Prepared by the individual entrepreneur
Candidate of economic sciences

S.I. Davydov
(signature, seal)

2013

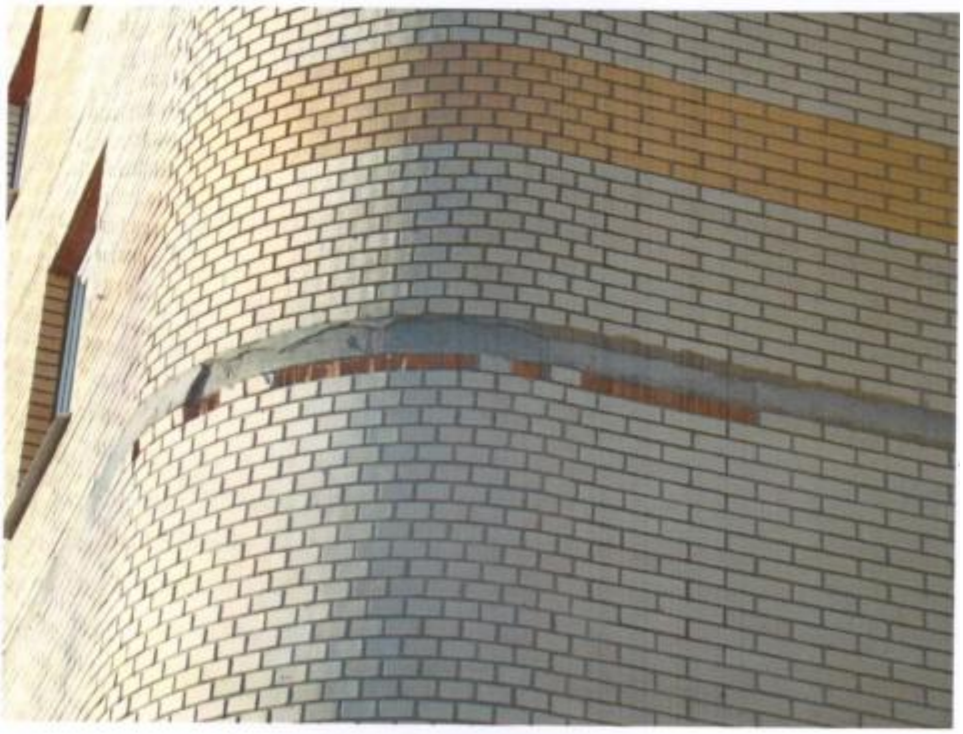
1. General information

Voluntary energy examination is subject to the provisions of Article 15 Federal Act RF No.261-FZ of November 23, 2009 “On Energy Saving and Enhancement of Energy Efficiency and Amendments in Some Legal Acts of the Russian Federation”.

The objects of the repeat voluntary energy examination were bearing and enclosing structures of a residential apartment building in Saint Petersburg, Prospekt Solidarnosti, 9/3, fragments of which are painted with Bronya liquid heat insulation.

The structure of the residential apartment building includes a bearing reinforced concrete frame, with bearing floor slabs going into balcony slabs. The enclosing structures consist of gas concrete blocks and brick. Project design aimed at reduction of heat loss through floor slabs and balcony slabs is represented by thermal inserts from foam material in the places of projection of a floor slab above the heated building area.

Picture 1. Overall view of the residential apartment building



Picture 2. Destruction of a floor slab edge

Visual inspection of the enclosing structures carried out in February 2013 showed local destruction of the protective layer of the concrete slab and the facing brick. The main reason for destruction of the brickwork and the projecting part of the concrete slab under such conditions is pressure on pore sides and mouths of microcracks imposed by freezed water appearing on the enclosing structures because of atmospheric precipitation. Recurrence of freezing and defrosting causes gradual softening of the concrete structure and its destruction. Firstly destruction affects the projecting sides, then step-by-step spreads deep into the concrete.

The visual inspection included thermal imaging of the enclosing structures, results of which are specified below. The maximum temperature drop in the building facade at the outside air temperature of -1.5°C was 8.9°C, the temperature drop in the inner surface of apartment walls, at the air temperature of +23.0°C, was 8.1°C. Significant temperature drops at the enclosing structures surface proved the low efficiency of the building heat insulation.

