Ministry of Education and Science of Ukraine
Ternopil Ivan Pul'uj National Technical University
(full name of higher education institution)
Faculty of Engineering of Machines, Structures and Technologies
(faculty name)
Building Mechanics
(full name of department)

EXPLANATORY NOTE

for diploma project (thesis)

Master of science
(educational-proficiency level)

topic: The project of sports complex with gyms, sports hall and swimming pool with the study of holding elements of structure

Submitted by: fourth year student group IMBm-62
Specialism (field of study) 192 Construction and Civil Engineering
(code and name of specialism (field of study))

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INTRODUCTION

The number of buildings with welded steel structures in Ukraine is increasing. These structures include: heavy truss trusses, bridges and truss trusses, supports and runways of process equipment overpasses, conveyor gallery farms, etc. The most common rolling rod joints in these building structures are welded T-, V- K- and TC-like nodes. Together with the benefits of using welded farms in construction, the problem is the complex stress-strain state (SSS) and the high concentration of stresses at the nodes.

Researching the SSS of farm nodes has always been a pressing task. For statically loaded structures that perceive large values of load, early appearance of plastic deformation is possible, which can lead to a loss of load carrying capacity of the farm. It is especially important to know the stress concentration sites for structures that are subject to cyclic loading and are therefore dangerous from the point of view of the fatigue crack origin

The design and manufacture of welded farms does not exclude the influence of subjective factor and therefore the designer can not with high level of probability to assert the actual durability and durability of the construction. This scientific problem can be solved by determining the actual SSS at the farm units, taking into account their structural and technological features

The classic design calculation of welded farms does not take full account of these features. It is assumed that the new design has no deviations from the project in its manufacture and installation. The design scheme of the object is considered ideal

At the same time, the current state of the art of computer engineering and numerical methods opens wide opportunities for assessing the rigidity of welded farms in the context of a multifactor computer simulation experiment

Investigation of the influence of structural and technological features of the units on the strength of the welded farm will enable with high degree of probability to determine the functional suitability of the structure, and the obtained results will be of theoretical and practical interest.

1. Architectural and structural part

1 Architectural-planning solutions

1.1 Brief description of the construction area

A fitness center is being built in Kiev.

Natural and climatic characteristics of the construction area are presented in table 1.

Table 1.2 - Natural and climatic characteristics of the construction area

№	Name of characteristic	Characteristic	Justification
1	Construction site	Kiev	on assignment
2	Climate and Subarea	IIv	(1, pic.1)
3	Humidity zone	Dry	(1, pic.1*)
4	Outside air temperature of the coldest five-day period, deg.	-27	(1, table.1)
5	Period duration with outside temperature less air 8 deg., day.	275	(1, table.1)
6	Average temperature of the heating period, deg.	-3,2	(1, table.1)
7	Maximum freezing depth, m	2,1m.	(1, attach.1, pic.3)
	Wind repeatability, % : - in January: N NE E SE S SW W NW 10 5 8 21 20 15 10 11 - in July: N NE E SE S SW W NW 16 9 9 13 9 12 15 17		(2, attach.4) (2, attach.4)

Table 1.3 - Collection of loads on the GFGS farm according to the series 1.263.2

Load type	Normative	γ_f	Estimated
1. Constant			
1. Waterproof carpet (Fibrotek Master s 120)	0,04	1,3	0,052
	0,052	1,3	0, 07
2. Thermal insulation boards			
ROCKWOOL Flexi Butts brands (thickness			
130mm, γ =40kg/m3=0.4кН/m3)	0,05	1,3	0,07
0.4·0,13=0,052(kN/m2).			
3. Vapor barrier;	0,1	1,05	0,105
	0,1	1,05	0,105
	0,3	1,05	0,315
4. Steel Profiled Flooring;			
5. Net weight of runs			
6. Net weight of a farm			
Total constant:	0,642		0,717
2. Temporary			
Snow	2,24		3,2
TOTAL:	2,88		3,92

The value of snow cover weight for Kiev - V snow district, $s_g = 3{,}2$ kN/m^2, then $s_0 = 3{,}2 \cdot 0{,}7 = 2{,}24$ kN/m^2.

Estimated snow load per m^2 of roof:

$$s_{est} = s_g \cdot \mu = 3{,}2 \cdot 1 = 3{,}2 \text{ kN/m}^2,$$

where μ – the coefficient of transition from the weight of the snow cover of the earth to the snow load on the coating at ($\mu = 1$ at $\alpha < 25°$).

Estimated linear load (3.2+0.717)*6= 23,5 kN/m

I accept a farm of the GFGS 24 series with an estimated linear 2.6 tf / m according to the picture 2.1, 2.2, 2.3

K4	3150	110	220	2	0,261	0,552	0,033	0,066	0,61

Table 1.4 – Bill of quantities

№	Name of work and processes	Units	Number
1	2	3	4
Steel frame mounting			
1	Farm assembly	1 piece	12
2	Column Installation	1 piece	24
3	Truss mounting	1 piece	12
4	Installation of runs	1 piece	126
5	Installation of columns of the third block	1 piece	8
6	Larger assembly GB1	1 piece	8
7	Mounting GB1	1 piece	8
Monolithic overlap and pool bath			
8	Scaffolding	100 м.	10,88
9	Installation of beam formwork	1 $м^2$.	334,9
10	Installation of floor formwork	1 $м^2$.	611,2
11	Manual installation of frames and nets (up to 20 kg.)	1 шт.	211
12	Manual installation of frames and nets (up to	1 шт.	146

	50 kg.)		
13	Concrete supply	1 $м^3$.	106,96
14	Concrete laying	1 $м^3$.	106,96
15	Watering a concrete surface with water	100 $м^2$.	8,12
16	Formwork dismantling	1 $м^2$.	946,1
17	Installation of wall panels	1 шт.	488

$\sum E = E_1 + E_2 \cdot x = 30 \cdot 22{,}1 \cdot 1 = 52{,}1$ (UAH.), where

E_1=30 (UAH.) – cost of relocation of the crane,

$E_2 = 22{,}1$(UAH.) – primary boom replacement cost.

2. Pneumatic crane KS 5363. Main boom 15 m., With inserts and jib 30 ± 10 m. Carrying capacity 25 t.

Determining the cost of renting a crane:

$A = C_{м-с} \cdot T_ч + \sum E = 6{,}02 \cdot 28{,}2 + 101{,}06 = 373{,}9$ (UAH.), where

$T_x = \frac{\sum Q}{П_р} = \frac{200}{7{,}1} = 28{,}2$ (h.), where

$\sum E = E_1 + E_2 \cdot x = 68 \cdot 33{,}06 \cdot 1 = 101{,}06$ (UAH.).

For the installation of the main load-bearing elements, we accept the crawler crane E-1258B.

Technological map for the installation of the frame of a fitness center

Application area

The flow chart is designed for installation work by the mixed method of supporting structures of the frame of a one-story building, with dimensions in the plan of 60.9 m. Building height 11, 55 m.

1.4 Organization and technology of the construction process

1.5 Frame mounting

Installation of the frame is carried out in two stages: installation of columns (racks), installation of the truss (crossbar). The installation of the frame elements is carried out with the help of a crawler crane E-1258B. The columns are supplied from the on-site

warehouse, the column is slinged using a standardized two-branch sling 2ST16-5 and 3KDv tick capture. Before the beginning
installation on the foundations cause alignment risks, on the base of the columns the risks of geometric axes. The column is slinged, fed to the installation site, installed in the design position and temporarily unfastened with braces. After that, the rack is unfastened and verified, controlling the accuracy of bringing the rack to its design position using theodolites along two mutually perpendicular axes.

Before mounting the farm, it is pre-assembled from two sending elements (FS1) by means of enlargement joints on flange joints. The farm is slinged for 4 points, using the VNIPI traverse (code 290700-39i). To improve orientation during installation, we use a flexible manipulator. The manipulator consists of two winches mounted on a crane, and going from them through the outlet blocks of bridle cables attached to the ends of the mounting beam. Orientation is carried out by the crane operator at the signal of the installer. During installation, the bolt is fixed with 40X SELECT high-strength bolts. The first farm is additionally unfastened with braces.

The brace is removed only after installing the runs that play the role of horizontal ties.

1.6 . Installation of runs

Runs are served by the on-site warehouse. Slinging is carried out using a unified double-sided sling 2ST16-5. At the installation site, the runs are laid on the top belt of the farm, laying is carried out from the rolling sites. Welds are performed by manual welding, with electrodes E-42A. Weld legs are adopted 6mm.

1.7 Installation of columns and fachwerk

The supply of columns is made from the on-site warehouse. Slinging of columns is carried out using a unified double-sided sling 2ST16-5. Before installing the columns, the alignment risks are applied to the foundations; the risks of geometric axes are applied to the column. The column is rafter and served by a crane to the installation site, temporarily unfastened with braces. After that, the column is unfastened and verified using theodolite along two mutually perpendicular axes. The brace is removed after installing the main beams and runs.

1.8 Mounting the main beams (block 3)

To feed the main beams from the on-site warehouse, they are slinged with the help of the unified traverse TSNIIOMTP. Beams are installed on the head of the columns and bolted to the nodes of the pair of elements, and then unzipped.

1.9 Installation of wall panels

For the installation of wall panels, an MK6.3 truck crane with a lifting capacity of 6.3 tons is used, boom length 12.1 m.

Since it is forbidden to use steel cables to move the package of panels (due to possible damage to the panels), soft STP 2.0-8.0 slings are used to move the packages and install them.

Installation is carried out by a link of four installers. Two installers are on the ground and carry out all the preparatory work, the other two installers install and fix the panels. Inside the building, SPO-15 autohydraulic hoists are used as installer jobs. The installation of panels of the outer walls is carried out, relying them on verified

with respect to the mounting horizon, beacons are wooden planks, the thickness of which can vary depending on the results of level shooting of the mounting horizon, but on average should be 12 mm.

Two beacons are placed under each panel at a distance of 15 ... 20 cm from the side faces closer to the outer plane of the building wall. A porous gernite cord is laid on the upper face of the underlying panel on a thin layer of insulating mastic. Immediately before installing the panel, the surface of the cord is covered with a layer of mastic, spread cement the solution along the entire supporting plane of the panel with a layer 3 ... 5 cm above the level of the beacons. The bed of the mortar should not reach the edge of the wall by 2 ... 3 cm so that the mortar does not squeeze out and does not contaminate the facade of the building. At the end of panel installation, a layer of sealant paste is applied on the outside of all joints. For slinging panels with a length of 6 m, two-branch slings are used. At the end of the sling, the link instructs the crane operator to raise the panel by 20 ... 30 cm. After checking the reliability of the sling, the panel is moved to the installation site. The position of the panel in space when it is lifted, the installers adjust using guy wires. At a height of 15 ... 20 cm from the mounting mark, the installers accept the panel

and direct it to the installation site. The panels are installed starting from the “lighthouse” corner, on which the intermediate panels of the row are checked. Having installed the panel in place, when the slings are stretched, they correct its position with assembly crowbars. After the panel is installed

in the design position, the welder fixes it, welding the embedded parts of the panel and frame structure. Then loops of slings are released, the horizontal seam of the panel is sealed and aligned.

Panel fastening is carried out by self-drilling screws 300 mm long. Corner joints are closed with molded steel elements fastened with 20mm self-drilling screws.

Horizontal load code	1	2	3
Wind areas by DBN B.1.2-2: 2006	I ... III	IV ... V	VI ... VII
Uniform horizontal load (standard value), kgs / m2	38	60	85

Picture 1.10- Unified horizontal load according to the series 1.420.3-37.06

Mass Frame	Mark, H, m	Mark Brand	the num. e-nts frame	Section code of the frame elements mass of one element,kg						
				Vertical load code						
				I	II	III	IV	V	VI	VII
1	2	3	4	5	6	7	8	9	10	11
PO 1x240.H-*	6.0	P1-	2	75Н5.3гд 456	75Н6.4гд 540	75Н6.5ди 654	90Н8.4ги 728	90Н8.5ик 872	90Н8.6ил 970	90Н8.7кл 1078
		P2-	1	75Н5.2гв 677	75Н5.3гв 716	75Н5.4дг 889	90Н6.4кд 1124	90Н6.4иг 1100	90Н6.5кд 1288	90Н6.6кд 1395
		K1-	2	30(75)Н5.3гд 397	30(75)Н5.4ги 467	30(75)Н5.5дк 581	30(90)Н6.5ги 592	30(90)Н6.5ил 722	30(90)Н6.6им 825	30(90)Н6.7км 973
		Масса рамы, кг		2384	2730	3360	3766	4288	4878	5498
	7.2	P1-	2	75Н5.3гд 456	75Н6.4гд 540	75Н6.4ди 603	90Н8.4ги 728	90Н8.5ди 806	90Н8.6ик 941	90Н8.7ик 1010
		P2-	1	75Н5.1гв 649	75Н5.3гв 716	75Н5.4кд 958	90Н6.4иг 1124	90Н6.5кд 1271	90Н6.5ки 1336	90Н6.7лк 1669
		K1-	2	30(75)Н5.3гд 462	30(75)Н5.4ги 544	30(75)Н5.5ди 645	30(90)Н6.5ги 685	30(90)Н6.5дл 786	30(90)Н6.6им 955	30(90)Н6.7им 1041
		Масса рамы, кг		2486	2883	3452	3951	4454	5129	5772
	8.4	P1-	2	75Н5.3гд 456	75Н6.4гд 540	75Н6.4ди 603	90Н8.4гд 696	90Н8.5ди 806	90Н8.6ик 941	90Н8.7ик 1010
		P2-	1	75Н5.1гв 649	75Н5.3дг 786	75Н5.4дд 916	90Н6.4ид 1124	90Н6.5ид 1271	90Н6.6ки 1433	90Н6.7ли 1669
		K1-	2	30(75)Н5.3гд 524	30(75)Н5.4гд 585	30(75)Н5.5ди 731	30(90)Н6.5ги 775	30(90)Н6.5дл 894	30(90)Н6.6ил 1040	30(90)Н6.7им 1181
		Масса рамы, кг		2610	3035	3583	4066	4670	5395	6052
	9.6	P1-	2	75Н5.3гд 456	75Н6.4гд 540	75Н6.4ди 603	75Н8.5ди 666	90Н8.5ди 806	90Н8.6ик 950	90Н8.7ик 1018
		P2-	1	75Н5.2гв 677	75Н5.3дг 786	75Н5.4кд 958	75Н5.6ки 1261	90Н6.5ки 1319	90Н6.7кк 1606	90Н6.8лк 1797
		K1-	2	30(75)Н5.3гд 586	30(75)Н5.4гд 654	30(75)Н5.5ги 771	30(75)Н5.5дк 859	30(90)Н6.5дк 955	30(90)Н6.6дк 1058	30(90)Н6.7дл 1205
		Масса рамы, кг		2761	3173	3706	4312	4840	5622	6243
	10.8	P1-	2	75Н5.3гд 456	75Н6.3гд 540	75Н6.4дд 571	75Н6.5ди 666	90Н8.5ди 814	90Н8.6ик 950	90Н8.7ик 1018
		P2-	1	75Н5.3гг 739	75Н5.4дд 896	75Н5.5кд 1033	75Н5.6ки 1261	90Н6.6ки 1433	90Н6.7кк 1606	90Н6.8лл 1866
		K1-	2	30(75)Н5.3гд 648	30(75)Н5.3ги 758	30(75)Н5.4ди 811	30(75)Н5.5дк 951	30(90)Н6.5ги 956	30(90)Н6.6дк 1168	30(90)Н6.7дл 1331
		Масса рамы, кг		2947	3492	3795	4496	4975	5842	6565
	12.0	P1-	2	75Н5.4гд 505	75Н6.4гд 540	75Н6.4дд 582	75Н6.5ди 666	90Н8.5ди 814	90Н8.6ик 950	90Н8.7ик 1018
		P2-	1	75Н5.4дд 896	75Н5.4дд 896	75Н5.5ки 1104	75Н5.6кк 1314	90Н6.6кк 1486	90Н6.7пк 1669	90Н6.8лл 1866
		K1-	2	30(75)Н5.4ги 836	30(75)Н5.4ги 838	30(75)Н5.4ди 889	30(75)Н5.5дк 1043	30(90)Н6.5ги 1047	30(90)Н6.6дк 1279	30(90)Н6.7дл 1458
		Масса рамы, кг		3578	3652	4044	4732	5208	6126	6818

Picture 1.11 - Codes of sections of frame elements in a series 1.420.3-37.06

In accordance with figures 2.5, 2.6 and 2.7, the frame mark is 1.240.96-V. Frame weight 4840 kg.

2. Design and calculation part

2 Building construction

2.1 Variant design

In this section, we will consider three options for the layout of the transverse frame:
- frames with elements of variable rigidity from welded I-beams
- lattice frame "UNITEC»
- a frame formed by a truss from bent sections and a column from a rolled I-beam.

2.2 Option number 1. GFGS series 1.263.2.

Frame crossbar - a typical 24-meter truss from bent sections according to series 1.263.2 “Typical structures of steel trusses for covering hall rooms of public buildings»

Column - rolling type I tee in accordance with GOST 26020-83.

The cross-sections of frame structures are selected according to the design codes of the vertical load, which are determined depending on the basic code of the vertical load on the coating.

