The solution of proofing pie for the waste sorting plant

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Abstract. The modern way of establishment of a flat roof is considered in the article. The standard project of the waste sorting plant was adapted under the conditions of the Republic of Karelia. Instead of the traditional roof with a slope from the concrete coupler, provided by the project, the option with the use of heater in the form of wedge-shaped plates was offered.

1 Introduction

Changes in the legislation of the Russian Federation on the ecological safety of the environment assume the development of the territorial schemes with the solid municipal waste (SMW) by all the subjects [1].

Within this programme, according to the calculations of accumulation of waste in the Republic of Karelia, the construction of switchyards, the waste incineration and overworking plants is planned. [2] This project is quite capital-intensive; therefore to lower the load for the regional budget, it is necessary to attract private investments into the construction of such objects. Thus, it is necessary to calculate the future cost of the construction, presumable revenue (for example, from the realization of secondary raw materials) and also the payback of the plant.

It is preferable to use standard decisions for the fast implementation of the programme. First of all construction of the waste sorting plant near the village Orzega is offered for the adjustment of the territorial scheme of utilization.

The building is a one-storey metal framework (spatial rod system, formed by columns two-Tauris and bent-and-welded farms). [3] The spatial rigidity is provided by the system of horizontal and vertical communications

The building plan, flight and step of columns are submitted in the Figure 1.

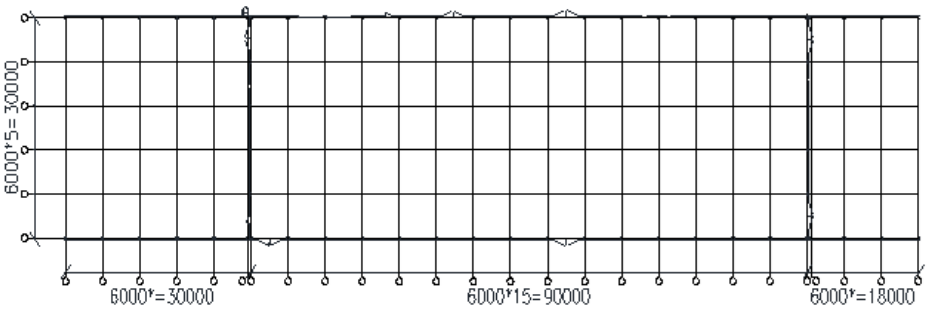

Figure 1. Building plan

The production building of 138·30 m in size is divided into three blocks:

- two non-heated shop floors in which protective constructions is the pro-thinned-out flooring of the N60-845-0.7 brand,
- one heated shop, where the thermal circuit is created for the score sandwich panels and roofing pie.

This standard project was adapted under conditions of Karelia, heat-and-technical calculation on the basis of which materials of walls and a roof were picked up is made.

As wall constructions will be applied sandwich panel, as well as it was supposed initially in the project as this material is rather new, heat-effective, easy in mounting [4].

The constructive solution of roofing pie over the heated shop floor assumed use of a concrete screeds for creation of a slope arrangement on a plane roof for increase in service life of a covering. If water stands on a surface, then it destroys a high layer of a roof because of repeated processes of freezing and defrosting therefore important competently to project a drainage system from a plane roof [5].

Creation of a screeds from light concrete is a traditional method, however such layer renders additional load of construction, sags increase, also it is the most expensive. Therefore the decision to find other method of creation of a slope on the roof was made.

2 Methods and Materials

The option of the use of N30-KLIN TEKHNORUF heater of 1.7%, instead of the use of a coupler was considered for the economy of means [6].

This technology is used in civil and industrial construction as a heat-insulation layer as well as for the creation of a bias, which promotes removal of water to reservoir points. Material represents nonflammable, heat-insulating plates with a bias created in advance. It is more expedient to use these plates under TEHNORUF V60 heater, which also represents mineral-cotton plates on the basis of basalt rocks.

The main physic-mechanical and geometrical characteristics are provided in table 1 and table 2 respectively.

Table 1. Main physical-and-mechanical characteristics

Name		Unit of measurement	Technoroof N30 Klin (1.7%)	Testing method
Durability on compression at 10% of deformation, at least		kPa	30	GOST R EN 826
Combustibility		degree	NG	GOST 30244
Heat conductivity	λ_{25}	W/m ·C	0.038	GOST 7076 GOST 7076 ST23-101-2004
	λ_A		0.041	GOST 7076
	λ_B		0.042	ST23-101-2004
Humidity on weight, not more		%	0.5	GOST 17177
Water absorption on volume, not more		%	1.5	GOST R EN 1609
Content of organic substances, not more		%	4.5	GOST R 52908-2008 (EN 13820-2003)
Density		kg/m^3	100-130	GOST R EN 1602

Table 2. Geometrical parameters

Name	Unit of measurement	Value	Unit volume, m^3
Angle of gradient, %	gr	1.7	
Technoroof N30 Klin (1.7%), Element A, thickness, min - max	mm	30-50	0.0576
Technoroof N30 Klin (1.7%), Element B, thickness, min - max	mm	50-70	0.0864
Technoroof N30 Klin (1.7%), Element C, thickness, min - max	mm	40-40	0.0576
Length	mm	1200	
Width	mm	1200	

For the assessment of suitability of the use of this material in the conditions of the Republic of Karelia heat-and-technical calculation which is based on the Russian regulatory base was carried out: [7]

- Joint venture 50.13330.2012 "Set of rules. Thermal protection of buildings";
- Joint venture 23-101-2004 "Design of thermal protection of buildings;
- GOST P 54851—2011 "National standard of the Russian Federation. Protecting non-uniform building structures. Calculation of the specified resistance to the heat transfer";
- STO 00044807-001-2006 "Heat-shielding properties of the protecting structures of buildings".