In 2013 on the basis of the investigation results, in order to prevent further destruction of the surface layer and to eliminate cold bridges of the enclosing structures, it was recommended to develop technical solutions with application of liquid heat insulation.

Technical solutions for elimination of cold bridges and prevention of further destruction of the floor slab concrete implied a protective coating of Bronya Winter heat insulation.

Additional heat insulation with application of Bronya Winter liquid heat insulation was performed in the autumn of 2013 at the temperatures close to subzero. According to the manufacturer’s data Bronya Winter heat insulation consists of a composition of special acrylic polymers and foamglass microgranules dispersed in it, as well as of coloring, fire-retarding, rheological and inhibiting additives which make it possible to work at the minimum temperature of -30°C.

Picture 3. Application of Bronya Winter heat insulation on the butt end of a reinforced concrete floor

Picture 4. Fragment of the building facade with Bronya Winter heat insulation applied

Picture 5. Fragment of the building facade with Bronya Winter heat insulation applied

Picture 6. Fragment of the building socle with Bronya Winter heat insulation applied

Picture 7. Fragment of the building socle with Bronya Winter heat insulation applied

2. Thermovision diagnostics

Energy examination was performed with application of the method of thermovsion diagnostics of thermal fields on the surface of the enclosing structures from the inside and outside of the building.

Thermovision diagnostics of thermal fields makes it possible to check the main heat engineering properties of the enclosing structures of residential premises promptly and with minimal expenses.

Thermovision diagnostics includes estimation of heat loss through the enclosing structures both at the moment of examination and under design conditions of residential premises. Thermal imaging clearly shows defects associated with enhanced heat conductivity and air permeability: wall defects, joints between different materials and structures of walls, junctions of floors, areas of enhanced exfiltration and infiltration in the joints between slabs or in rabbet ledges, defects of window installation.

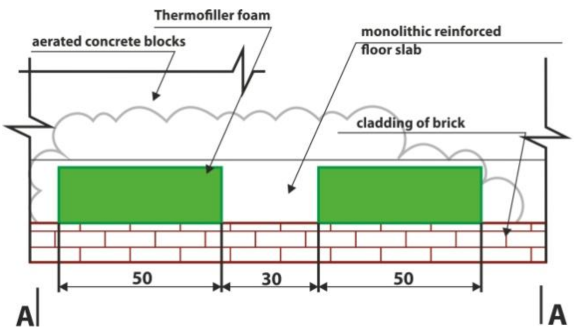
In the course of thermovision diagnostics thermograms were made, as well as pictures and schemes of operation of thermal inserts additionally painted with Bronya Winter liquid heat insulation.

The thermograms processed in IRSoft are shown below.

Actual and recommended heat insulation schemes

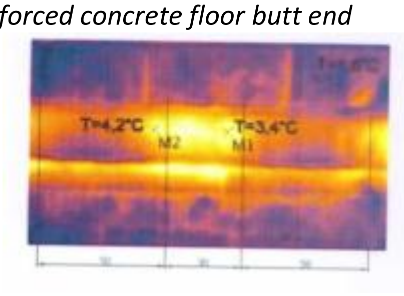
Comparative thermograms of fragments of the reinforced concrete floor butt ends

Thermal insert in floor slabs without coating

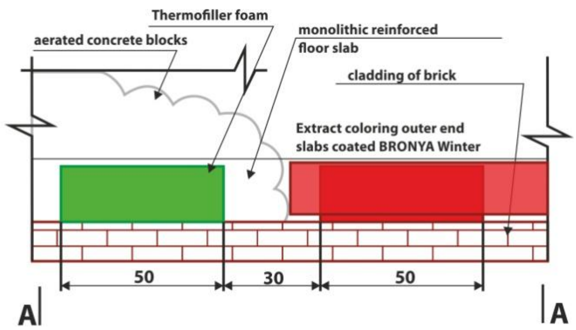


View A-A

Thermogram of a fragment of outer walls and a reinforced concrete floor butt end

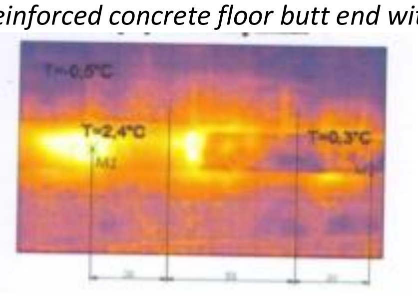


Thermal insert in floor slabs with coating



View A-A

Thermogram of a fragment of outer walls and a reinforced concrete floor butt end with coating