Table 2.3 - the collection of loads (GFGS series 1.263.2)

Load type	Normative	γ_f	Estimated
1. Constant			
1. Waterproof carpet (Fibrotek Master s 120)	0,04	1,3	0,052
	0,052	1,3	0, 07
2. Thermal insulation boards ROCKWOOL Flexi Butts brands (thickness 130mm, γ=40kg/m3=0.4кH/m3) 0.4·0,13=0,052(kN/m2).	0,05	1,3	0,07
3. Vapor barrier;			

4. Steel Profiled Flooring; 5. Net weight of runs 6. Net weight of a farm	0,1 0,1 0,3	1,05 1,05 1,05	0,105 0,105 0,315
Total constant:	0,642		0,717
2. Temporary Snow	 2,24		 3,2
TOTAL:	2,88		3,92

The value of snow cover weight for Kiev - V snow district, $s_g = 3{,}2$ kN/m^2, then $s_0 = 3{,}2 \cdot 0{,}7 = 2{,}24$ kN/m^2.

Estimated snow load per m^2 of roof:

$s_{est} = s_g \cdot \mu = 3{,}2 \cdot 1 = 3{,}2$ kN/m^2,

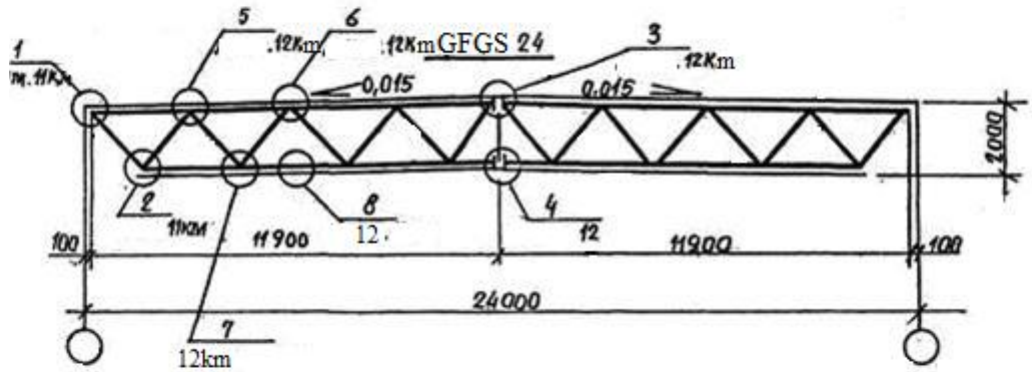
where μ – the coefficient of transition from the weight of the snow cover of the earth to the snow load on the coating at ($\mu = 1$ at $\alpha < 25°$).

Estimated linear load (3.2+0.717)*6= 23,5 kN/m

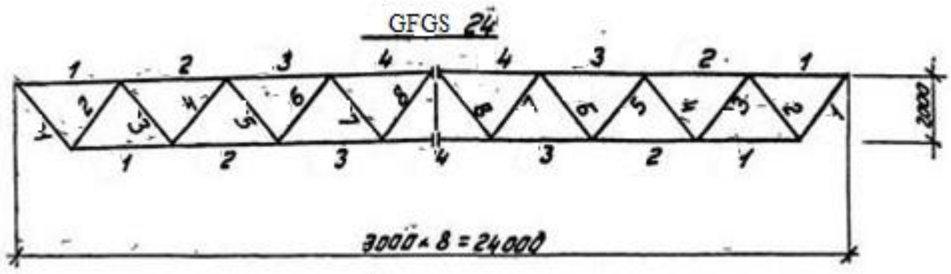
I accept a farm of the GFGS 24 series with an estimated linear 2.6 tf / m according to the picture 2.1, 2.2, 2.3

Brands	Nominal span, mm	Estimated Chasing Capacity Tf/m	Consumption of steel, kg		Farm weight, kg
			09g2s	VSt3p6	
GFGS 15 - 2,8	15000	2,8	734	140	883
GFGS 18 - 2,4	18000	2,4	844	184	1038
GFGS 21 - 2,0	21000	2,0	1026	234	1272
GFGS 21 - 2,5	21000	2,5	1199	234	1447
GFGS 24 - 1,5	24000	1,5	1056	263	1342
GFGS 24 - 1,8	24000	1,8	1254	263	1542
GFGS 24 - 2,2	24000	2,2	1499	340	1857
GFGS 24 - 2,6	24000	2,6	1698	340	2058
GFGS 27 - 1,2	27000	1,2	1248	314	1578
GFGS 27 - 1,5	27000	1,5	1473	314	1805
GFGS 27 - 1,8	27000	1,8	1627	404	2051
GFGS 27 - 2,0	27000	2,0	1871	404	2298
GFGS 27- 2,3	27000	2,3	2084	494	2604
GFGS 30 - 1,0	30000	1,0	1328	358	1703
GFGS 30 - 1,3	30000	1,3	1610	358	1988
GFGS 30 - 1,5	30000	1,5	1898	436	2357
GFGS 30 - 1,8	30000	1,8	2151	436	2613
GFGS 30 - 2,0	30000	2,0	2432	512	2973

Picture 2.5 - The nomenclature of farms in the series 1.263.2-4



Picture 2.6 - The adopted farm scheme for the series 1.263.2-4



Picture 2.7 - The geometric scheme of the farm in a series 1.263.2-4

Define the loads acting on the farm:

1. Roof load: (linear load from coating)

$q_r = (g/\cos\alpha)\cdot\gamma_n\cdot B = (1{,}25/0{,}9966)*6*0{,}95 = 7{,}15kN/m$,

where $g = 1{,}25\kappa H/\mathcal{M}^2$ - roof weight .

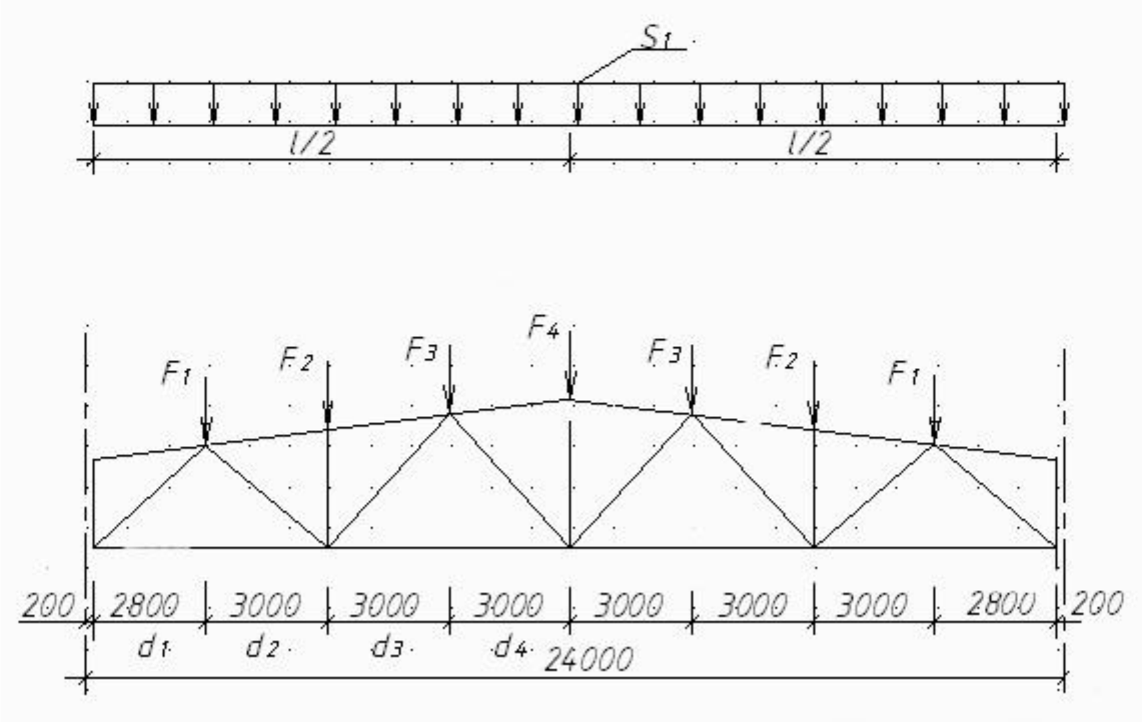
Define the forces acting on the farm from a constant load.

$$F_1 = q_{\kappa p}\cdot\frac{d_1+d_2}{2} = 7{,}15*\frac{2{,}8+3}{2} = 20{,}74kN$$

$$F_2 = q_{\kappa p}\cdot\frac{d_2+d_3}{2} = 7{,}15*\frac{3+3}{2} = 21{,}45kN$$

$$F_4 = F_3 = F_2 = 21{,}45\,\text{kN}$$

Define the snow load



Picture 2.8 - Snow load on the farm

For Kiev - $S_g = 3{,}2kN/m^2$

$\mu_1 = 1$ because $\alpha \le 25°$;

$S_1 = S_g\cdot\mu_1\cdot B\cdot\gamma_n = 3{,}2*6*0{,}95 = 18{,}24kN/m$;

$$F_1 = S_1\cdot\frac{d_1+d_2}{2} = 18{,}24\frac{2{,}8+3}{2} = 52{,}9kN;$$

$$F_2 = S_1 \cdot \frac{d_2 + d_3}{2} = 18{,}24 * 3 = 54{,}7kN;$$

$$F_4 = F_3 = F_2 = 54{,}7kN.$$

2.9 Option number 2. Lattice frame "Unitec". Series 1.420.3-36.03

The main supporting structures of the Unitec framework are welded frames of bent welded pipes in accordance with GOST 30245-03.

The cross-sections of frame structures are selected according to the design codes of the vertical load, which are determined depending on the basic code of the vertical load on the coating.

Table 2.10 - the collection of loads (Unitec series 1.420.3-36.03)

Load type	Normative	γ_f	Estimated
1. Constant			
1. Waterproof carpet (Fibrotek Master s 120)	0,04	1,3	0,052
	0,052	1,3	0, 07
2. Thermal insulation boards			
ROCKWOOL Flexi Butts brands (thickness			
130mm, γ=40kg/m3=0.4кН/m3)	0,05	1,3	0,07
0.4·0,13=0,052(kN/m2).			
3. Vapor barrier;	0,1	1,05	0,105
	0,1	1,05	0,105
	0,3	1,05	0,315
4. Steel Profiled Flooring;			
5. Net weight of runs			
6. Net weight of a farm			

Total constant:	0,642		0,717

The base code V is based on the snowy region of Kiev, then the unified vertical load is

Table 2.11 - Basic Code (Unitec Series 1.420.3-36.03)

Vertical load base code	I	II	III	IV	V	VI
DBN B.1.2-2:2006	I	II	III	IV	V	VI
Unified vertical load $q_{code.,} kg/m^2$	155	180	240	315	390	480

The horizontal load code is determined based on the value of the wind load for Kiev - IV, the standard value of the wind pressure is 0.048 T / m2, then the basic horizontal load code is 2.

Table 2.12 - Basic code horizontal load

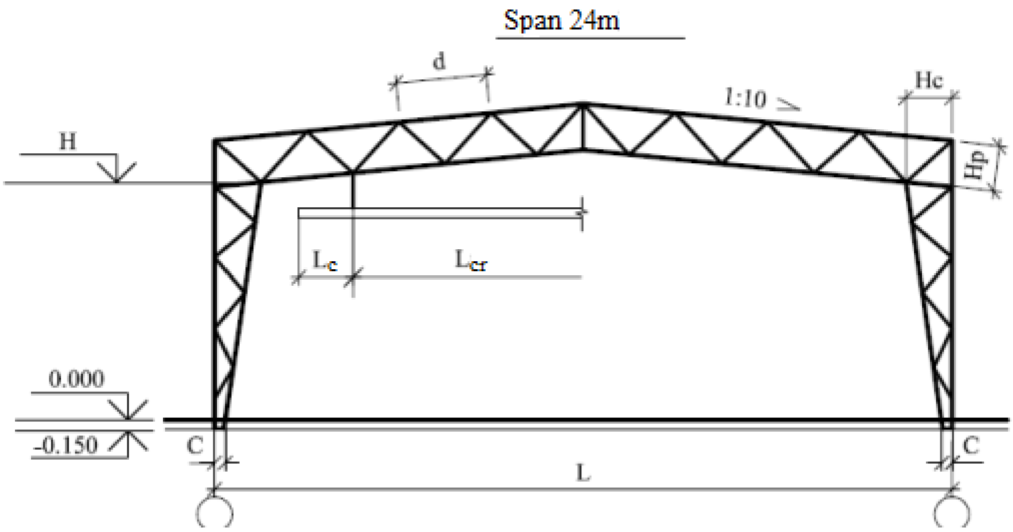
Horizontal load code	1	2
The magnitude of the regulatory wind load kgs/m^2	qv≥38	38< qv≤85

Structural steel is chosen depending on the climatic region of construction and the type of building.

Table 2.13 - Steel for building type

Climate areas	Estimated temperature of the construction area, °C	Steel when building type	
		Unheated	Heated
$II_4 II_5$	-30 °C >t≥ -40 °C	C255	C255
$I_1 II_2 II_3$	- 40 °C > t≥ -50 °C	C345-3	C345-3(C255[1])
I_1	-50 °C >t≥ -65 °C	C345-4	C345-4(C255[1])

In accordance with table 2.5, I choose steel S255.



Picture 2.14- Schematic of the Unitec frame, 24m.

Table 2.15 - Code frame "Unitec»

Frame code	Frame size, m					
	L	H	Hp	Hc	C	d
2PTO240.60 - *	24.0	6.0	1.5	1.5	0.3	1.5
2PTO240.72 - *	24.0	7.2	1.5	1.5	0.3	1.5
2PTO240.84 - *	24.0	8.4	1.5	1.5	0.3	1.5
2PTO240.96 - *	24.0	9.6	1.5	1.5	0.3	1.5

In accordance with table 2.6, the code of the supporting frame is 2 PT0 240.96-V-1

Table 2.16 - the specification of the columns of the series “Unitec»

Brand element	Weight by profiles,kg																							Total mass
	bent welded pipes																					Sheet steel	other	
	80x4	100x4	100x200x6	120x4	120x160x5	140x4	140x160x5	140x160x6	140x180x5	140x180x6	160x5	160x6	160x8	160x240x6	160x240x8	160x240x10	180x5	180x6	180x8	200x6	200x8			
K1.210.96- I(II)-*(c)		92							221								255					92		660
K1.210.96- III(IV)-*(c)		92							221								255					109		677
K1.210.96- V(VI)-*(c)		92							221									303				122		738
K1.240.60- I(II)-*(c)		91							136									190		109		104		521
K1.240.60- III(IV)-*(c)		91								161									248			124		624
K1.240.60- V(VI)-*(c)		91	150																		278	132		651
K1.240.72- I(II)-*(c)		91							164								192					104		551
K1.240.72- III(IV)-*(c)		91								194								228				124		637
K1.240.72- V(VI)-*(c)			181	110																254		132		677
K1.240.84- I(II)-*(c)		91							192								223					104		610
K1.240.84- III(IV)-*(c)		91								228								265				124		708
K1.240.84- V(VI)-*(c)			213																	300		132		755
K1.240.96- I(II)-*(c)		91							221									303				104		719
K1.240.96- III(IV)-*(c)		91								262									395			124		872
K1.240.96- V(VI)-*(c)			244	110																	443	132		929

Table2.17-the specification of the crossbars "Unitec"

SPECIFICATION OF ROGELS OF SINGLE FLIGHT FRAMES																
Brand element	WEIGHT BY PROFILES															Total mass, kg
	Welded pipe bent													Sheet steel	other	
	80x4	100x4	120x4	120x5	120x6	140x4	140x5	140x6	140x8	160x6	160x8	180x6	180x8	180x10		
1P1.180 - I (III–IV) -*(c)	85/85			407/417											161/161	36/36	689/696
1P1.180 - V (VI) -*(c)	85/85				480/490										175/175	36/36	776/785
1P1.210 - I (III) -*(c)		129					540								176	39	884
1P1.210 - III (IV) -*(c)		129						640							190	39	998
1P1.210 - V (VI) -*(c)		129							827						227	49	1232
1P1.240 - I (III) -*(c)		151					601								187	21	960
1P1.240 - III (IV) -*(c)		151						713							212	21	1096
1P1.240 - V (VI) -*(c)			183								1068				257	45	1553
1P1.300 - I (III) -*(c)			81							577					238	39	935
1P1.300 - III (IV) -*(c)						95						655			295	62	1107
1P1.300 - V (VI) -*(c)						95							854		338	62	1349
1P2.300 - I (III) -*(c)			154								506				99	-	759
1P2.300 - III (IV) -*(c)						181							575		128	-	884
1P2.300 - V (VI) -*(c)						181								703	155	-	1039
2P1.180 - I (III–IV) -*(c)	98/98			430/440											164/164	36/36	729/739
2P1.180 - V (VI) -*(c)	98/98				507/518										178/178	36/36	820/831
2P1.210 - I (III) -*(c)		145					568								182	39	936
2P1.210 - III (IV) -*(c)		145					672								197	39	1053
2P1.210 - V (VI) -*(c)		145						870							233	49	1297
2P1.240 - I (III) -*(c)		182					629								193	21	1025
2P1.240 - III (IV) -*(c)		182						744							218	21	1165
2P1.240 - V (VI) -*(c)			221								1118				264	45	1648

In accordance with tables 2.7 and 2.8, the mass of the UNITEC frame with a span of 24 meters is 1648 + 929 = 2577 kg.