3 Results

This roofing pie is proved to be heat-effective, heat losses for the heating season were insignificant. Heat transfer resistance meets the sanitary and hygienic requirements as well as the basic values of bit-by-bit requirements.

The section of the roofing covering is presented in the figure 2. Heat-and-technical characteristics of the covering are presented in Table 3.

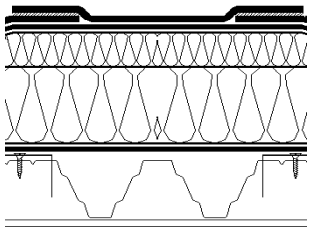

Figure 2. Pie of the roofing covering

Table 3. Heat-and-technical characteristics of the covering

Name	ρ, kg/m³	λ, W/m²·°C	δ, m
1	2	3	4
polymeric membrane	600	0.17	0.002
Technoroof V60	600	0.17	0.05
Technoroof N30	1800	0.93	x
vapours barrier	400	0.14	0.002
profiled sheeting N60	160	0.040	0.06

Thus, two layers participate in thermal insulation: Tekhnoroof V60 and Tekhnoroof N30, therefore, other layers can be not taken into account as their influence is insignificant.

The name of the object is the waste sorting plant.

The chamber is the production heated shop.

Axes are the following: 6-21/A-E.

t_{int} = 18 ℃ (calculated internal temperature);

t_{ext} = -28 ℃ (calculated winter temperature of external air for a cold five-day week);

t_{ht} = -3.2 ℃ (the average temperature of the heating period, according to the table 1, SP 131.13330.2012;

Z_{ht} = 235 days – duration of the heating period, according to the table 1, SP 131.13330.2012;

Service conditions of the protecting designs are the following: B.

Roof:

$$GOSP = (t_{int} - t_{ht}) \cdot Z_{ht} = (18-(-3.2)) \cdot 235 = 4982 \text{ °C per day} \quad (1)$$

R_{reg} = 2.746 m² · ℃ /W (the required thermal resistance to the protecting design, SP 50.13330.2012).

α_{int} = 8.7 – coefficient of thermolysis of an internal surface of the protecting designs, according to the table 4, SP 50.13330.2012.

α_{ext} = 23 – the coefficient of thermolysis of an external surface of the protecting designs accepted according to the table 6, SP 50.13330.2012.

Settlement formulas:

$$R_0 = \frac{1}{\alpha_{int}} + R_K + \frac{1}{\alpha_{ext}} \quad (2)$$

$$R_K = \sum R_i \quad (3)$$

$$R_i = \delta/\lambda \quad (4)$$

Layer 1 – Tekhnoroof N30:

δ=0.1 m – layer thickness;

λ=0.042 W/m²·℃ – settlement coefficient of heat conductivity of material;

Thermal resistance of a layer of the protecting design is calculated by a formula (4):

$$R_2 = 1.163\ m^2 \cdot ℃ /W$$

Layer 2 – Tekhnoroof V60:

δ=0.05 m (layer thickness);

λ=0.043 W/m²·℃ (settlement coefficient of heat conductivity of material);

Thus, the thermal resistance of all the layers of the protecting structure is calculated according to the formula (A.3):

$$R_K = \sum R_i = 3.544\ m^2 \cdot ℃ /W$$

Settlement thermal resistance to the protecting design on a formula (2):

$$R_0 = \frac{1}{\alpha_{int}} + R_K + \frac{1}{\alpha_{ext}} = 3.702\ m^2 \cdot ℃/W$$

Then:

$R_{reg} = 2.746\ m^2 \cdot ℃ /W < R_0 = 3.702\ m^2 \cdot ℃ /W$– the truth.

If the coefficient of heat-and-technical uniformity of r = 0.750:

$R_{reg} = 2.746\ m^2 \cdot ℃ /W < R_0 = 2.777\ m^2 \cdot ℃ /W$– the truth.

The chosen roofing pie meets requirements of thermal insulation.

Layer-by-layer calculation of protection against remoistening is presented in table 4.

Table 4. Calculation from remoistening.

	D (mm)	Material		R_v	x	$R_{v(b)}$	$R_{v.r1}$	$R_{v.r2}$
1	0	steel	0	10	-21516.1	0	0	0
2	0.1	vapors isolating membrane	0	7	0	0	0	0
3	50	mineral stone wool 75-120	0.58	0.09	50 (251.2)	17.09	-0.84	-0.4
4	100	mineral stone wool 170-220	0.5	0.20	100 (217.8)	17.29	0.99	4.12
5	2	paper roof covering	0.00136	1.47	-643.2	0	0	0

Where R_v - resistance to the design vapours penetration, (m² h Pas) / mg,

$R_{v.r}$ - the required resistance to vapours penetration. (m² h Pas) / mg,

X - coordinate of the plane of the maximum moistening, mm.

The structure meets the requirements of protection against remoistening.

4 Conclusions

Thus, this roofing pie satisfies to norms on the heat shield on condition of execution of requirements to specific power consumption by the building, to sanitary and hygienic norms, requirements of protection against remoistening and also from condensate drop-out.

Having calculated the roof device cost over the heated shop with use by a traditional slope from the concrete strainer and with the use of the cuneiform heat-insulating material, it is possible to estimate economic the efficiency of last. Thus, the use of Tekhnoroof N30 heater allows to spare up to 1.3 million rubles that is essential advantage. In addition to the economic benefit, it is worth marking also other pluses:

- mounting is executed without preliminary alignment;
- there are no wet processes when mounting;
- periods of mounting decrease as the labor input is less;
- there is no need for special or heavy machinery;
- long service life.

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