The objects of the repeat voluntary energy examination were bearing and enclosing structures of a residential apartment building in Saint Petersburg, Prospekt Solidarnosti, 9/3, fragments of which are painted with Bronya liquid heat insulation. The goal of this research is to estimate the energy efficiency and to reduce heat loss if the liquid heat insulation is applied, as well as to determine the heat conductivity coefficient of Bronya Winter heat insulation.

3. Devices for control measurement

Precise measurement of temperature, humidity and atmospheric pressure outside is performed with a TESTO 622 Hygrometer and its results are as follows:

- relative air humidity
  - indoor air - 43.2%;
  - outdoor air - 61.0%
- design indoor air temperature: +20.0°C in accordance with the requirements of SP 23-101-2000 "Designing of Thermal Protection of Buildings";
- outdoor air temperature - 1.5°C

Thermal imaging of the surface of the enclosing structures was performed with a TESTO 882 Hygrometer, which has the following technical parameters:

Detector type	FPA 320 x 240 pixels
Temperature sensitivity (NETD)	<60 mK at 30°C (0.06°C)
Optical field of view	32° x 23°
Minimum focal distance	0.2 m
Spatial resolution (IFOV)	1.7 millirad
Frame refresh rate	9 Hz
Spectral range	8 … 14 µm

4. Thermograms of structures under examination

Thermogram of the enclosing structures from the outside

Saint Petersburg, Prospekt Solidarnosti, 9/3

File:

IV_01285.BMT

Image parameters:

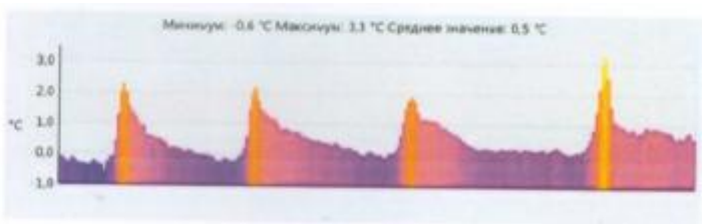
Ambient temperature, °C -1.8

Humidity, % 64.0

Image highlighting:

Examined objects	Temperature (°C)	Emission	Reflected temp. (°C)	Notes
Measurement point 1	3.3	0.95	0.0	-
Measurement point 2	0.9	0.95	0.0	-
Measurement point 3	2.2	0.95	0.0	-
Measurement point 4	0.2	0.95	0.0	-
Coldest point 1	-1.8	0.95	0.0	-

Profile line:



Minimum: -0.6°C Maximum: 3.3°C Average value: 0.5°C

Thermogram of the enclosing structures from the outside

Saint Petersburg, Prospekt Solidarnosti, 9/3

File:

IV_01288.BMT

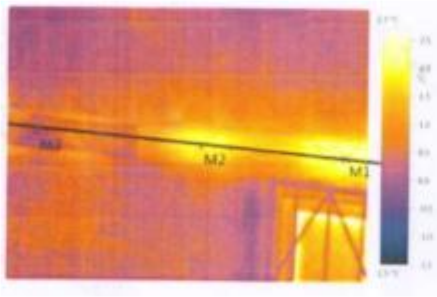


Image parameters:

Ambient temperature, °C	-1.8
Humidity, %	64.0

Image highlighting:

Examined objects	Temperature (°C)	Emission	Reflected temp. (°C)	Notes
Measurement point 1	2.4	0.95	0.0	-
Measurement point 2	2.1	0.95	0.0	-
Measurement point 3	0.3	0.95	0.0	-

Profile line:

Minimum: -0.4°C   Maximum: 2.5°C   Average value: 1.5°C

Thermogram of the enclosing structures from the outside

Saint Petersburg, Prospekt Solidarnosti, 9/3

File:

IV_01290.BMT

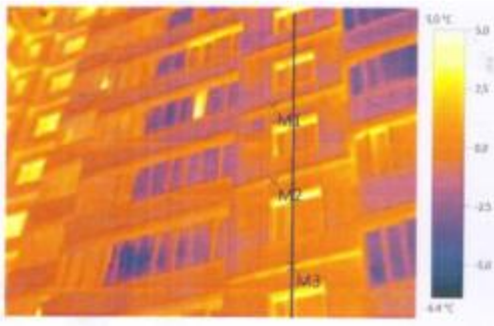


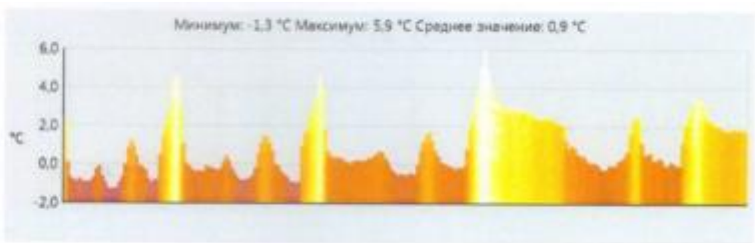
Image parameters:

Ambient temperature, °C	-1.8
Humidity, %	64.0

Image highlighting:

Examined objects	Temperature (°C)	Emission	Reflected temp. (°C)	Notes
Measurement point 1	0.6	0.95	0.0	-
Measurement point 2	1.4	0.95	0.0	-
Measurement point 3	2.3	0.95	0.0	-

Profile line:



Minimum: -1.3°C Maximum: 5.9°C Average value: 0.9°C

Thermogram of the enclosing structures from the outside

Saint Petersburg, Prospekt Solidarnosti, 9/3

File:

IV_01301.BMT

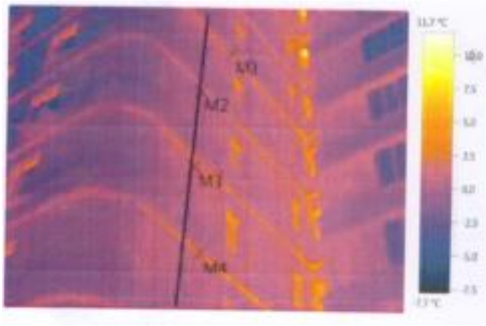


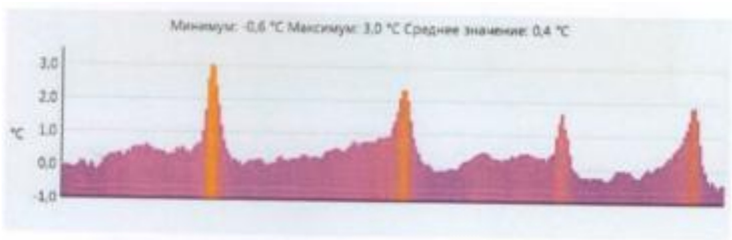
Image parameters:

Ambient temperature, °C	-1.8
Humidity, %	64.0

Image highlighting:

Examined objects	Temperature (°C)	Emission	Reflected temp. (°C)	Notes
Measurement point 1	2.2	0.95	0.0	-
Measurement point 2	0.3	0.95	0.0	-
Measurement point 3	1.1	0.95	0.0	-
Measurement point 4	3.2	0.95	0.0	-

Profile line:



Minimum: -0.6°C Maximum: 3.0°C Average value: 0.4°C

Thermogram of the enclosing structures from the inside

Saint Petersburg, Prospekt Solidarnosti, 9/3

File:

IV_01283.BMT

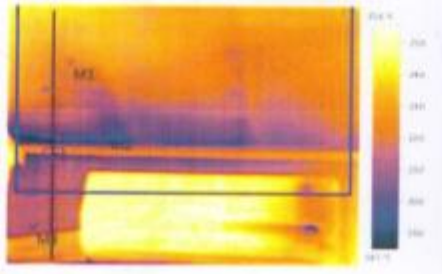


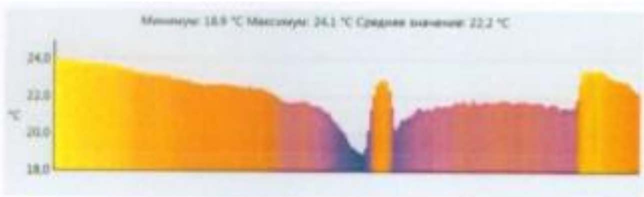
Image parameters:

Ambient temperature, °C	23.5
Humidity, %	42.2

Image highlighting:

Examined objects	Temperature (°C)	Emission	Reflected temp. (°C)	Notes
Measurement point 1	22.9	0.95	22.0	-
Measurement point 2	19.7	0.95	22.0	-
Measurement point 3	21.4	0.95	22.0	-
Coldest point 1	18.7	0.95	22.0	-

Profile line:



Minimum: 18.9°C Maximum: 24.1°C Average value: 22.2°C

Thermogram of the enclosing structures from the inside

Saint Petersburg, Prospekt Solidarnosti, 9/3

File:

IV_01282.BMT

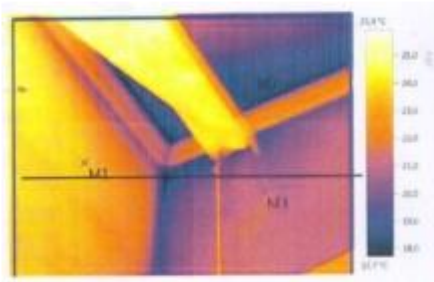


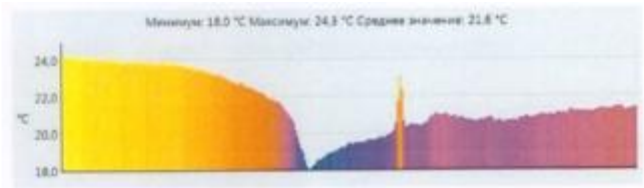
Image parameters:

Ambient temperature, °C	23.5
Humidity, %	42.2

Image highlighting:

Examined objects	Temperature (°C)	Emission	Reflected temp. (°C)	Notes
Measurement point 1	23.7	0.95	22.0	-
Measurement point 2	18.9	0.95	22.0	-
Measurement point 3	21.1	0.95	22.0	-
Coldest point 1	17.6	0.95	22.0	-

Profile line:



Minimum: 18.0°C Maximum: 24.3°C Average value: 21.6°C

Thermogram of the enclosing structures from the inside

Saint Petersburg, Prospekt Solidarnosti, 9/3

File:

IV_01280.BMT

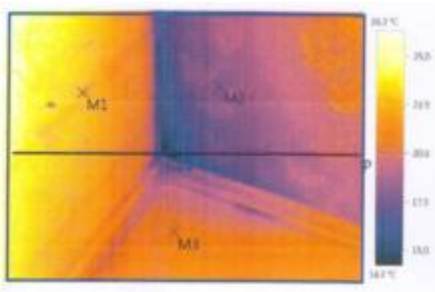


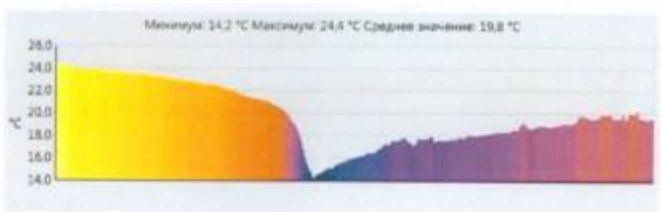
Image parameters:

Ambient temperature, °C	23.5
Humidity, %	42.2

Image highlighting:

Examined objects	Temperature (°C)	Emission	Reflected temp. (°C)	Notes
Measurement point 1	23.0	0.95	22.0	-
Measurement point 2	18.0	0.95	22.0	-
Measurement point 3	20.7	0.95	22.0	-
Coldest point 1	14.2	0.95	22.0	-

Profile line:



Minimum: 14.2°C Maximum: 24.4°C Average value: 19.8°C

Thermogram of the enclosing structures from the inside

Saint Petersburg, Prospekt Solidarnosti, 9/3

File:	**Date:**	**Time:**
IV_01275.BMT	12.02.2013	20:50:21

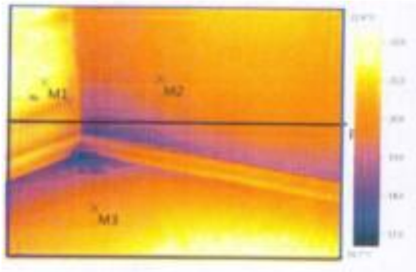


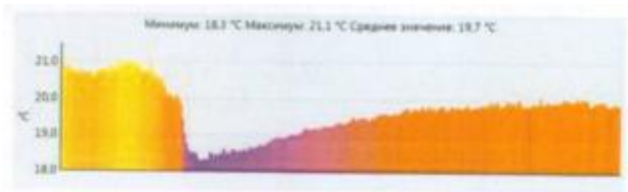
Image parameters:

Ambient temperature, °C 22.5
Humidity, % 42.2

Image highlighting:

Examined objects	Temperature (°C)	Emission	Reflected temp. (°C)	Notes
Measurement point 1	21.7	0.95	22.0	-
Measurement point 2	20.0	0.95	22.0	-
Measurement point 3	20.4	0.95	22.0	-
Coldest point 1	16.7	0.95	22.0	-

Profile line:



Minimum: 18.3°C Maximum: 21.1°C Average value: 19.7°C

5. Calculation

On the basis of the examination results thermal calculation was implemented for the parts of the enclosing structures.

The climate of Saint Petersburg, the district where the examined object is located, were given according to **TSN 23-340-2003 Energy Efficiency of Residential and Public Buildings, Standards for Energy Consumption and Thermal Protection.**

- average air temperature of the coldest five-day period t^5_c=28°C
- temperature of heating period t_{hp}=-1.8°C
- duration of heating period z_{hp}=220 days

The specified thermal design resistance of thermal inserts, which according to the design are heterogeneous, was obtained with application of the method for calculation of heterogeneous structure specified in SNiP II-3-79 “Construction Heat Engineering” and is 2.64 m2·°C/W; the specified thermal resistance of the enclosing structures is 2.80 m2·°C/W.

Besides the design data, information from TU 2216-006-09560516-2013 was used for comparative calculation of design thermal protection of the enclosing structures in the places of thermal inserts in the floor slabs and protection in terms of application of Bronya.

According to TU 2216-006-09560516-2013 the thermophysical properties of Bronya Winter are as follows:

Heat exchange	α_B = 2 W/m2 °C
Heat emission	α_H = 3 W/m2 °C
Heat conductivity	λ_{Bronya} = 0.001 W/m °C

Comparing the thermal resistance of the outer enclosing structures with and without Bronya Winter we use the following formula:

$$R_{actual} = \frac{1}{\alpha_B} + \sum \frac{\delta_i}{\lambda_i} + \frac{1}{\alpha_H};$$

Thermal resistance of the outer enclosing structures without coating according to the design data is as follows:

$$R_{design} = \frac{1}{\alpha_B} + \frac{\delta_{priv}}{\lambda_{priv}} + \frac{1}{\alpha_H} = \frac{1}{8.7} + 2.64 + \frac{1}{23} = 2.80$$

Thermal resistance of the outer enclosing structures with additionally applied Bronya Winter is as follows:

$$R_{w/Bronya} = \frac{1}{\alpha_B} + \frac{\delta_{priv}}{\lambda_{priv}} + \frac{\delta_{Bronya}}{\lambda_{Bronya}} + \frac{1}{\alpha_H} = \frac{1}{8.7} + 2.64 + \frac{0.0015}{0.001} + \frac{1}{3} = 4.59$$

Comparing the obtained values:

R_{design} and $R_{w/Bronya}$

We can draw the following conclusion:

Thermal resistance of the outer enclosing structures with additionally applied Bronya is 1.64-fold more than the similar area without coating.