2.1.3 Option 3. Frame with variable stiffness elements from welded I-beams Unimak. Series 1.420.3-37.06.

Table 2.18 - the collection of loads (Unimak series 1.420.3-37.06)

Load type	Normative	γ_f	Estimated
1. Constant			
1. Waterproof carpet (Fibrotek Master s 120)	0,04	1,3	0,052
	0,052	1,3	0, 07
2. Thermal insulation boards			
ROCKWOOL Flexi Butts brands (thickness			
130mm, γ =40kg/m3=0.4кH/m3)	0,05	1,3	0,07
0.4·0,13=0,052(kN/m2).			
3. Vapor barrier;	0,1	1,05	0,105
	0,1	1,05	0,105
4. Steel Profiled Flooring;			
5. Net weight of runs			
Total constant:	0,342		0,402
2. Temporary			
Snow	2,24		3,2
TOTAL:	2,6		3,6

Uniform vertical load qkod,kgs/m2	Vertical load code	I	II	III	IV	V	VI	VII
	Snow district DBN B.1.2-2: 2006	I	II	III	IV	V	VI	
For frame structures	Estimated	165	205	265	340	420	500	590
	Normative	130	160	200	260	315	370	435
For overlapping runs	Estimated	140	180	240	305	385	465	550
	Normative	105	135	175	225	280	335	395

Picture - Unified vertical load according to the series 1.420.3-37.06

Horizontal load code	1	2	3
Wind areas by DBN B.1.2-2: 2006	I ... III	IV ... V	VI ... VII
Uniform horizontal load (standard value), kgs / m2	38	60	85

Picture 2.19- Unified horizontal load according to the series 1.420.3-37.06

Mass Frame	Mark, H, m	Mark Brand	the num. e-nts frame	Section code of the frame elements mass of one element,kg						
				Vertical load code						
				I	II	III	IV	V	VI	VII
1	2	3	4	5	6	7	8	9	10	11
PO 1x240.H-*	6.0	P1-	2	75H5.3гд 456	75H6.4гд 540	75H6.5ди 654	90H8.4ги 728	90H8.5ик 872	90H8.6ил 970	90H8.7кл 1078
		P2-	1	75H5.2гв 677	75H5.3гв 716	75H5.4дг 889	90H6.4кд 1124	90H6.4иг 1100	90H6.5кд 1288	90H6.6кд 1395
		K1-	2	30(75)H5.3гд 397	30(75)H5.4ги 467	30(75)H5.5дк 581	30(90)H6.5ги 592	30(90)H6.5ил 722	30(90)H6.6им 825	30(90)H6.7ки 973
		Масса рамы, кг		2384	2730	3360	3766	4288	4878	5498
	7.2	P1-	2	75H5.3гд 456	75H6.4гд 540	75H6.4ди 603	90H8.4ги 728	90H8.5ди 806	90H8.6ик 941	90H8.7ик 1010
		P2-	1	75H5.1гв 649	75H5.3гв 716	75H5.4кд 958	90H6.4иг 1124	90H6.5кд 1271	90H6.5ки 1336	90H6.7лк 1669
		K1-	2	30(75)H5.3гд 462	30(75)H5.4ги 544	30(75)H5.5ди 645	30(90)H6.5ги 685	30(90)H6.5дл 786	30(90)H6.6им 955	30(90)H6.7им 1041
		Масса рамы, кг		2486	2883	3452	3951	4454	5129	5772
	8.4	P1-	2	75H5.3гд 456	75H6.4гд 540	75H6.4ди 603	90H8.4гд 696	90H8.5ди 806	90H8.6ик 941	90H8.7ик 1010
		P2-	1	75H5.1гв 649	75H5.3дг 786	75H5.4дд 916	90H6.4кд 1124	90H6.5кд 1271	90H6.6ки 1433	90H6.7ли 1669
		K1-	2	30(75)H5.3гд 524	30(75)H5.4гд 585	30(75)H5.5ди 731	30(90)H6.5ги 775	30(90)H6.5дл 894	30(90)H6.6ил 1040	30(90)H6.7им 1181
		Масса рамы, кг		2610	3035	3583	4066	4670	5395	6052
	9.6	P1-	2	75H5.3гд 456	75H6.4гд 540	75H6.4ди 603	75H8.5ди 666	90H8.5ди 806	90H8.6ик 950	90H8.7ик 1018
		P2-	1	75H5.2гв 677	75H5.3дг 786	75H5.4кд 958	75H5.6ки 1261	90H6.5ки 1319	90H6.7кк 1606	90H6.8лк 1797
		K1-	2	30(75)H5.3гд 586	30(75)H5.4гд 654	30(75)H5.5ик 771	30(75)H5.5дк 859	30(90)H6.5дк 955	30(90)H6.6дк 1058	30(90)H6.7дл 1205
		Масса рамы, кг		2761	3173	3706	4312	4840	5622	6243
	10.8	P1-	2	75H5.3гд 456	75H6.3гд 540	75H6.4дд 571	75H6.5ди 666	90H8.5ди 814	90H8.6ик 950	90H8.7ик 1018
		P2-	1	75H5.3гг 739	75H5.4дд 896	75H5.5кд 1033	75H5.6ки 1261	90H6.6ки 1433	90H6.7кк 1606	90H6.8лл 1866
		K1-	2	30(75)H5.3гд 648	30(75)H6.3ги 758	30(75)H5.4ди 811	30(75)H5.5дк 951	30(90)H6.5ги 956	30(90)H6.6дк 1168	30(90)H6.7дл 1331
		Масса рамы, кг		2947	3492	3795	4496	4975	5842	6565
	12.0	P1-	2	75H5.4гд 505	75H6.4гд 540	75H6.4дд 582	75H6.5ди 666	90H8.5ди 814	90H8.6ик 950	90H8.7ик 1018
		P2-	1	75H5.4дд 896	75H5.4дд 896	75H5.5ки 1104	75H5.6кк 1314	90H6.6кк 1486	90H6.7пк 1669	90H6.8лл 1866
		K1-	2	30(75)H5.4ги 836	30(75)H5.4ги 838	30(75)H5.4ди 889	30(75)H5.5дк 1043	30(90)H6.5ги 1047	30(90)H6.6дк 1279	30(90)H6.7дл 1458
		Масса рамы, кг		3578	3652	4044	4732	5208	6126	6818

Picture 2.20- Codes of cross-sections of frame elements according to the series 1.420.3-37.06

In accordance with figures 2.5, 2.6 and 2.7, the frame mark is 1.240.96-V. The mass of the frame is 4840 kg.

.

Table 2.21 - the cost of structures

Structure	Actual weight, t	The complexity of manufacturing, man-h.	Cost of constructions in business, UAH.
GFGS series 1.263.2	24,7	347	7747,0
Unitec series 1.420.3-36.03	30,9	366	9420
Unimak series 1.420.3-37.06	58	586	9141,0

In accordance with table 2.10, the most economical option is the use of GFGS series 1.263.2

2.22 Series frame design 1.263.2

2.23 Frame loads

$$q_p = q_{const} \cdot b \cdot \gamma_n = 0{,}717 \cdot 6 \cdot 0{,}95 = 4{,}087 \text{ кН/м},$$

where $\gamma_n = 0{,}95$ – safety factor for liability

Estimated column weight:

$$G = \gamma_n \cdot \gamma_f \cdot Q_к \cdot H_к$$

$$G_1 = 0{,}95 \cdot 1{,}05 \cdot 1{,}38 \cdot 9{,}6 = 13{,}2 \text{ kN};$$

where $\gamma_f = 1{,}05$ – load safety factor.

$Q_к$ и $H_к$ – weight of 1m linear and the height of the columns, respectively (previously we accept solid columns from I-beams 40К1).

Temporary load.

Snow load. Linear distributed snow load on the frame bolt:

$s = s_g \cdot \mu \cdot \gamma_n \cdot b = 3{,}2 \cdot 1 \cdot 0{,}95 \cdot 6 = 18{,}24$ kN/m.

Wind load. Standard speed pressure for the city of Kiev (IV wind region) according to $\omega_0 = 0{,}48$ kPa.

The estimated linear wind load transmitted to the frame rack at a certain point in height is determined by the formula:

$\omega = \gamma_f \gamma_n \omega_0 k c_e B$,

where c_e – aerodynamic coefficient (from the windward side equal to 0.8, from the leeward –c_{e3} = 0,6) [6, attach. 4];

$\gamma_f = 1{,}4$ – load safety factor [6, p. 6.11];

B – column pitch, м;

k – coefficient taking into account the height and protection from wind by other buildings. When the terrain type is in the coefficient k:

k = 0,5 – at height 5 m;

k = 0,65 – at height 10 m;

From active pressure:

$\omega_a^5 = 1{,}4 \cdot 0{,}95 \cdot 0{,}48 \cdot 0{,}5 \cdot 0{,}8 \cdot 6 = 1{,}53$ kN/m – at height 5 m;

$\omega_a^{9.6} = 1{,}4 \cdot 0{,}95 \cdot 0{,}48 \cdot 0{,}64 \cdot 0{,}8 \cdot 6 = 1{,}96$ kN/m – at height 9.6 m;

$\omega_a^{7.6} = 1{,}4 \cdot 0{,}95 \cdot 0{,}48 \cdot 0{,}56 \cdot 0{,}8 \cdot 6 = 1{,}71$ kN/m – at the bottom of the farm;

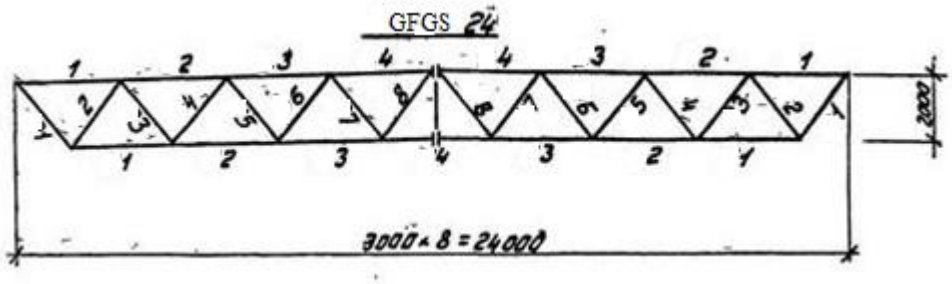
From passive pressure:

$\omega_a^5 = 1{,}4 \cdot 0{,}95 \cdot 0{,}48 \cdot 0{,}5 \cdot 0{,}6 \cdot 6 = 1{,}14$ кН/м – at height 5 m;

$\omega_a^{9,6} = 1{,}4 \cdot 0{,}95 \cdot 0{,}48 \cdot 0{,}64 \cdot 0{,}6 \cdot 6 = 1{,}47$ кН/м – at height 9,6 m;

$\omega_a^{7,6} = 1{,}4 \cdot 0{,}95 \cdot 0{,}48 \cdot 0{,}56 \cdot 0{,}6 \cdot 6 = 1{,}29$ кН/м – at the bottom of the farm.

2.24 Calculation and design of the truss truss.



Picture 2.25 - Designation of truss rods

The design effort in the rods of the farm is determined using an automated design and computing complex SCAD. Truss material steel S245: $R_y = 24$ кН/см^2. The upper and lower zones are designed without changing the section.

The sections of belts and gratings are taken from bent sections according to GOST 30245-94.

The calculation is carried out without taking into account the increase in bearing capacity due to cold work.

2.3.2.1 Calculation of the top belt of the farm**.**

An effort $N_{\max} = -676{,}51$ кН. $\gamma_c = 1$, $\mu_x = \mu_y = 1$, $l_{ef,x} = 300 см$, $l_{ef,y} = 300 cm$, for upper belt $\lfloor \lambda_{x,y} \rfloor = 180 - 60\alpha$

We are flexible $\lambda = 80$. Then according $\varphi = 0{,}686$. cm^2.

Accept section Bw. □ 180×140×7 with A = 42,84 cm^2, i_x=6,83 cm, i_y=5,61

$$\lambda_x = \frac{l_{ef,x}}{i_x} = \frac{300}{6{,}83} = 43{,}9$$

$$\lambda_y = \frac{l_{ef,y}}{i_y} = \frac{300}{5{,}61} = 53{,}5$$

$$\varphi = 0{,}821$$

$$\alpha = \frac{N}{\varphi A R_y \gamma_c} = \frac{676{,}51}{0{,}686 \cdot 42{,}84 \cdot 24 \cdot 1} = 0{,}8$$

$\lfloor\lambda_y\rfloor = 180 - 60\alpha = 180 - 60\cdot 0{,}8 = 132$; $\lambda_y = 53{,}5 < \lfloor\lambda_{x,y}\rfloor = 132$

The condition is met.

Checking the stability of the rod:

$$\sigma = \frac{N}{\varphi_{\min} A} = \frac{676{,}51}{0{,}821\cdot 42{,}84} = 19{,}23\kappa H/c\mathit{м}^2 > R_y\gamma_c = 24\cdot 1 = 24kN/cm^2$$

Sustainability provided

We accept the section of the upper belt Bw. □ 180×140×7.

2.25 Calculation of the lower farm belt**.**

An effort $N_{\max} = 763{,}69$ kN. For lower belt $\lfloor\lambda_{x,y}\rfloor = 400$; $\gamma_c = 0{,}95$; $\mu_{x,y} = 1$; $l_{ef,x} = l_{ef,y} = 3$ м. $A = \frac{N}{R_y\gamma_c} = \frac{763{,}69}{24\cdot 0{,}95} = 33{,}5\ \text{cm}^2$

Accept section Bw.□ 140×7 with A=37,24 cm^2, i_x=5,44 cm, i_y=5,44 cm The ratio of the height of the wall to its thickness:

$\frac{D_b}{t} = \frac{140}{7} = 20 < 45$ does not exceed the limit value.

Rod flexibility:

$$\lambda_{x,y} = \frac{l_{ef,\text{ч},y}}{i_x} = \frac{300}{5{,}44} = 55{,}1 < \left[\lambda_{x,y}\right] = 400;$$

The condition is met.

Checking the tensile strength of the cross section:

$$\sigma = \frac{N}{A} = \frac{763{,}69}{37{,}24} = 20{,}5\kappa H/cm^2 < R_y\gamma_c = 24\cdot 0{,}95 = 22{,}8kN/cm^2.$$

Durability Provided.

Checking the flexibility of the wall:

$$\frac{h_{ef}}{t} = \frac{D_b - 4t}{t} = \frac{140 - 4\cdot 7}{7} = 16 < \left[\frac{h_{ef}}{t}\right] = 1{,}29\sqrt{\frac{E}{R_y}} = 1{,}29\cdot\sqrt{\frac{2{,}06\cdot 10^4}{24}} = 37{,}8$$

The condition is satisfied. Finally accept the section of the lower belt Bw.□ 140×7.

2.26 Brace calculation

Brace B2 - compressed. $N_{max} = -297{,}51$ kN.

$\gamma_c = 1$, $\mu_x = \mu_y = 1$, $l_{ef,x} = 250cm$, $l_{ef,y} = 250cm$. $\lfloor \lambda_{x,y} \rfloor = 180 - 60\alpha$

We are flexible $\lambda = 80$. Then according $\varphi = 0{,}686$.

$$A = \frac{N}{\varphi R_y \gamma_c} = \frac{279{,}51}{0{,}686 \cdot 24 \cdot 1} = 16{,}98 \text{ cm}^2.$$

Accept section Bw. □ 120×4 with A = 18,56 cm^2, i_x=4,74 cm, i_y=4,74 cm.

$$\lambda_x = \frac{l_{ef,x}}{i_x} = \frac{250}{4{,}74} = 52{,}74$$

$$\lambda_y = \frac{l_{ef,y}}{i_y} = \frac{250}{4{,}74} = 52{,}74$$

$$\varphi = 0{,}831$$

$$\alpha = \frac{N}{\varphi A R_y \gamma_c} = \frac{279{,}51}{0{,}831 \cdot 16{,}98 \cdot 24 \cdot 1} = 0{,}83$$

$\lfloor \lambda_y \rfloor = 180 - 60\alpha = 180 - 60 \cdot 0{,}83 = 130{,}2$; $\lambda_y = 52{,}74 < \lfloor \lambda_{x,y} \rfloor = 130{,}2$.

The condition is met.

Checking the stability of the rod.

$$\sigma = \frac{N}{\varphi_{\min} A} = \frac{279{,}51}{0{,}831 \cdot 42{,}84} = 7{,}85 \kappa H / cm^2 > R_y \gamma_c = 24 \cdot 1 = 24 \kappa H / cm^2.$$

Sustainability provided. We accept the section of the upper belt Bw. □ 120×4.

Brace B1 - extended. $N_{max} = 284{,}8$ kN.

$\lfloor \lambda_{x,y} \rfloor = 400$; $\gamma_c = 0{,}95$; $\mu_{x,y} = 1$; $l_{ef,x} = l_{ef,y} = 3$m.

$$A = \frac{N}{R_y \gamma_c} = \frac{284{,}8}{24 \cdot 0{,}95} = 12{,}5 \text{ cm}^2$$

Accept section Bw.□ 100×4 with A=15,36 cm^2, i_x=3,92 cm, i_y=3,92 cm

The ratio of the height of the wall to its thickness:

$\frac{D_b}{t} = \frac{100}{4} = 25 < 45$ does not exceed the limit value.

Rod flexibility:

$$\lambda_{x,y} = \frac{l_{ef,ч,y}}{i_x} = \frac{250}{3,92} = 63,8 < [\lambda_{x,y}] = 400;$$

The condition is met.

Checking the tensile strength of the cross section:

$$\sigma = \frac{N}{A} = \frac{284,8}{15,36} = 18,5 кH / cm^2 < R_y \gamma_c = 24 \cdot 0,95 = 22,8 kN / cm^2.$$

Durability Provided.