Transforming the heat conductivity equations and substituting actual temperature values we obtain the heat conductivity coefficient value of Bronya superfine heat insulation for the examined object:

$$\lambda_{Bronya} = \frac{\delta_{Bronya}}{\frac{t_{indoor\ air} - t_{outdoor\ air}}{\alpha_H \cdot (t_{Bronya} - t_{outdoor\ air})} - \left(\frac{1}{\alpha_{int}} + \frac{\delta_{rc\ slab}}{\lambda_{rc\ slab}} + \frac{\delta_{thermal\ insert}}{\lambda_{thermal\ insert}}\right)}$$

where λ_{Bronya} = 1.5 mm = 0.0015 m – Bronya coating thickness;

$t_{indoor\ air}$ = +22°C – indoor air temperature;

$t_{outdoor\ \ air}$ = -1.5 °C – outdoor air temperature;

t_{Bronya} = +1 °C – average temperature of Bronya surface;

α_H = 3 W/m2 °C – heat emission coefficient of Bronya (according to TU 2216-006-09560516-2013);

α_{int} = 8.7 W/m2 °C - heat emission coefficient of the surface from the warm side (norms of SNiP 23-02-2003);

$\delta_{rc\ slab}$ = 450 mm = 0.45 m – thickness of the reinforced concrete floor slab from the indoor area to the outdoor area (according to the design data);

$\lambda_{rc\ slab}$ = 2.04 W/m °C – heat conductivity of the reinforced concrete floor slab;

$\delta_{thermal\ \ inser\,t}$ = 50 mm = 0.05 m – thickness of a thermal insert from foam plastic in the joint structure (according to the design data);

$\lambda_{thermal\ \ insert}$ = 0.04 W/m °C - heat conductivity of the thermal insert;

After all required transformations and substitution of the values in the formula we obtain the heat conductivity design coefficient of Bronya heat insulation, which is as follows under the given conditions:

$$\lambda_{Bronya} = \frac{0.0015}{\frac{22-(-1.5)}{3\cdot(1-(-1.5))}-\left(\frac{1}{8.7}+\frac{0.45}{2.04}+\frac{0.05}{0.04}\right)} = 0.000969 = 0.001\ \text{W/m·°C}$$

Thus heat conductivity coefficient of Bronya superfine heat insulation is 0.001 W/m °C.

6. General conclusions and recommendations

In January 2013 additional heat insulation of the floor slabs and elimination of the cold bridges in the enclosing structures of the examined object located in Saint Petersburg, Prospekt Solidarnosti, 9/3, with application of the liquid heat insulation, resulted in reduction of the peak temperature values in the equivalent points from 2.4°C to 0.3°C and general reduction of the values of thermal fields painted with Bronya material in contrast to the fields which were not painted. Calculations made on the basis of the current regulations, laboratory tests and technical specifications of the manufacturer provided the following results:

- thermal resistance of the building envelope additionally coated with Bronya is 1.64-fold more than a similar area without coating.

- heat conductivity coefficient of Bronya superfine heat insulation is 0.001 W/m °C.

Head of Department of
ENERGY EFFICIENCY, candidate of economic sciences *(Signature)* S.I. Davydov

Self-Regulating Organization
Non-Commercial Partnership
“CENTRE OF NEW ENERGY SAVING TECHNOLOGIES
“ENERGY AUDIT AND ENERGY EFFICIENCY”

CERTIFICATE

No.SRO-E-070-024-F

This is to certify that
SERGEY IVANOVICH DAVYDOV
109548, Moscow, Guryanova St., 17/2, apt.108
INN 772338237021

is a member of
SELF-REGULATING ORGANIZATION
Non-Commercial Partnership
“CENTRE OF NEW ENERGY SAVING TECHNOLOGIES
“ENERGY AUDIT AND ENERGY EFFICIENCY”,
included by the Ministry of Energy of the Russian Federation
in the State Register of Self-Regulating Organizations
in the Area of Energy Inspection on March 22, 2011
under registration number SRO-E-070.

Date of issue:	**March 23, 2011**
Area of validity:	**territory of the Russian Federation**
Valid till:	**unlimited**

General Director **S.A. Nosov**
(signature, seal)

Self-Regulating Organization
Non-Commercial Partnership
“CENTRE OF NEW ENERGY SAVING TECHNOLOGIES
“ENERGY AUDIT AND ENERGY EFFICIENCY”

CERTIFICATE

No.SRO-E-070-024-F-R

This is to certify that
SERGEY IVANOVICH DAVYDOV
109548, Moscow, Guryanova St., 17/2, apt.108
INN 772338237021

is authorized to perform works in the area of energy inspection as a member of:
SELF-REGULATING ORGANIZATION
Non-Commercial Partnership
“CENTRE OF NEW ENERGY SAVING TECHNOLOGIES
“ENERGY AUDIT AND ENERGY EFFICIENCY”,
included by the Ministry of Energy of the Russian Federation
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in the Area of Energy Inspection on March 22, 2011
under registration number SRO-E-070.

Date of issue:	**March 23, 2012**
Area of validity:	**territory of the Russian Federation**
Valid till:	**till March 23, 2013**

General Director **I.A. Sokolovsky**
(signature, seal)

Self-Regulating Organization
Non-Commercial Partnership
“CENTRE OF NEW ENERGY SAVING TECHNOLOGIES
“ENERGY AUDIT AND ENERGY EFFICIENCY”

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Date of issue:	**March 23, 2013**
Area of validity:	**territory of the Russian Federation**
Valid till:	**till March 23, 2014**

General Director **E.I. Shcheglova**
(signature, seal)

Self-Regulating Organization
based on the membership of persons engaged in construction
Non-Commercial Partnership of organizations of the construction industry
“Construction Resource”
191028, Saint Petersburg, Kirochnaya St., 12A, office 17-H
http://stroyresurs.info
registration number in the state register
of self-regulating organizations:
SRO-S-236-22042011

Saint Petersburg **May 5, 2012**

CERTIFICATE
of authorization for works of certain type or types which
affect the safety of capital construction facilities
No.CPOCP-C-4200.1-05052012

No.4200.C

Issued to a member of the self-regulating organization **Individual Entrepreneur Davydov Sergey Ivanovich,** INN 772338237021, OGRN 308770000042964, address: 109548, Russian Federation, Moscow, Guryanova St., 17/2, apt.108, date of birth: 23.01.1961.

Grounds for issue of the Certificate: Decree of the Council of SRO NP “Construction Resource”, Protocol No.271 dated May 5, 2012.

This certificate confirms authorization for works specified in Appendix to this Certificate, which affect the safety of capital construction facilities.

Valid from May 5, 2012.

The Certificate is not valid without the Appendix.

The Certificate was issued without limitations of the period and area of its validity.

The Certificate was issued instead of the previous _______.

Director of SRO NP *(signature, seal)* V.A. Eroshkin
“Construction Resource”

Appendix 1
to Certificate of authorization for works of certain type or types which affect the safety of capital construction facilities
of May 5, 2012
No.CPOCP-C-4200.1-05052012

Types of works which affect the safety of capital construction facilities **(excluding extremely hazardous and technically complex facilities, atomic energy facilities)** and are covered by the Certificate issued to the member of the Self-Regulating Organization based on the membership of persons engaged in construction Non-Commercial Partnership "Construction Resource"

Individual entrepreneur Sergey Ivanovich Davydov

No.	Types of works
32	**Construction supervision by a legal entity or an individual entrepreneur engaged by a developer or the owner**
32.1	Construction supervision of general construction works (groups of types of works N 1-3, 5-7, 9-14)
32.4	Construction supervision of works in the area of water supply and sewage (types of works N 15.1, 23.32, 24.29, 24.30, groups of types of works N 16, 17)
32.5	Construction supervision of works in the area of heat and gas supply and ventilation (types of works N 15.2, 15.3, 15.4, 23.4, 23.5, 24.14, 24.19, 24.20, 24.21, 24.22, 24.24, 24.25, 24.26, groups of types of works N 18, 19)
32.7	Construction supervision of works in the area of power supply (type of works N 15.5, 15.6, 23.6, 24.3-24.10, group of types of works N 20)

Director of SRO NP "Construction Resource" *(signature, seal)* V.A. Eroshkin