Checking the flexibility of the wall:

$$\frac{h_{ef}}{t} = \frac{D_b - 4t}{t} = \frac{100 - 4 \cdot 4}{4} = 21 < \left[\frac{h_{ef}}{t}\right] = 1,29\sqrt{\frac{E}{R_y}} = 1,29 \cdot \sqrt{\frac{2,06 \cdot 10^4}{24}} = 37,8$$

The condition is satisfied. Finally accept the section of the lower belt

Bw.□ 100×4.

Further calculations of the rods are carried out similarly to the calculation of a compressed and stretched rod B2 and B1. The calculation results are tabulated 2.11

Table 2.11 - Design efforts and selection of sections

Elem. Farms.	№ rod	Design effort	Calculation section	Accepted section	Cross-sectional area , cm^2	Estimated length , m		Radius of inertia	
						In the plane	From the plane	i_x	i_y
Upper belt	U4	-676,51	Bw.□180×140×7	Bw .□180×140×7	42,84	3,00	3,00	6,83	5,61
Lower belt	N4	763,69	Bw.□140×7	Bw .□140×7	37,24	3,00	3,00	5,44	5,44
Braces	B1	284,8	Bw .□100×4	Bw .□120×5	23	2,50	2,50	4,69	3,69
	B2	-297,5	Bw .□120×4	Bw .□120×5	23	2,50	2,50	4,69	4,69
	B3	194	Bw .□80×3	Bw .□100×4	15,36	2,50	2,50	3,92	3,92
	B4	-194	Bw .□100 ×3	Bw .□100×4	15,36	2,50	2,50	3,92	3,92
	B5	119	Bw .□80×3	Bw .□100×4	15,36	2,50	2,50	3,92	3,92
	B6	-117,8	Bw .□80 ×3	Bw .□100×4	15,36	2,50	2,50	3,92	3,92
	B7	40,2	Bw .□80×3	Bw .□100×4	15,36	2,50	2,50	3,92	3,92
	B8	-37,4	Bw .□80×3	Bw .□100×4	15,36	2,50	2,50	3,92	3,92

2.3.2.4 Calculation of welds for attaching truss rods.

Semi-automatic welding in carbon dioxide according to GOST 8050-88 welding wire brand SV08-G2S according to GOST 2246-70 * with a diameter of 2 mm.

The truss material is steel S245, the material of the supporting flanges of the upper and lower chords is steel S245: $R_y = 24\,\text{kN/cm}^2$.

Corner welds without cutting the edges of the section of the belts. For steel S245: design resistance of the fillet weld to shear (conditional) for weld metal $R_{wf} = 21{,}5$ кН/см^2; design resistance of the fillet weld to a shear (conditional) for the metal of the fusion boundary $R_{wz} = 16{,}5$ kN/cm^2.

The design resistances taken when calculating the weld metal:

$R_{wf}\beta_f\gamma_{wf} = 21{,}5 \cdot 0{,}9 \cdot 1 = 19{,}35$ kN/cm^2.

The design resistance adopted when calculating the metal alloy boundary:

$R_{wz}\beta_z\gamma_{wz} = 16{,}5 \cdot 1{,}05 \cdot 1 = 17{,}33$ kN/cm^2.

The condition for the calculation of compounds for metal fusion boundary is accepted:

$R_{wz}\beta_z\gamma_{wz} = 17{,}33 kN/cm^2 < R_{wf}\beta_f\gamma_{wz} = 19{,}35 kN/cm^2$.

Upper belt (core B2)

We accept a leg of a seam $k_f = 8$ mm.

We check the strength of the seam according to the formula:

$$\sigma_w = \frac{N_{cm}}{l_w k_f} + \frac{N_{cm} e}{W_w} = \frac{662{,}96}{63 \cdot 0{,}8} + \frac{662{,}96 \cdot 0{,}30}{86{,}4} = 15{,}46 кН/см^2 < R_{wz}\beta_z\gamma_{wz}\gamma_c = 17{,}33 kN/cm^2,$$

где $N_{cm} = N_{B3} + \cos\alpha \cdot N_{P6} = 589{,}5 + \cos 47° \cdot 107{,}71 = 662{,}96$ kN/cm^2 – joint force;

$l_w = 2(D_b + D) - 1 = 2 \cdot (18 + 14) - 1 = 63$ cm;

$e = 0{,}30$ cm – eccentricity

$W_w = \frac{2 l_{wв}^2 k_f}{6} = \frac{2 \cdot 18^2 \cdot 0{,}8}{6} = 86{,}4$ cm^3– resistance moment of vertical welds.

Seam strength ensured.

Upper belt. (core B1)

We accept a leg of a seam $k_f = 8$mm.

Normal stresses in the weld connecting the upper belt to the flange: $\sigma_w = \frac{N_{B1}}{l_w k_f} = \frac{156{,}76}{63 \cdot 0{,}8} = 3{,}11$ kN/cm^2,

Tangent stresses in the weld

$\tau_w = \frac{R_A}{l_w k_f} = \frac{284{,}76}{63 \cdot 0{,}8} = 5{,}65$ kN/cm^2,

R_A– farm support reaction:

$R_A = \frac{(q_n + q_s)l}{2} = \frac{(6,2 + 17,53) \cdot 24}{2} = 284,76$ kN.

Strength of a seam according to reduced stresses

$\sigma_{np} = \sqrt{\sigma_w^2 + 3 \cdot \tau_w^2} = \sqrt{3,11^2 + 3 \cdot 5,65^2} = 10,27 kN/cm^2 < 1,15 R_{wy}\gamma_c = 1,15 \cdot 20,4 \cdot 1 = 23,46 kN/cm^2$

Weld strength ensured.

Lower belt (core L4)

We accept a leg of a seam $k_f = 8$ mm.

Check the strength of the seam by the formula: $\sigma_w = \frac{N_{H4}}{l_w k_f} = \frac{763,69}{55 \cdot 0,8} = 17,3 kN/cm^2 < R_{wz}\beta_z\gamma_{wz}\gamma_c = 17,33$ kN/cm^2

where $l_w = 2(D_b + D) - 1 = 2 \cdot (2 + 20) - 1 = 79$ cm;

$\gamma_c = 1$.

Seam strength ensured.

Check the flange for separation in the heat affected area:

$\sigma_z = \frac{N_{H4}}{1,4\beta_f k_f l_w} = \frac{763,69}{1,4 \cdot 0,9 \cdot 0,8 \cdot 55} = 13,8 kN/cm^2 < R_{th}\gamma_c = 18 \cdot 1 = 18 kN/cm^2$,

where $R_{th} = 0,5R_u = 0,5 \cdot 36 = 18$ kN/cm^2. Here $R_u = 36$ kN/cm^2 – design resistance of steel by temporary resistance.

Strength condition met.

Stretched brace B1

We accept a leg of a seam $k_f = 5$ мм.

Length of longitudinal seams:

$b = \frac{d_b}{\sin\alpha} = \frac{120}{\sin 50°} = 156,6$ mm.

Ratio of quantities:

$\frac{c}{b} = \frac{2}{15,66} = 0,128 < 0,25$.

Estimated seam length:

$l_w = 2b + d = 2 \cdot 15,6 + 12 = 43,2$ cm.

Normal voltage:

$$\sigma_w = \frac{N_{P1} \cdot \sin\alpha}{k_f l_w} = \frac{284{,}8 \cdot \sin 50°}{0{,}5 \cdot 43{,}2} = 10{,}1 kN/cm^2 < R_{wy}\gamma_c = 20{,}4 \cdot 1 = 20{,}4 kN/cm^2,$$

where $R_{wy} = 0{,}85 R_y = 0{,}85 \cdot 24 = 20{,}4$ kN/cm^2 – design resistance of the butt joint by yield strength.

The condition is met.

Tangential stress: $\tau_w = \frac{N_{P1} \cdot \cos\alpha}{k_f l_w} = \frac{284{,}8 \cdot \cos 50°}{0{,}5 \cdot 43{,}2} = 8{,}5 kN/cm^2 < R_{ws}\gamma_c = 13{,}86 \cdot 1 = 13{,}86 kN/cm^2$,

where $R_{ws} = 0{,}58 \frac{R_{yn}}{\gamma_m} = 0{,}58 \cdot \frac{24{,}5}{1{,}025} = 13{,}86$ kN/cm^2 – design resistance of the butt joint to shear.

Here $R_{yn} = 24{,}5$ kN/cm^2 – yield strength of steel , $\gamma_m = 1{,}025$ - material safety factor.

The condition is met.

Reduced voltage:

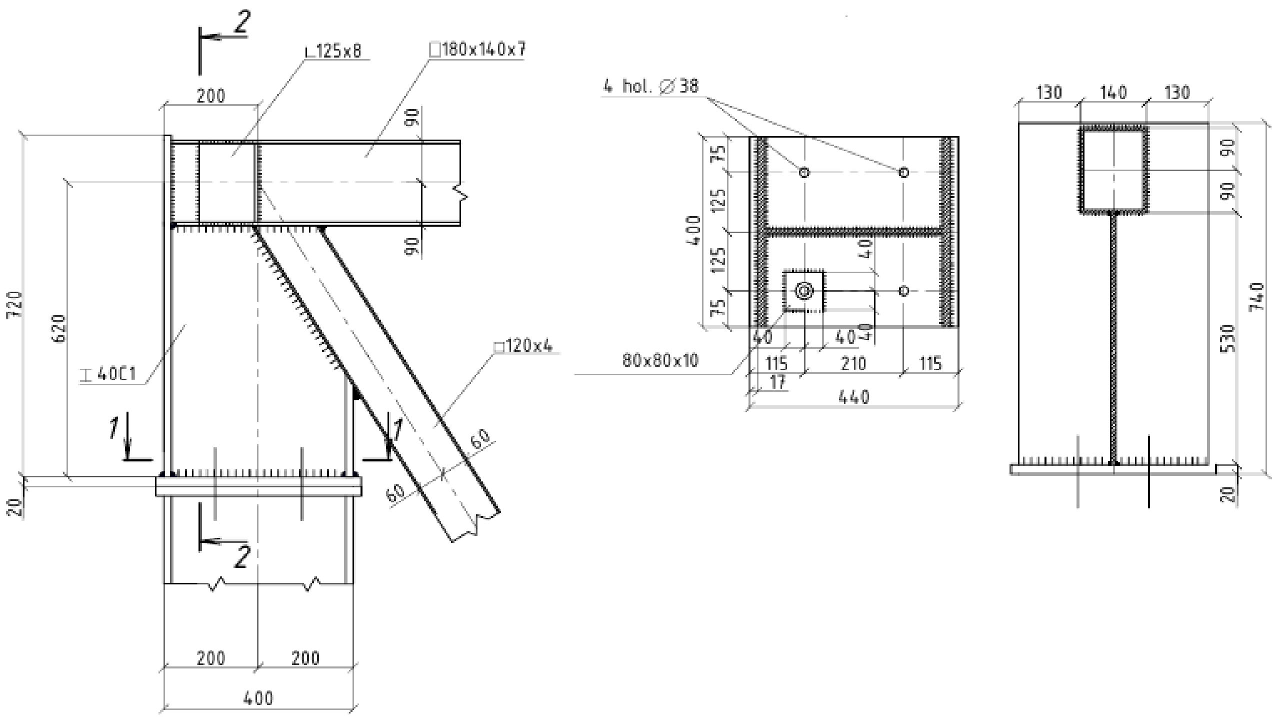
$$\sigma_{np} = \sqrt{\sigma_w^2 + 3 \cdot \tau_w^2} = \sqrt{10{,}1^2 + 3 \cdot 8{,}5^2} = 17{,}9 kN/cm^2 < 1{,}15 R_{wy}\gamma_c = 1{,}15 \cdot 20{,}4 \cdot 1 = 23{,}46 kN/cm^2$$

The condition is met.

2.3.3 Farm Node Design

Node 1. Welds for fastening the upper belt and the brace to the column are calculated earlier. We accept structurally supporting I-beam 40K1, picture 2.9

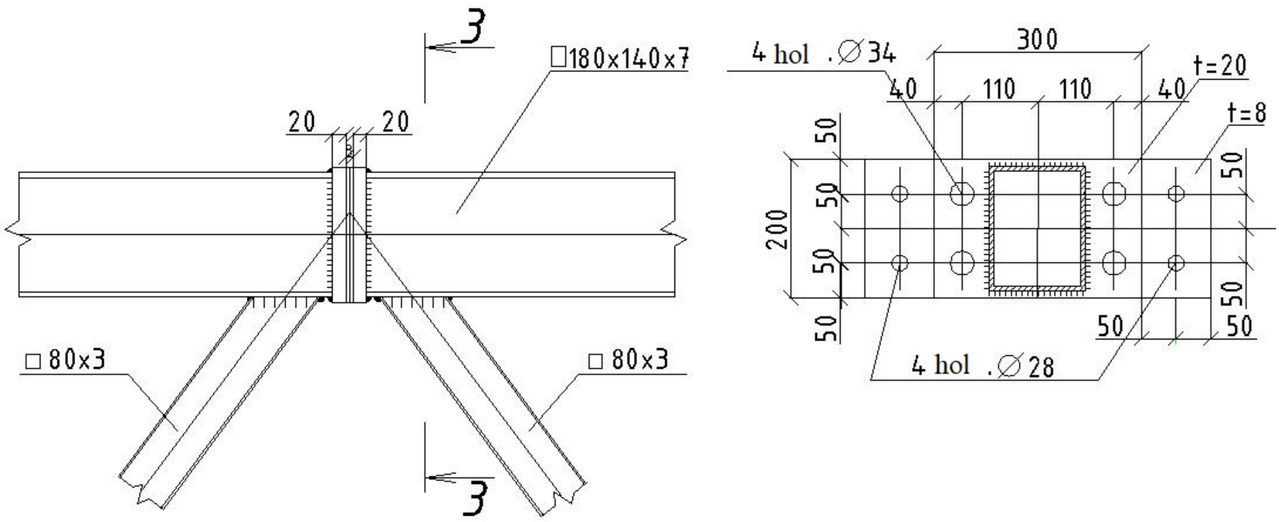
For fastening the column to the column, we accept M36 bolts according to ST SEV 180-75.



Picture 2.27 - the reference node of the farm

Node 2. Mounting joint works on compression. We accept flanges with a thickness of 20 mm and dimensions of 300 × 200 mm from steel S245. M30 bolts, class 5.6. We place bolts so that design requirements are observed. We accept the diameter of the washers mm, the diameter of the holes is 34 mm.

We check the design conditions for the placement of bolts, picture 2.10



Picture 2.28 - Upper Farm Trunk Assembly

$$b_1 = 40mm > \frac{d_ш}{2} + k_f + 2mm = \frac{40}{2} + 8 + 2 = 30mm;$$

$$b_1 = 40mm < 3{,}5d = 3{,}5 \cdot 30 = 105mm;$$

$$b_1 = 40mm > 1{,}2d = 1{,}2 \cdot 30 = 36mm;$$

$$a = 40mm > 0{,}8d_ш = 0{,}8 \cdot 40 = 32mm;$$

$$w = \frac{200}{2} = 100mm < 4 \cdot (b_1 - k_f) = 4 \cdot (40 - 8) = 128\text{ mm},$$

where b_1 – distance from the edge of the belt to the axis of the bolt;

$d_ш$ – washer outer diameter;

a – distance from flange face to bolt axis;

w – flange width per bolt.

To prevent shear in the flange connection, the condition:

$$Q = 210{,}4 \le \mu N_{cm} = 0{,}35 \cdot 832{,}56 = 232\text{ kN},$$

where Q– conditional shear force:

$$Q = \frac{q_s l}{2} = \frac{17{,}53 \cdot 24}{2} = 210{,}4\,\text{kN};$$

$\mu = 0{,}35$– coefficient of friction

The condition is met.

Check the junction of the upper belt with a flange:

$$\sigma_w = \frac{N_{cm}}{l_w k_f} + \frac{N_{cm} e}{W_w} = \frac{662{,}96}{63 \cdot 0{,}8} + \frac{662{,}96 \cdot 0{,}30}{84{,}8} = 15{,}495 kN/cm^2 < R_{wz}\beta_z\gamma_{wz}\gamma_c = 17{,}33 kN/cm^2$$

Seam strength ensured.

Node 3. We calculate the flange connection of the lower belt. Tensile force $N = 763{,}68$ kN.

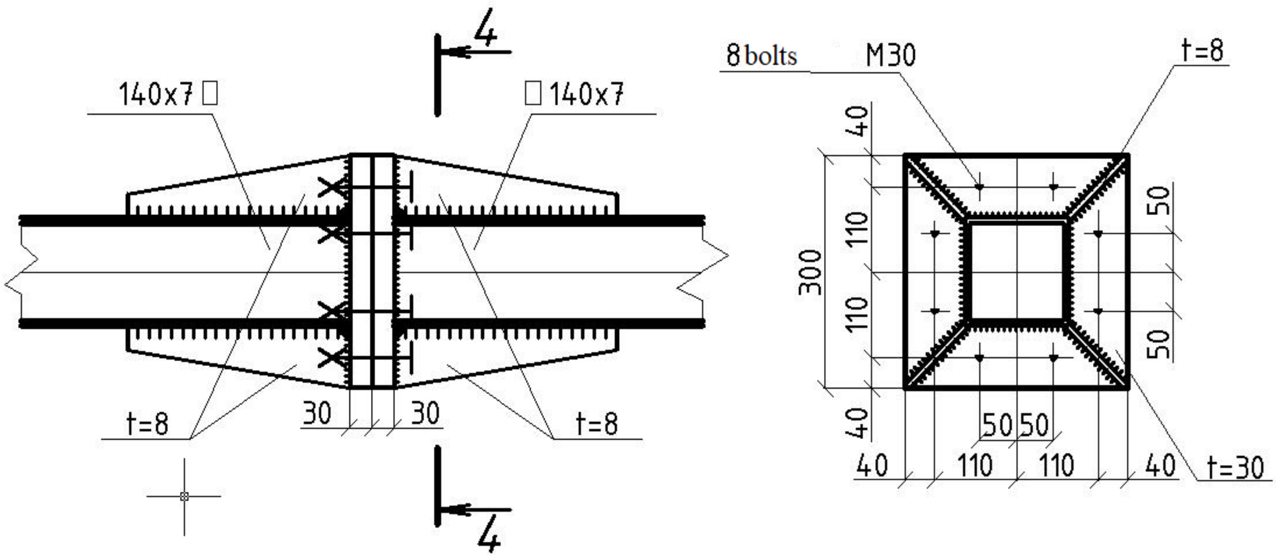
We accept high-strength bolts M30 from steel 40X "Select". Washer Diameter $d_ш = 40$ mm, hole diameter – 34 mm. Flange thickness 30 mm.

Bolt Cross Section $A_{bn} = 5{,}60\,\text{cm}^2$.

Estimated tensile strength of high strength bolt:

$R_{bh} = 0{,}7 R_{bun} = 0{,}7 \cdot 95 = 66{,}5\,\text{kN/cm}^2$,

where $R_{bun} = 95\,\text{kN/cm}^2$– standard resistance of bolt steel.



Picture 2.29 Farm Trunk Lower Assembly

The strength of the connection is provided if the condition is met: $N \le n \cdot N_1 + \sum_1^n N_j$, where $N_1 = 0{,}9 R_{bh} A_{bn} = 0{,}9 \cdot 66{,}5 \cdot 5{,}6 = 335{,}16$ kN;

N_j – design force on the j-th bolt of the outer zone, equal to

$N_j = \min\left(N_{bj}, N_{fj}\right)$.

Here N_{bj} – design force on the j-th bolt, determined from the strength condition

bolted connections:

$$N_{bj} = (\alpha - \beta \lg \chi) R_{bh} A_{bn} = (0{,}388 - 0{,}257 \cdot \lg 1{,}852) \cdot 66{,}5 \cdot 5{,}6 = 118{,}88 \text{ kN}$$

Here $\alpha = 0{,}388$ and $\beta = 0{,}257$ – coefficients taken by depending on the ratio $\dfrac{t_{fl}}{d_b} = \dfrac{30}{30} = 1$;

χ – bolt stiffness parameter determined by the formula:

$$\chi = \frac{d_b^2 \left(\dfrac{b}{t_{fl}}\right)^3}{\omega\left(t_{fl} + 0{,}5 \cdot d_b\right)} = \frac{3^2 \cdot \left(\dfrac{4{,}2}{2}\right)^3}{10 \cdot (3 + 0{,}5 \cdot 3)} = 1{,}852,$$

$b = b_1 - k_f = 50 - 8 = 42$ mm – the distance between the axis of the bolt and the edge of the weld.

N_{fj} – design force on the j-th bolt, determined from the condition of the flexural strength of the flange:

$$N_{fj} = 1{,}3 \frac{1 + \dfrac{1}{\gamma}}{\mu} \cdot R_{bh} A_{bn} = 1{,}3 \cdot \frac{1 + \dfrac{1}{1{,}388}}{3{,}128} \cdot 66{,}5 \cdot 5{,}6 = 266{,}28 \text{ kN},$$

where γ – parameter determined by [7, table 81];

$$\mu = \frac{5{,}4 \cdot R_{bh} A_{bn} b}{R_y w t^2} = \frac{5{,}4 \cdot 66{,}5 \cdot 5{,}6 \cdot 4{,}2}{30 \cdot 10 \cdot 3^2} = 3{,}128.$$

$$N = 763{,}68 < n \cdot N_1 + \sum_1^n N_j = 8 \cdot 335{,}16 + 8 \cdot 118{,}88 = 3632{,}32 \text{ kN}.$$

Connection strength ensured.

Check the connection for shear. Contact Shear:

$$V = R_{bh} A_{bn} - 1{,}2 N_{bj} = 66{,}5 \cdot 5{,}6 - 1{,}2 \cdot 118{,}88 = 229{,}74 \text{ kN}.$$

Shear force:

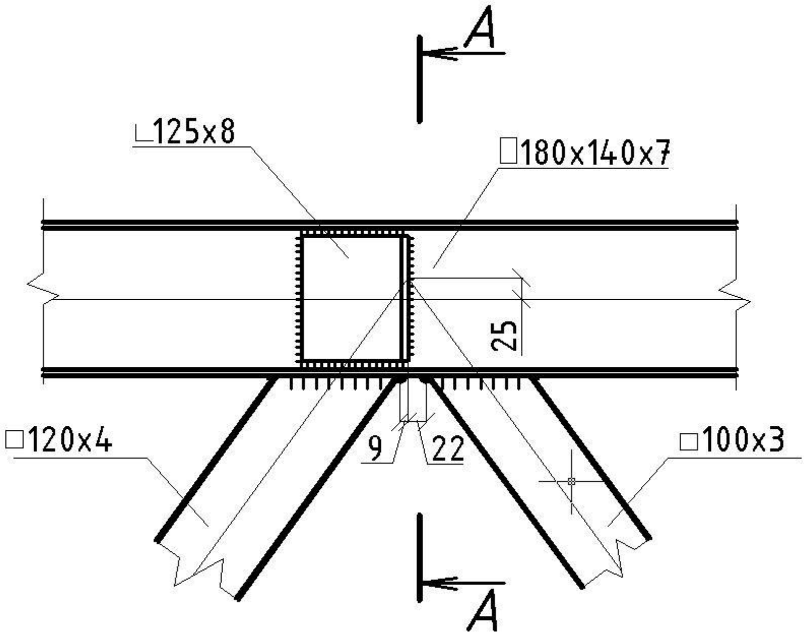
$$Q_{ef} = 0{,}1 \mu N = 0{,}1 \cdot 0{,}25 \cdot 763{,}68 = 19{,}1 \text{ kN}.$$

Check condition:

$Q = Q_{ef} = 19{,}1 < \mu n V = 0{,}25 \cdot 4 \cdot 229{,}74 = 229{,}74$ kN.

Durability Provided.

Node 5.



Pic 2.30 Farm Intermediate

When designing the adjacency of the braces to the truss belt, the intersection of their axes is shifted from the belt axis by the value e. This is done in order to fulfill the required clearance between the "socks" of the braces. The bending moment arising from the eccentric application of the load is allowed not to be taken into account when the eccentricity e is not more than 0.25 of the height of the section of the belt.

Check the strength of the farm node. The angle of inclination of the braces $\alpha = 36°$.

We determine the projection of the heights of the braces on the belt:

$$b_1 = \frac{d_{b1}}{\sin\alpha} = \frac{120}{\sin 36°} = 204{,}2 \text{ mm};$$

$$b_2 = \frac{d_{b2}}{\sin\alpha} = \frac{100}{\sin 36°} = 170{,}1 \text{ mm}.$$

The gap between the shelves of the braces $2c = 31$ mm.

$$\frac{c}{b_1} = \frac{15{,}5}{204{,}2} = 0{,}08 < 0{,}25$$

$$\frac{c}{b_2} = \frac{15{,}5}{170{,}1} = 0{,}09 < 0{,}25$$

$\frac{d_1}{D} = \frac{120}{180} = 0{,}67 < 0{,}9$; $\frac{d_2}{D} = \frac{100}{180} = 0{,}56 < 0{,}9$.

Determine the bearing capacity:

for compressed braces B2 $P_0 = \frac{R_y t_{d1}\left(b_1 + c + \sqrt{2Df_1}\right)}{f_1\left(0{,}4 + 1{,}8\frac{c}{b_1}\right)} = \frac{24 \cdot 0{,}7^2\left(20{,}42 + 1{,}55 + \sqrt{2 \cdot 18 \cdot 3}\right)}{3 \cdot \left(0{,}4 + 1{,}8 \cdot \frac{1{,}55}{20{,}42}\right)} = 236{,}4\,\text{kN},$

where $f_1 = \frac{D - d_1}{2} = \frac{180 - 120}{2} = 30\,\text{mm}.$

for stretched brace B3

$$P_0 = \frac{R_y t_{d2}\left(b_2 + c + \sqrt{2Df_2}\right)}{f_2\left(0{,}4 + 1{,}8\frac{c}{b_2}\right)} = \frac{24 \cdot 0{,}7^2\left(17{,}01 + 1{,}55 + \sqrt{2 \cdot 18 \cdot 4}\right)}{4 \cdot \left(0{,}4 + 1{,}8 \cdot \frac{1{,}55}{17{,}01}\right)} = 159{,}3\,\text{kN},$$

where $f_2 = \frac{D - d_2}{2} = \frac{180 - 100}{2} = 40\,\text{mm}.$

The bearing capacity of the node is considered to be provided for each element, calculated separately, if the conditions are met:

$$\frac{P'}{P_0} \le \gamma_c \gamma_v,$$

where P' – projection of the force in the element adjacent to the belt (brace or stand), but perpendicular to its axis:

$$P' = N_d \sin\alpha;$$

γ_v – coefficient taking into account the type of stress state of the belt; $\gamma_v = 1$ in tension or in compression, if the condition: $\frac{\sigma_f}{R_y} \le 0{,}5$,

$\gamma_v = 1{,}5 - \left|\frac{\sigma_f}{R_y}\right|$ at $\left|\frac{\sigma_f}{R_y}\right| > 0{,}5$ [6, pag.171]. Here $\sigma_f = \frac{N_f}{A_f}$.

N_d, N_f – force, respectively, in the brace and belt.

The bearing capacity of the rod R2 for punching (since the brace is compressed):

$$\sigma_f = \frac{N_f}{A_f} = \frac{170{,}58}{42{,}84} = 3{,}98\,\text{kN/cm}^2.$$

$$\frac{\sigma_f}{R_y} = \frac{3{,}98}{24} = 0{,}17 < 0{,}5$$, consequently $\gamma_v = 1$.

$$P' = N_d \sin\alpha = 279{,}51 \cdot \sin 36° = 164{,}29\,\text{kN};$$

$$\frac{P'}{P_0} = \frac{164{,}29}{236{,}4} = 0{,}69 < \gamma_c \gamma_v = 1 \cdot 1 = 1.$$

The condition is met.

The bearing capacity of the R3 rod to tear (since the brace is stretched):

$$\sigma_f = \frac{N_f}{A_f} = \frac{454{,}98}{42{,}84} = 10{,}62\ \text{kN/cm}^2.$$

$$\frac{\sigma_f}{R_y} = \frac{10{,}62}{24} = 0{,}442 < 0{,}5$$, consequently $\gamma_v = 1$.

$$P' = N_d \sin\alpha = 194{,}01 \cdot \sin 36° = 114\,\text{kN};$$

$$\frac{P'}{P_0} = \frac{114}{159{,}3} = 0{,}72 < \gamma_c \gamma_v = 0{,}95 \cdot 1 = 0{,}95$$

The condition is met.

Belt Edge Strength Provided.

We check the local stability of the side faces of the belt under a compressed brace.

With the ratio:

$$\frac{D_b}{t} = \frac{180}{7} = 25{,}7$$

coefficient $k = 1$ by then

$$k\gamma_v R_y \gamma_c = 1 \cdot 1 \cdot 24 \cdot 1 = 24\,\text{kN/cm}^2;$$

$$\sigma = \frac{P'}{2tb_1} = \frac{164{,}29}{2 \cdot 0{,}7 \cdot 20{,}42} = 5{,}7 kN/cm^2 < 24 kN/cm^2.$$

Stability of the side edges of the belt provided.

We check the lateral faces of the compressed brace for stability.

$$\frac{d_b}{t} = \frac{120}{4} = 30;\ k = 1.$$

The condition must be met:

$$N_d \le \frac{\gamma_c \gamma_d k R_{yd} A_d}{1 + 0{,}013 D/t},$$

where γ_d – the coefficient of influence of the sign of effort in the adjacent element, taken equal to 1.2 in tension and 1.0 in other cases.

$$N_d = 279{,}51kN \le \frac{\gamma_c \gamma_d k R_y A_d}{1+0{,}013D/t} = \frac{1\cdot 1\cdot 1\cdot 24\cdot 18{,}56}{1+0{,}013\cdot \frac{12}{0{,}6}} = 320{,}46kN\,.$$

The condition of local stability of the side faces is satisfied.

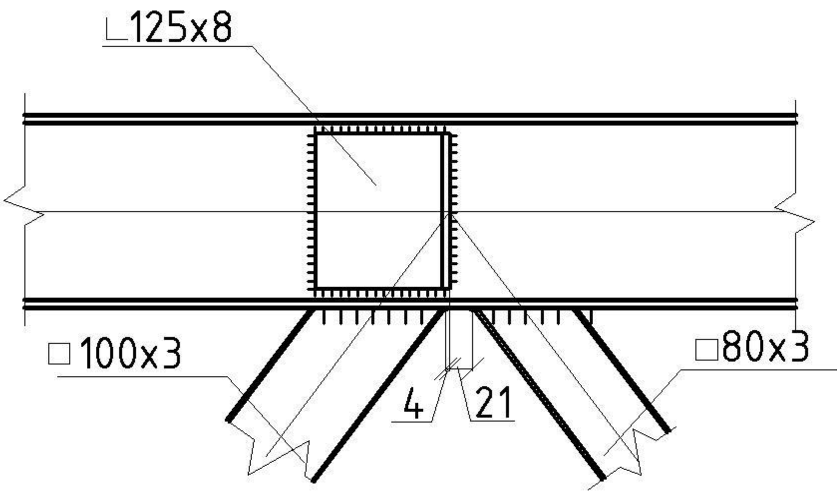
We check the local stability of the lateral sides of the extended brace.

$$\frac{d_b}{t} = \frac{100}{3} = 33{,}3;\; k = 1.$$

$$N_d = 194{,}01kN \le \frac{\gamma_c \gamma_d k R_y A_d}{1+0{,}013D/t} = \frac{0{,}95\cdot 1{,}2\cdot 1\cdot 24\cdot 11{,}64}{1+0{,}013\cdot \frac{10}{0{,}6}} = 222{,}19kN$$

The condition is met.

Node 6.



Picture 2.31 Farm Intermediate

The calculation is performed similarly to the calculation of the node 4.

The angle of inclination of the braces $\alpha = 36°$.

We determine the projection of the heights of the braces on the belt:

$$b_1 = \frac{d_{b1}}{\sin\alpha} = \frac{100}{\sin 36°} = 170{,}1\text{mm};$$

$$b_2 = \frac{d_{b2}}{\sin\alpha} = \frac{80}{\sin 36°} = 136{,}1\text{mm}.$$

The gap between the shelves of the braces $2c = 25$ mm.

$$\frac{c}{b_1}=\frac{12,5}{170,1}=0,07<0,25$$

$$\frac{c}{b_2}=\frac{12,5}{136,1}=0,09<0,25$$

$$\frac{d_1}{D}=\frac{100}{180}=0,556<0,9\ ;\ \frac{d_2}{D}=\frac{80}{180}=0,444<0,9\,.$$

Determine the bearing capacity:

for compressed brace B4 kN,

where $f_1=\frac{D-d_1}{2}=\frac{180-100}{2}=40$ mm.

for stretched brace B5

$$P_0=\frac{R_y t_{d2}\left(b_2+c+\sqrt{2Df_2}\right)}{f_2\left(0,4+1,8\frac{c}{b_2}\right)}=\frac{24\cdot 0,7^2\left(13,61+1,55+\sqrt{2\cdot 18\cdot 5}\right)}{5\cdot\left(0,4+1,8\cdot\frac{1,55}{13,61}\right)}=117,6\,\text{kN},$$

where $f_2=\frac{D-d_2}{2}=\frac{180-80}{2}=50$ mm.

The bearing capacity of the R4 rod for punching (since the brace is compressed):

$$\sigma_f=\frac{N_f}{A_f}=\frac{454,98}{42,84}=10,62\,\text{kN/cm}^2.$$

$$\frac{\sigma_f}{R_y}=\frac{10,62}{24}=0,442<0,5\text{, consequently } \gamma_v=1.$$

$$P'=N_d\sin\alpha=194,08\cdot\sin 36°=114\,\text{kN};$$

$$\frac{P'}{P_0}=\frac{114}{167,14}=0,682<\gamma_c\gamma_v=1\cdot 1=1.$$

The condition is met.

The bearing capacity of the R5 rod to tear (since the brace is stretched):

$$\sigma_f=\frac{N_f}{A_f}=\frac{643,7}{42,84}=15,0\,\text{kN/cm}^2.$$

$$\frac{\sigma_f}{R_y}=\frac{15,0}{24}=0,625<0,5\text{, consequently } \gamma_v=1.$$

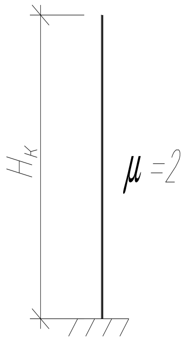
$$P'=N_d\sin\alpha=119,1\cdot\sin 36°=70\,\text{kN};$$

$$\frac{P'}{P_0}=\frac{70}{117,6}=0,595<\gamma_c\gamma_v=0,95\cdot 1=0,95$$

The condition is met.

2.32 Calculation and design of the column rod.

The efforts in the columns are determined using an automated design and computing complex SCAD. $M = 23{,}99 kNm$, $N = -279{,}86 kN$



Column material steel S255 with $R_y = 24 kN/cm^2$ at t sheet hire 10…20 mm.

Semi-automatic welding - in the environment of carbon dioxide, welding wire SV-08G2S.

Determination of design column lengths:

$$l_{ef,x} = \mu_x l_x = 2 \cdot 8{,}87 = 17{,}74 m$$

$$l_{ef,y} = \mu_y l_y = 1 \cdot 8{,}87 = 8{,}87 m$$

where μ_x and μ_y – length cast factors .

Column section selection:

Pre-set the column height h=300mm > (1/30)H

By the formula we find:

$$\bar{\lambda}_x = \frac{l_{ef,x}}{0{,}42h} \cdot \sqrt{\frac{R_y}{E}} = \frac{1774}{0{,}42 \cdot 30} \cdot \sqrt{\frac{24}{20600}} = 4{,}81$$

$$m_{ef} = 1{,}25 \cdot \frac{M_x}{N \cdot 0{,}35h} = 1{,}25 \cdot \frac{23{,}99 \cdot 10^2}{279{,}86 \cdot 0{,}35 \cdot 30} = 1{,}02$$

We preliminarily set the flexibility of the column $\lambda = 100$.

Then $\varphi = 0{,}542$.

The required cross-sectional area of the column:

$$A_{mp} = \frac{N}{\varphi R_y \gamma_c} = \frac{279{,}86}{0{,}542 \cdot 24 \cdot 1} = 21{,}5 \text{cm}^2.$$

Accept column I-beam 26C1: $A = 75{,}77$ cm^2; $i_x = 10{,}02$ cm; $i_y = 6{,}04$ cm; $W_x = 661$ cm^3.

Check the stability of the assigned section:

$$\bar{\lambda}_x = \frac{l_{ef,x}}{i_x} \cdot \sqrt{\frac{R_y}{E}} = \frac{1774}{10{,}02} \cdot \sqrt{\frac{24}{20600}} = 6{,}04$$

$$m = \frac{M_X}{N} \cdot \frac{A}{W_x} = \frac{23{,}79 \cdot 10^2}{279{,}86} \cdot \frac{75{,}77}{661} = 0{,}974$$

At $A_f / A_w = 240 \cdot 12 / [(230 - 2 \cdot 12) \cdot 8] = 1{,}748$

The coefficient of influence of the shape of the cross section is calculated by the formula

$$\eta = (1{,}90 - 0{,}1m) - 0{,}02 \cdot (6 - m) \cdot \bar{\lambda}_x = (1{,}90 - 0{,}1 \cdot 0{,}974) - 0{,}02 \cdot (6 - 0{,}974) = 1{,}7$$

$m_{ef} = \eta \cdot m = 1{,}7 \cdot 0{,}974 = 1{,}66$, then $\phi_e = 0{,}273$

$$\frac{N}{\phi_e A R_y \gamma_c} = \frac{279{,}86}{0{,}273 \cdot 75{,}77 \cdot 24 \cdot 1} = 0{,}564$$

Stability of the column in the plane of the frame provided.

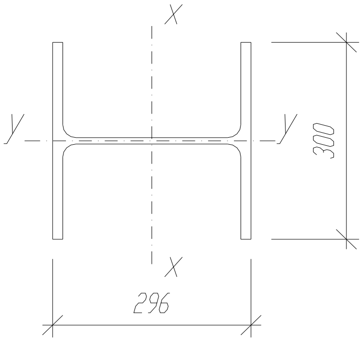
Ultimate Column Rod Flexibility

$\lambda_{\lim} = 180 - 60\alpha = 180 - 60 \cdot 0.564 = 146{,}16$, где $\alpha = \dfrac{N}{\phi_e A R_y \gamma_c} = 0.564 < 1$

We will check the column for ultimate flexibility:

Relative to axis x- $\lambda_x = \dfrac{l_{ef,x}}{i_x} = \dfrac{17{,}74 \cdot 10^2}{10{,}02} = 177{,}05 > \lambda_{\lim} = 146{,}16$

Relative to axis y- $\lambda_y = \dfrac{l_{ef,y}}{i_y} = \dfrac{8{,}87 \cdot 10^2}{6{,}04} = 146{,}8543 > \lambda_{\lim} = 146{,}16$



Since the flexibility of the rod from the plane in the plane of the frame is greater than the limit, we accept the I-beam 40C1

$A = 108{,}0\,\text{cm}^2$; $i_x = 12{,}95\,\text{cm}$; $i_y = 7{,}50\,\text{cm}$; $W_x = 1223\,\text{cm}^3$.

$$\bar{\lambda}_x = \frac{l_{ef,x}}{i_x} \cdot \sqrt{\frac{R_y}{E}} = \frac{1774}{12{,}95} \cdot \sqrt{\frac{24}{20600}} = 4{,}68$$

$$m = \frac{M_X}{N} \cdot \frac{A}{W_x} = \frac{23{,}79 \cdot 10^2}{279{,}86} \cdot \frac{108{,}0}{1223} = 0{,}751$$

At $\dfrac{A_f}{A_w} = \dfrac{81}{27} = 3$

The coefficient of influence of the shape of the cross section is calculated by the formula

$$\eta = (1{,}90 - 0{,}1m) - 0{,}02 \cdot (6 - m) \cdot \bar{\lambda}_x = (1{,}90 - 0{,}1 \cdot 0{,}751) - 0{,}02 \cdot (6 - 0{,}751) = 1{,}72$$

$m_{ef} = \eta \cdot m = 1{,}72 \cdot 0{,}751 = 1{,}292$, тогда $\phi_e = 0{,}309$

$$\alpha = \frac{N}{\phi_e A R_y \gamma_c} = 0{,}454$$

$$\lambda_{\lim} = 180 - 60\alpha = 180 - 60 \cdot 0.454 = 152{,}76$$

We will check the column for ultimate flexibility:

Relative to axis x- $\lambda_x = \frac{l_{ef,x}}{i_x} = \frac{17{,}74 \cdot 10^2}{12{,}95} = 136{,}99 < \lambda_{\lim} = 146{,}16$

Relative to axis y- $\lambda_y = \frac{l_{ef,y}}{i_y} = \frac{8{,}87 \cdot 10^2}{7{,}50} = 118{,}27 < \lambda_{\lim} = 146{,}16$

Checking the stability of the column rod from the plane of action of the moment

Maximum moment $M = 23{,}99 kNm$

$$m_x = M \cdot A/(N \cdot W_x) = 23.99 \cdot 10^2 \cdot 108.0/(279.86 \cdot 1223) = 0{,}88$$

$$\lambda_c = 3{,}14 \cdot \sqrt{\frac{E}{R_y}} = 3{,}14 \cdot \sqrt{\frac{20600}{24}} = 91{,}99$$

$$\phi_c = 0{,}598$$

$$\alpha = 0.65 + 0.05 m_x = 0.65 + 0.05 \cdot 0.88 = 0{,}694$$

$$\lambda_y = 132{,}4$$

$$\phi_c = 0{,}305$$

$$\beta = \sqrt{\frac{\phi_c}{\phi_y}} = \sqrt{\frac{0.598}{0.305}} = 1{,}4$$

$$c = \beta/(1 + \alpha \cdot m_x) = 1.4/(1 + 0.694 \cdot 0.88) = 0{,}749 < c_{\max} = 0{,}758$$

here $c_{\max}$ determined by the formula

$$\rho = (I_x + I_y)/(A \cdot \bar{h}^2) = (10299.99 + 3517)/83.08 \cdot (25.5 \cdot 1.2)^2 = 0{,}2816$$

$$\mu = \frac{2 + 0{,}156 \cdot I \cdot \lambda_y^2}{A \cdot \bar{h}^2} = \frac{2 + 0{,}156 \cdot 44{,}56 \cdot 132.4^2}{83.08 \cdot 30{,}6^2} = 1{,}6$$

$$\delta = \frac{4 \cdot \rho}{\mu} = \frac{4 \cdot 0{,}2816}{1{,}6} = 0{,}704$$

$$c_{\max} = \frac{2}{\left[1 + \delta + \sqrt{(1 - \delta^2 + \frac{16}{\mu} \cdot \left(\frac{M_x}{N\bar{h}}\right)^2}\right]} = \frac{2}{\left[1 + 0{,}704 + \sqrt{(1 - 0{,}704^2 + \frac{16}{1{,}6} \cdot \left(\frac{23{,}99 \cdot 10^2}{279{,}86 \cdot 30{,}6}\right)^2}\right]} = 0{,}758$$

$$\frac{N}{c\phi_y AR_y} = \frac{279{,}86}{0{,}749 \cdot 0{,}305 \cdot 83{,}08 \cdot 24} = 0{,}614$$

All checks are completed, we finally make a decision on the possibility of using the I-beam 40C1 as a column core.

2.33 Design of the column head.

Thick planed base plate $t_{pl} = 30$мм пweld to the milled end of the column rod with fillet welds $k_f = k_{f\,\min} = 12$ mm. Plate dimensions in plan 400×440 mm.

As a columnar, we take I-beam 40C1. The height of the I-beam is 820 mm.

Check the strength of the wall of the I-beam for crushing.

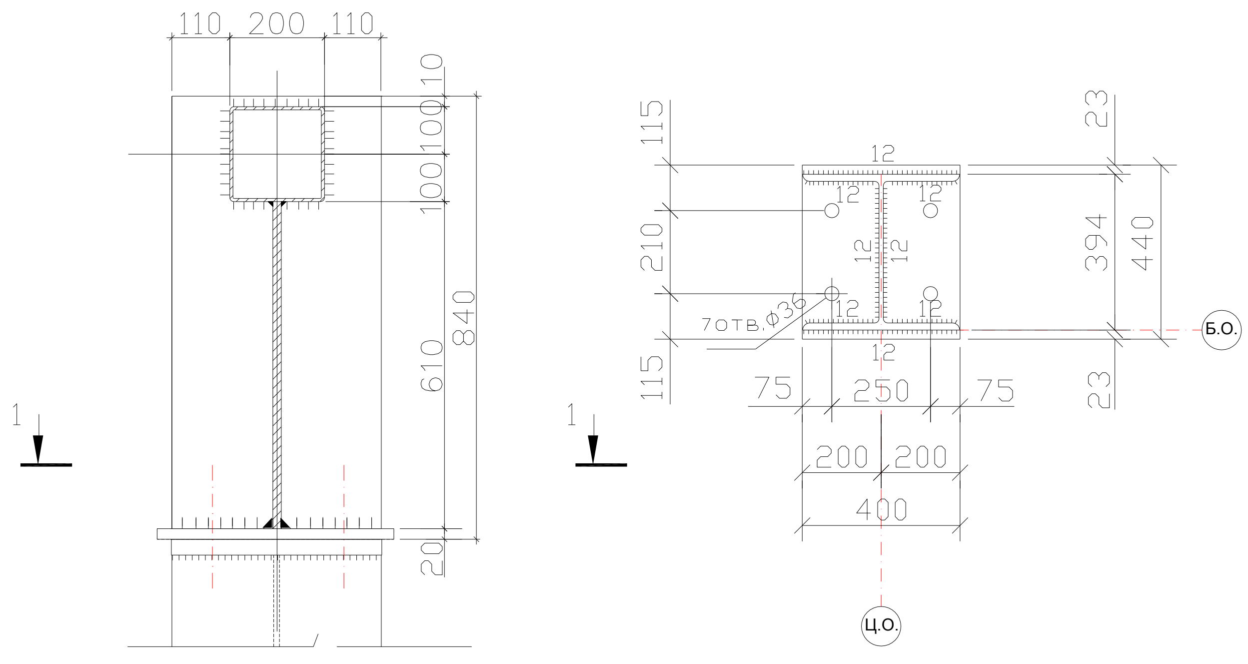
Wall thickness $s = 11$mm, bearing width $b = 400$mm. Estimated length of creaseable wall surface: $l_{ef} = b + 2t_{pl} = 400 + 2 \cdot 30 = 460$mm.

$$\sigma_p = \frac{1{,}2R_A}{A_p} = \frac{1{,}2 \cdot 311{,}60}{506} = 0{,}73кН/см^2 < R_p\gamma_c = 36 \cdot 1 = 36kN/cm^2,$$

where $A_p = 46 \cdot 11 = 506$cm^2 – area of crease surface.

Strength condition is met.

Picture 2.34 - Column head 40C1



2.35 Calculation and design of the column base

Calculation of the base plate. We accept concrete of the foundation of class B10. The calculated concrete resistance to axial compression is kN/cm^2. In the calculations, we will take the calculated concrete crush resistance, determined by the formula:

$R_{b,loc} = \alpha \varphi_b R_b = 1 \cdot 1{,}2 \cdot 0{,}6 = 0{,}72$ kN/cm^2

where $\alpha = 1$ for concrete of a class below B25;

φ_b tentatively taken equal

The connection of the columns with the foundation is rigid, as a result of which we accept the base of the column in the form of a flat base plate. The load will be transferred to the foundation through the milled end of the column.

Base plate material - steel S245: $R_y = 23$кН/см^2 at thickness of hire 21...30 mm.

We set the width of the plate

$B = b_f + 2c = 40 + 2 \cdot 15 = 70$ cm,

where b_f – 40C1 I-beam Shelf Width;

$c = 150$ mm – overhang base.

Accept the width of the plate $B = 70$ cm.

From the condition $\sigma_{\max} \le R_{b,loc}$ get the length of the plate:

$$L = \frac{N}{2 \cdot B \cdot R_{b,loc}} + \sqrt{\left(\frac{N}{2 \cdot B \cdot R_{b,loc}}\right)^2 + \frac{6M}{BR_{b,col}}} =$$

$$= \frac{279{,}86}{2 \cdot 70 \cdot 0{,}72} + \sqrt{\left(\frac{279{,}86}{2 \cdot 70 \cdot 0{,}72}\right)^2 + \frac{6 \cdot 23{,}99 \cdot 10^2}{70 \cdot 0{,}72}} = 32{,}88$$

Minimum plate length:

$L_{\min} = h + 2c = 39{,}3 + 2 \cdot 15 = 69{,}3$ см,

where h – I-beam height 40C1.

Accept the length of the base plate $L = 70$ cm.

Maximum stresses in concrete under the base plate:

$$\sigma_{\max} = \frac{N}{BL} + \frac{6M}{BL^2} = \frac{279{,}86}{70 \cdot 70} + \frac{6 \cdot 23{,}99 \cdot 10^2}{70 \cdot 70^2} = 0{,}195 kN/cm^2 < R_{b,loc} = 0{,}72 kN/cm^2.$$

Minimum voltage:

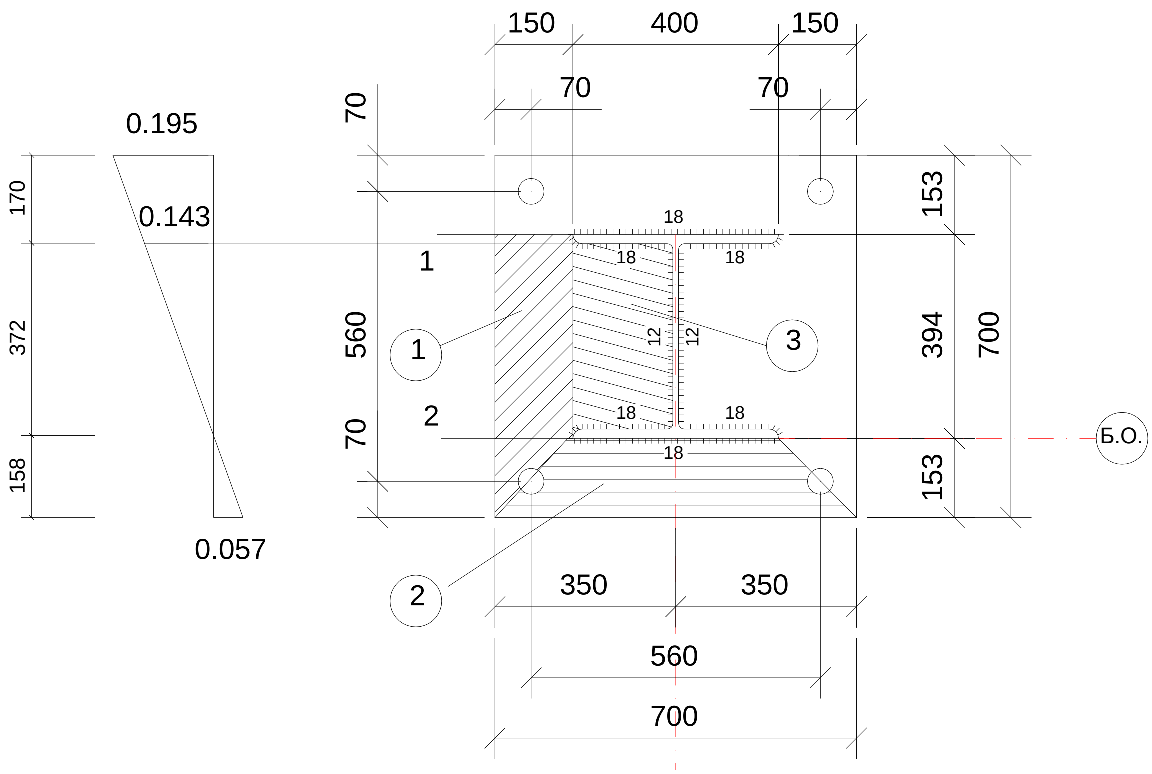
$$\sigma_{\min} = \frac{N}{BL} - \frac{6M}{BL^2} = \frac{279{,}86}{70 \cdot 70} - \frac{6 \cdot 23{,}99 \cdot 10^2}{70 \cdot 70^2} = -0{,}057 kN/cm^2$$

The distance from the edge of the plate to the point with zero voltage:

$$x = \frac{|\sigma_{\min}| \cdot L}{|\sigma_{\max}| + |\sigma_{\min}|} = \frac{0{,}057 \cdot 70}{0{,}057 + 0{,}195} = 15{,}83\,\text{cm}.$$

The voltage in cross section along the inner edge of the flange:

$$\sigma_1 = \sigma_{\max} \cdot \frac{273}{273 + 98} = 0{,}195 \cdot \frac{273}{371} = 0{,}143\,\text{kN/cm}^2.$$



Picture 2.15

- To the calculation of the base plate

To determine the thickness of the plate, we break the base plate into sections (Picture 2.15) and determine the bending moment in each section.

Area 1.

Land area: $A_1 = 39{,}4 \cdot 15 + 2 \cdot \frac{15 \cdot 15{,}3}{2} = 820{,}5\,\text{cm}^2.$

$$c_1 = \frac{S_1}{A_1} = \frac{\dfrac{39{,}4 \cdot 15^2}{2} + 2 \cdot 15{,}3 \cdot 15 \cdot \dfrac{1}{2} \cdot \dfrac{2}{3} \cdot 15}{820{,}5} = 8{,}2 cm$$

Bending moment:

$$M_1 = \sigma_{\max} A_1 c_1 = 0{,}195 \cdot 820{,}5 \cdot 8{,}2 = 1312 \,\text{kN·cm.}$$

Plate thickness:

$$t_{pl} = \sqrt{\frac{6M_1}{hR_y\gamma_c}} = \sqrt{\frac{6 \cdot 1312}{39{,}4 \cdot 23 \cdot 1{,}2}} = 2{,}69 \,\text{cm.}$$

Area 2.

Land area: $A_2 = 40 \cdot 15{,}3 + 2 \cdot \dfrac{15 \cdot 15{,}3}{2} = 841{,}5 \,\text{cm}^2.$

$$c_2 = \frac{S_2}{A_2} = \frac{\dfrac{40 \cdot 15{,}3^2}{2} + 2 \cdot 15 \cdot 15{,}3 \cdot \dfrac{1}{2} \cdot \dfrac{2}{3} \cdot 15{,}3}{841{,}5} = 8{,}35 \,\text{cm.}$$

Bending moment:

$$M_1 = \sigma_{\max} A_2 c_2 = 0{,}195 \cdot 841{,}5 \cdot 8{,}35 = 1370{,}17 \,\text{kN·cm.}$$

Plate thickness:

$$t_{pl} = \sqrt{\frac{6M_1}{hR_y\gamma_c}} = \sqrt{\frac{6 \cdot 1370{,}17}{40 \cdot 23 \cdot 1{,}2}} = 2{,}72 \,\text{cm.}$$

Area 3.

This site is supported on three edges (picture 2.15). ratio of the fixed side of the plate to the free $b_1/a_1 = 194{,}5/394 = 0{,}482 < 0{,}5$. Consequently, the plot is calculated as a cantilever unit width with a departure b_1:

$$M_3 = \frac{\sigma_1 b_1^2}{2} = \frac{0{,}143 \cdot 19{,}45^2}{2} = 27{,}05 \,\text{kN.}$$

Plate thickness:

$$t_{pl} = \sqrt{\frac{6M_3}{R_y\gamma_c}} = \sqrt{\frac{6 \cdot 27{,}05}{23 \cdot 1{,}2}} = 2{,}42 \,\text{cm.}$$

We set the plate thickness $t_{pl} = 32 \,\text{mm}$.

Check the strength of section 1-1 (picture 2.12):

$$Q_{1-1} = \sigma_{\max} s = 0{,}195 \cdot 70 \cdot 15{,}3 = 208{,}85 \,\text{kN;}$$

$$M_{1-1} = 372 \cdot 15{,}3/2 = 2845{,}8 \,\text{kN·cm.}$$

Normal stress:

$$\sigma_x = \frac{M_{1-1}}{W_{pl}} = \frac{6M_{1-1}}{Bt_{pl}^2} = \frac{6 \cdot 2845{,}8}{70 \cdot 3{,}2^2} = 23{,}82 кН/см^2 < R_y\gamma_c = 23 \cdot 1{,}2 = 27{,}6 kN/cm^2.$$

Tangential stress:

$$\tau_{xy} == \frac{Q_{1-1}}{Bt_{pl}} = \frac{208{,}85}{70 \cdot 3{,}2} = 0{,}93 \text{kN/cm}^2.$$

Verification of reduced voltages:

$$\sigma_{ef} = \sqrt{\sigma_x^2 + 3\tau_{xy}^2} = \sqrt{23{,}82^2 + 3 \cdot 0{,}93^2} = 23{,}87 kN/cm^2 < 1{,}15 R_y\gamma_c = $$
$$= 1{,}15 \cdot 23 \cdot 1{,}2 = 31{,}74 kN/cm^2.$$

Section strength ensured.

2.36 Calculation of Anchor Bolts

Calculation of anchor bolts attaching the base plate to the foundation, we make efforts: $N_{\min} = -135{,}84$ kN; $M_{approp.} = -73{,}06$ kN·m

$$\sigma_{\max} = \frac{N}{BL} + \frac{6M}{BL^2} = \frac{135{,}84}{70 \cdot 70} + \frac{6 \cdot 73{,}06 \cdot 10^2}{70 \cdot 70^2} = 0{,}156 kN/cm^2;$$

$$\sigma_{\min} = \frac{N}{BL} - \frac{6M}{BL^2} = \frac{135{,}84}{70 \cdot 70} - \frac{6 \cdot 73{,}06 \cdot 10^2}{70 \cdot 70^2} = -0{,}1 kN/cm^2;$$

$$x = \frac{|\sigma_{\max}| \cdot L}{|\sigma_{\max}| + |\sigma_{\min}|} = \frac{0{,}156 \cdot 70}{0{,}156 + 0{,}1} = 42{,}66 \text{ cm.}$$

Force in Anchor Bolts:

$$z = \frac{M - Nb}{y} = \frac{73{,}06 \cdot 10^2 - 135{,}84 \cdot 19{,}7}{51{,}7} = 89{,}55 \text{ kN.}$$

We accept bolts from steel VSt3kp2. The calculated shear resistance of such bolts, according to [7, tab. 60 *], $R_{ba} = 18{,}5$ kN/cm^2.

Required Bolt Area:

$$A_b = \frac{z}{R_{ba}} = \frac{89,55}{18,5} = 4,84 \text{ см}^2.$$

Accept 4 bolts Ø27 mm.

The area of one bolt $A_{bh} = 4,27$ см^2.

Check the strength of the section 2-2:

$Q_{2-2} = z = 89,55$ kN;

$M_{2-2} = Q_{2-2} \cdot 5,3 = 89,55 \cdot 5,3 = 474,62$ kN·cm.

Normal stress:

$$\sigma_x = \frac{M_{2-2}}{W} = \frac{6M_{2-2}}{2 \cdot 11,85 \cdot t_{pl}^2} = \frac{6 \cdot 474,62}{2 \cdot 11,85 \cdot 3,2^2} = 11,73 кН / см^2 <$$

$$< R_y \gamma_c = 23 \cdot 1,2 = 27,6$$

Tangential stress:

$$\tau_{xy} = \frac{Q_{2-2}}{2 \cdot 11,85 \cdot t_{pl}} = \frac{89,55}{2 \cdot 11,85 \cdot 3,2} = 1,18 \text{ kN/cm}^2.$$

Verification of reduced voltages:

$\sigma_{ef} = \sqrt{\sigma_x^2 + 3\tau_{xy}^2} = \sqrt{11,73^2 + 3 \cdot 1,18^2} = 11,91 kN / cm^2 < 1,15 R_y \gamma_c = 1,15 \cdot 23 \cdot 1,2 = 31,74 kN / cm^2$ Section strength ensured.

Technological part 3

<u>Technological part</u>

Introduction:

The technological map is developed for the production of stone works by a flow-dismembered method by a team of masons with the use of standard equipment for mechanization, equipment, tools, tools and installation of floor slabs above the first floor.

When performing work, it is necessary to comply with the requirements of SNiP 3.01.01-85 "Organization of construction", SNiP II-22-81 "Stone and reinforced structures", SNiP 2.03.01-84 "Concrete and reinforced concrete structures", SNiP 3.03.01-87 "Bearing and enclosing structures".

Designing a Routing Chart

for masonry and installation process.

3.1. Organization and technology of basic construction works.

Prior to the commencement of the production of masonry, the following work shall be performed:

◦ arranged entrances, temporary highways and storage areas;

◦ the crane is provided;

◦ imported and installed building materials;

◦Prepared and submitted to workplaces mechanization, inventory and adaptations in accordance with the scheme of work organization;

◦ completed the work of the zero cycle;

◦ alignment axes are laid on the foundation;

◦ marks of the first row of brickwork;

◦ submitted to the workplace solution, brick in accordance with the scheme of organization of workplaces.

Technological sequence of brickwork operations:

◦ breakdown of axes and marking of walls, installation of orderings and pulling of the pier;

◦ feeding and laying bricks on the wall;

◦ feeding, spreading and leveling the mortar;

◦ laying the brick on the "bed" of the mortar;

◦ checking the correctness of the masonry;

◦ jointing and mortar cutting;

Slab and grate of bricks (if necessary).

The production of brickwork with the use of normokomplekt rationally conduct links "deuce" and "troika".

To conduct stone and related works, the building is divided into two hangers. When assigning capture boundaries, it is taken into account that the volume of stone work on each seizure should be approximately the same and their boundaries are linked to the location of the lifting mechanisms.

In turn, the walls for masonry within the seizure are broken up into plots. The number of plots on the seizure is taken by the number of links of masons taking into account the number of members and the qualifications of masons.

The size of the plots.

Masonry	Wall thickness, mm			
	640		250	
	Link number, people			
	3	**2**	**3**	**2**
Simple, m	25	13	18	10
Average difficulty, m	15	12	14	9

The length of the plot is assigned taking into account the performance of the masonry of the walls by the link of masons to a height of one tier per shift. After the end of the 1st tier laying on the first grab, the links leading the masonry go to the second grab, and the links that make up the inventory scaffolding and erection of the reinforced concrete structures - onto the first grab.

3.2 Masonry of external walls.

The working area of masons is 600-650mm. The storage area for materials should correspond to the width of the pallets with bricks and boxes with mortar. Usually it is 60-100 cm between pallets with bricks and boxes with a solution of 30-40cm. The transport zone is 950 mm. The total width of the working space for the erection of brick walls is 200-250 cm.

The stock of bricks at the workplace is taken from the calculation of the two-hour demand. Mortar boxes in the workplace are filled with a solution in 10-15 minutes. before the beginning of the masonry, in the process of laying the stock of materials is replenished.

The solution is supplied to the workplaces of masons by means of a crane in solution boxes with a capacity of 0.27 m3. Wall masonry is plotted. The number of plots on the seizure is taken according to the number of links of masons taking into account the number of members and the qualifications of the workers.

For the laying of walls, wooden or metal orders are installed, installed on the boundaries of the seizure at the intersections and at the corners of the walls. To maintain the straightness of the walls and the thickness of the rows in the process of brickwork, a pier is used - a strong twisted cord. The verticality of the laying of the corners of the piers and pillars is verified by means of a plumb, the horizontality of rows of masonry is checked by rule and level.

The masonry is carried out by the shuttle method, in which the masons, laying out the outer verst, move in one direction, the inner one in the other; Thus, the shuttle method of masonry excludes unnecessary transitions of masons.

The foreman makes the marking of the window and door openings using templates.

Bricklayer spreads the templates to the desired width on the marks that are marked on them, fixes in this position with a clamping screw and places them on the spaces of the pier walls and openings.

Brick wall masonry is performed with a multi-row dressing. Laying of narrow piers and pillars is made by a three-row dressing system. When multi-row: the ligation of the walls is carried out by paired sticks, laid every 3 or 5 rows of masonry in height. Longitudinal and transverse walls form wells, which are filled with heat-insulating materials. Thermal insulation boards are installed close to the surface of the inner brick wall and unclamped by staples laid in the seams of the outer wall masonry no less than 500 mm along the height of the wall. Thermal insulation boards should be closely adjacent to each other in vertical and horizontal joints, as well as to the laying of transverse walls. Within each floor, the slabs are supported by a tumbler masonry row located in the overlapping level.

Metal brackets must be protected with an anti-corrosion coating made of stainless steel.

The laying of the first tier of the outer wall is performed in the following order:

prepare, establish and verify intermediate and angular orders;

pull the mooring line;

first lay out the outer versts, and then the inner and backstage;

fill the gap.

3.3 Organization of the workplace when laying outer walls with a thickness of 640mm with a "two" link.

In the process of laying the walls, the work in the "two" link is distributed as follows. When laying the outer verst, the leading bricklayer pulls and rearranges the pier, performs laying of the verst rows, checks the laid out laying and partially places the scuff. The mason-handmaid shovels the mortar and spreads it on the wall, makes a brick for the leading bricklayer by the arm, he helps the leading mason to install the pier, gives brick and mortar to the wall, and in his spare time helps to maintain the masonry of the scraper.

When laying the inner verst, the link performs the same operations, moving in the opposite direction. Laying of the walls of the link "deuce" is simultaneously on the entire plot. While the mason-assistant on one of the piers makes a backstage and spreads the mortar, the leading mason is laying verst bricks on another pier. Then the masons change and continue laying the piers in the same sequence.

3.4 Organization of the workplace when laying outer walls with a thickness of 640mm with the "troika" link.

When laying the walls with the "troika" links, the most skilled bricklayer leads the masonry of verst rows, the remaining operations are performed by masons of lower ranks. One of them helps the leading mason to install and rearrange the pier and feeds the brick and mortar for the verst rows, the second lays the scaffold and helps the first bricklayer to feed the materials to the wall. The inner and outer versts are laid in the same order, but always in the opposite direction.

In the process of laying walls, installation openings must be left, as well as holes and grooves provided for in the design, wooden window and door frames and boxes must be installed in the openings. Fastening of frames and boxes is made to wooden antiseptirovannym inserts, which are laid in the slopes of the openings during the construction of walls.

3.5 Laying of internal walls with a thickness of 380 mm.

Link "deuce" leads the laying of internal walls with a thickness of 380 mm.

The lead mason sets the orders and stretches the picks, leads the masonry of the outer spoon and bump versts, checks the horizontal and vertical rows of the masonry.

The mason-handmaid shovels the mortar and spreads it along the wall, delivers the brick to the wall, helps to lay the inner spoon and bunch rows, install the order and lead the masonry.

For the installation of ventilation ducts in the process of masonry in the standard set templates of different sections and configurations are provided.

The principle of working with them is as follows: on the wall in places where ventilation ducts are provided, templates are installed in a vertical or inclined position (according to the project) and are covered with brick and mortar as the wall is built.

When the template is laid on 2/3 of the wall, its handle, located at the top, is pulled up, and so on until the end of the masonry wall. With a break in the clutch up to two hours, the templates are removed from the channels.

3.6 Installation of inventory scaffolds and filling openings.

Before installing the hinged panel scaffolds, the serviceability of the hinged joints, fixing elements, flooring is checked; the latter is cleaned of foreign objects. The rearrangement of scaffolding is performed only after the removal of building materials located on them. When installing scaffolding to a height of 1,200 and 1,800 mm, it is necessary to install guards.

Prior to installation in the opening of the surface of window and exterior door blocks, adjacent to the stone walls, must be antiseptic upholstered with roll-on waterproofing materials.

After installing the unit in the opening, it is verified horizontally and vertically by level and plumb line. The fastening of the blocks to the wall is carried out by the ruffs to the wooden plugs embedded in the piers. Fences included in the standard set are installed, which are intended for temporary fencing of window openings. The fences are attached to the bottom of the window opening by means of clamps.

3.7 Installation of prefabricated reinforced concrete elements.

Mounting of slabs is carried out in the following order:

◦ slinger inspects the plate, cleans it of dirt, snow, checks the strength of the mounting loops;

◦ the slinger slings the slab with a four-lash slings and signals the crane driver to lift and move it to the place of packing;

◦ bricklayers clean the brick wall with shovels from a box of mortar and lay it on the supporting surface of the wall with a layer 10-15 mm thick;

◦ stonemasons take the crane served by the crane, guide it to the place of packing and put it back into place, standing on previously laid slabs;

◦ without weakening the tension of the branches of the sling, the slabs of the slab are straightened to the design position.

The operations related to the installation of the first plate are carried out from the installer's site, included in the standard set.

Work on the erection of buildings and structures should be carried out according to the approved project for the production of works in accordance with SNiP 3.03.01-87 "Bearing and enclosing structures".

Lift the structure in two steps: first to a height of 20-30 cm, then, after checking the reliability of the slinging, make a further rise. Installation of slabs and coverings is made with the help of a four-lash sling 4KK1-3,2.

The installation of the structures of each higher storey (storey) of the building should be carried out after the design fixation of all the assembly elements and the achievement of concrete (mortar) pinned joints of load-bearing strength structures specified in the PPR.

Concrete grade and grade of mortar for embedding joints and seams are specified in the design and must meet the requirements of GOST 7473-94, GOST 28013-98.

When installing slabs, it is necessary to monitor compliance with the conditions of their support on load-bearing structures and their design requirements. The slabs are laid on a freshly-leveled layer of mortar 10-15mm thick. After the installation of the slab in the design position, the construction is unloaded.

To provide a hard disk, the slabs are anchored in the wall thickness by welding T-shaped anchors to the hinges. Anchors are protected from corrosion by a layer of cement mortar grade M100. After reconciliation of the correct installation of the elements, acceptance of welded joints and anticorrosion protection of the anchors, an embedment is made between the panels.

3.8. Material and technical resources.

External and internal walls made of bricks.

№ p/p	Name	Units measurements	Number per 1m ^{3} masonry	Scope masonry, m ^{3}	Quantity for the whole volume, pcs.
1	2	3	4	5	6

External walls with a thickness of 640 mm					
1	Clay brick ordinary	thing.	402	168	67536
2	Solution	m^3	0,237	168	39,8
Internal walls 510 mm thick					
3	Clay brick ordinary	thing.	402	34	13668
4	Solution	m^3	0,237	34	8
Internal walls 250 mm thick					
5	Clay brick ordinary	thing.	402	9	3618
6	Solution	m^3	0,237	9	2,133

3.9 Jumper List

Position	Notation	Name	Number of	Weight units. kg	Note
1	1.038 1-1 v.4	9PB 13-37p	123	74	
2	1.038 1-1 v.4	9 PB 25-3p	3	140	
3	1.038 1-1 v.4	9 PB 21-8p	12	118	

4	1.038 1-1 v.4	10 PB 21-27p	1	246	
5	1.038 1-1 v.4	9 PB 16-37p	10	88	
6	1.038 1-1 v.4	9 PB 18-37p	4	103	
7	1.038 1-1 v.4	9 PB 18-8p	3	103	
8	1.225-2 V 11	PB 32-1 4-4t	2	350	
9	1.03 B 1-1 v4	9 PB 29-4p	1	162	
Monolithic bridge MB					
10	GOST 5781-82	Diameter 12 A III L = 52,800		45,83	
11	GOST 5781-82	Diameter 6 A I L = 29440		6,54	

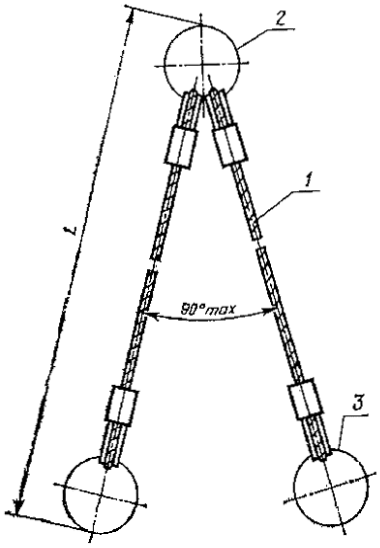
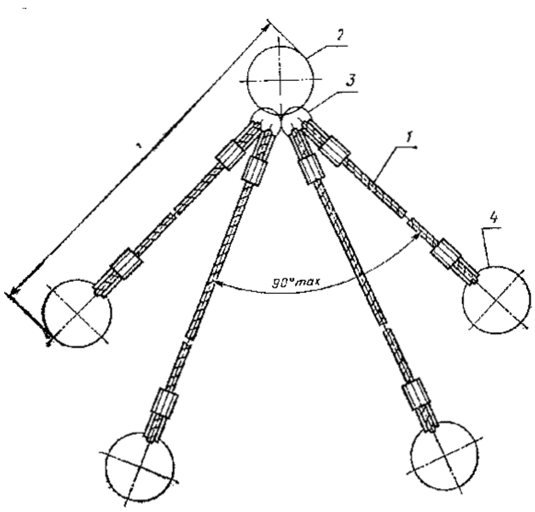
3.10 Specification of slabs and floors

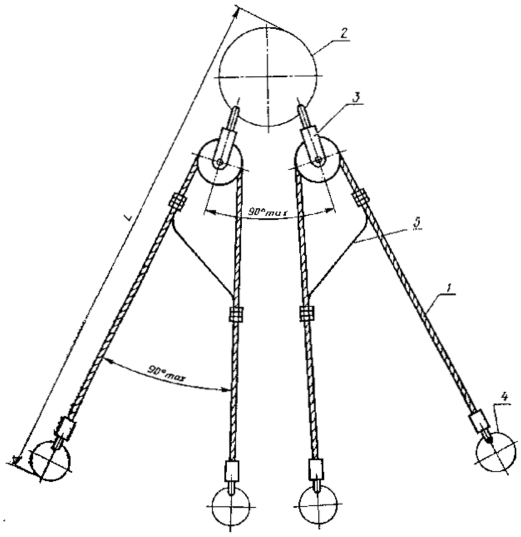
Position	Name	Number of	Weight units. kg	Note
P1	PK 72.15	4	3330	
P2	PK 72.12	3	2500	

P3	PK 42.12	7	1490	
P 4	PK 30.12	5	1080	
P 5	PK 42.15	13	1970	
P 6	PK 30.15	4	1430	
P 7	PK 42.15	1	1970	
P 8	P 11g	2	270	
P 9	P 8g	2	210	
P 10	P 15g	5	410	

3.11 The sheet of load-lifting devices.

№	Name	Marka	Main technological data	Sketch of the mounted element with a tooling indicating the main overall dimensions	Required quantity
1	2	3	4	5	6

1	Two-lined sling	2CK-3.2 GOST 25573-82	Length of the sling: 1400-16000m Load-carrying capacity-3,2 tons Weight: 10,7 kg	 *1 - rope branch; 2 - link: 3 - grip*	1
2	Four-lone sling	4CK1-5.0 * GOST 25573-82	Length of the sling: 1600-16000 Carrying capacity-5,0 tons Weight: 20 kg	 *1 - link; 2 - rope branch; 3 - grip*	1

3	Four-lone sling	4KS2-4.0 GOST 25573-82	Length of the sling: 1600-15000 Load-carrying capacity-4,0 t Weight: 15,2 kg	 *1 - rope branch; 2 - link 1; 3 - link 2 (equalizing); 4 - capture; 5 - equalizing branch*	2

<u>3.12 Normocomplekt of mechanisms, tools, devices for the production of stone works and installation of prefabricated reinforced concrete structures</u>

№	Name	Type, make of drawing	Type, make of drawing
1	2	3	4
1			
2	Box - container for mortar	IOMTPS No. 140-00	10
3	Swivel-panel scaffolding	TERNOPILSKA	10
4	Lamp	TsNIIOMTP 3294.51	4

5	Electric Drilling Machine / drill bit 10 - 12mm /	IE-I 022A TERNOPIL power tools	1
6	Capture Case	B-8 TsNIIOMTP	2
7	Level		2
8	Transition platform for staircase right	IOMTPS 372.00-00-000	2
9	Same as the left	IOMTPS 373.00-00-000	2
10			
11	Step ladder inventory	IOMTPS 361.00-00-000	3
12	Trowel for concrete and stone KB works	GOST 9538-71	12
13	Hammer - kirochka	MKI GOST 11042-72 12	MKI GOST 11042-72 12
14	Meter folding steel	GOST 7253-54	10
15	Plumb boring Q = 600	GOST 7948-71	10
16	Rake the order	IOMTPS 286.00-00-000	6
17	Mooring staples	IOMTPS 240.00-00-000	12
18	Mooring line	IOMTPS 240.00-00-000	6
18	Rule	2000×50×300mm	8
1	2	3	4

19	Construction level	US1-300 GOST 0416-64	2
20	Roulette	PC-20 GOST 1602-69	2
21	The convex and concave extensions	GOST 12803-67	9
22	Pattern of sliding for marking openings	TsNIIOMTP № 107.00-000	6
23	Scissors manual for cutting reinforcement	TsNIIOMTP № 107.00-000	1
24	Shovel solution	GOST 3620-63	9
25	Swabbing	IOMTPS 369.00-00-000	2
26	Scraper	IOMTPS 370.00-00-000	1
27	Checkered corner	IOMTPS 362.00-00-000	1
28	Coil with a plumb line	IOMTPS 287.00-00-000	7
	Tubular forest without bolt		

3.13 The statement of labor costs and wages (calculation).

Calculation of labor costs and wages for the kladochno-installation process.

№	Name of works	Unit. amend. by ENIR	Scope of work	ENIR, table number, row, column number	Time of normal person-hour.		Labor costs for the whole volume, Tn				Composition of the link according to ENIR			Rates, UAH		Salary fund, UAH		
					Mounting (Nvr.month)	Machinists (Nvr.Mash.), Machine-hour.	Mounting (Nvr.month)		Machinists (Nvr.Mash.), Machine-hour.		Profession	Discharge	amount	Installers	Installers	Installers (Zmont)	Machinists (Zmash)	Total (Zobshch)
							person-hour.	person-days	person-hour.	person-days								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

1	Masonry of external walls 640 mm thick	On 1 m3 of the wall	16 8	E3-3, A, Table No. 3, line № 8, the post. b)	2,9	-	487,2	60,9	-	-	Mason	5 3	1 2	2-03	-	341-04	-	341-04

2	Brick wall masonry with a thickness of 510 mm	On 1 m3 of the wall	34	E3-3, A, Table No. 3, line №6, a post. b)	3,2	-	108,8	13,6	-	-	Mason	4 3	1 1	2-24	-	76-16	-	76-16
3	Brick wall masonry with a thickness of 250 mm	On 1 m3 of walls	9	E3-3, A, Table No. 3, line №1, a post. a)	3,2	-	28,8	3,6	-	-	Mason	2	1	2 - 24	-	20-16	-	20-16

4	Mounting jumpers up to 1 t	At one opening	32	E3-16, Table No. 1, line №2, pillar. a), b), d)	0,66	0,22	21,12	2,64	7,04	0,88	Stone-box Crane operator	4 3 2 5	1 1 1 1	0-46,9	0-20	15-00	6-40	21-40
5	Arrangement and dismantling of inventory scaffolds for masonry	On a 10m masonry	21,1	E3-20, A, Table No. 2, line No. 3, pillar. a), b)	0,93	0,31	16,62	6,54	2,078	0,817	A carpenter Crane operator	4 2 4	1 2 1	0-64,2	0-24,5	13-55	5-13	18-68

6	Supply of bricks on one pallet by means of a crane	1000 pieces of brick	84,822	E3-21, Table No. 1, lines №№17,18	0,76	0,38	64,46	32,23	8,06	16,11	Rigger Crane operator	2 4	1 1	0-48,6	0-30	41-22	25-45	66-67
7	Supply of mortar in bins, capacity up to 0,25 m3	1 m^3	49,933	E1-7, Table No. 1, line №9	0,54	0,27	26,96	13,48	3,37	1,68	Rigger Crane operator	2 5	2 1	0-34,6	0-24,6	17-28	12-28	29,56

8	Stacking reinforced concrete. floor slabs of up to 5 m. sq. m.	Per 1 item	18	E4-1-7, Table No. 1, line №2 pillar. a)	0,56	0,14	10,08	2,52	1,26	0,31	Rigger Crane operator	4 3 2 6	1 2 1 1	0-39,6	0-14,8	7-13	2-66	9-79
9	Stacking reinforced concrete. floor slabs with an area of up to 10 m.sq.	Per 1 item	28	E4-1-7, Table No. 1, line No. 3 pillar. a)	0,72	0,18	20,16	5,04	2,52	0,63	Mountin g-nick structure s Crane operator	4 3 2 6	1 2 1 1	0-50,9	0-19,1	14-25	5-35	19-60

10	Welding joints of floor slabs	10 m seam	3,68	E22-1-2 Table No. 1, line №1 column a)	2,4	-	8,83	1,10	-	-	Electro welders	3 4 5 6	1 1 1 1	2-18	-	8-02	-	8-02
11	Filling joints of slabs	At 100 m seam	4,665	E4-1-26, Table No. 1, line No. 3	4	-	18,66	2,333	-	-	Installer	4 3	1 1	2-98	-	13-90	-	13-90

3.14 Selection of installation methods and installation cranes.

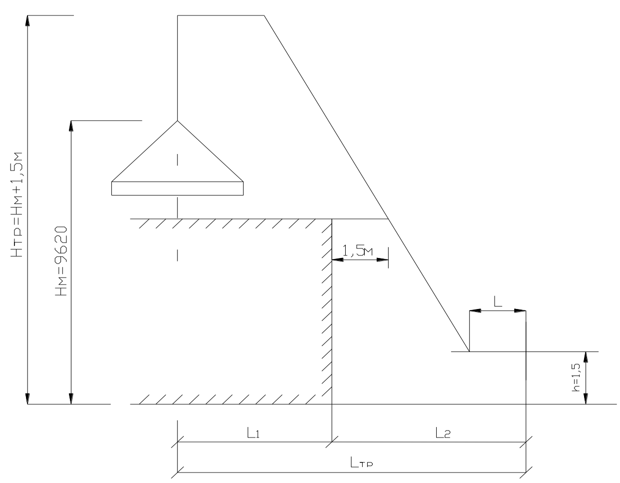
In the production of works, a separate element-by-element method of installation is used.

When installing load-bearing structures, a free and limited-free installation method is used. With this method, the installation is carried out either by means of devices that provide partial restriction of the movement of the structure from the action of its own mass and external loads, or without such devices. With this method, instrumental adjustment of the position of the mounted elements during the installation is necessary.

The leading machine during installation is the boom. Installation is made from vehicles, i.e. prefabricated elements are delivered to the construction site in the zone of operation of the crane in a strict technological sequence and delivered directly to the installation. This method reduces the labor costs of workers, reduces the construction time and its cost, although it requires much greater efforts to coordinate the supply of materials and the installation process from the engineering department, as well as more detailed installation plans.

The delivery of structures is carried out: slabs of overlapping - paneling on the basis of the truck-tractor KAMAZ.

3.15 Determination of the required parameters of the boom crane.



The following parameters must be provided:

Required crane lifting capacity:

$Q_к = m_э + m_{ос} + m_{гр} = 3{,}33+0+0{,}1=3{,}34$ т

Required hook radius:

$L_к = 9{,}25$ м

Hook lifting height:

$H_к = 9{,}62$ м, (Нм=hо+hз+hэ+hс=5,3+0,5+0,22+3,6=9,6м)

Length of boom: $L_{ст} = 11{,}1$м

We choose cranes: КС-4561А and МКА-16

Crane	Carrying capacity, t		Departure, m		Lifting height, m	
	The least	The greatest	The least	The greatest	The least	The greatest
KS-4561A boom 14m with a goose 5m	1	10,7	4,2	13	16	17,8
MKA-16 boom 23 m with a jib 2,3 m	0,3	4	7,5	20	18,8	26

3.15Economic comparison of options for cranes.

$З=С+Ен Ф_i T_i/T_{ri}$

2. Calculation of the cost of work

$$С=1,08(Е_{ед}+С_{м.см} \text{ x } Т_{оi})+1,05\ З_{пл}$$

З - reduced costs

С - cost price of mechanized works

Her - the one-off costs associated with the organization of mechanized works and not included in the cost of the machine in shifts

$С_{м.см}$ – car cost per shift

$Т_{оi}$ - the duration of the i-th machine at the site

$Т_{гi}$ – annual number of shifts

$З_{пл}$ – wages of assembly workers

1,08; 1,05 – overhead costs for the car and wages

$Ф_i$ – balance or wholesale value of the i-th machine according to the norms

$Е_н$ =0,15 - normative coefficient of efficiency

Crane	Initial data		Annual costs		One-time costs, UAH			Current opera	
	Wholesale price	расчетная стоимость, тыс. грн	Amortization deductions,%	Annual amount of depreciation, thousand UAH.	Cost of transportation	installation, dismantling	total	Maintenance staff	Maintenance and
1	2	3	4	5	6	7	8	9	
КС-4561А	35	38,1	15,5	5,91	189	17,1	206,1	0,95	
МКА-16	33	35,8	15,5	5,55	162	16,1	178,1	0,95	

For KS-4561A:

З = C + ЕнФiTi / Tri = 1314,31grn + 0,15x38100грнx20,427 people.-day / 375 = 1625,62 UAH.

C = 1.08 (Egd + cm.cm x T0i) +1.05 Zpl = 1.08 (206.1 UAH + 41.6grn x 20.427-day) + 1.05x165.7grn = 1314.31grn

For MKA-16:

З = C + ЕнФiTi / Tri = 1250,54грн + 0,15x35800грнx20,427.-day / 375 days = 1543,05 UAH

C = 1.08 (Egd + cm.cm x T0i) +1.05 Zpl = 1.08 (178.1grn + 40.08grn x 20.427chel-dn) + 1.05x165.7grn = 1250.54grn

Finally we accept: MKA-16 (with a boom length of 23 m, jib 2.3)

3.16. Schedule of production processes.

Quality control.

The quality of the brickwork must satisfy the requirements set out in SNiP 3.03.01-87 "Bearing and enclosing structures".

Quality control begins already with the acceptance of the delivered prefabricated elements. All of them must correspond in appearance and size to the requirements of the project and should not have deviations exceeding, permissible SNiP.Приемка законченных каменных конструкций должна сопровождаться проверкой:

◦ the correctness of dressing, filling and thickness of seams, verticality, horizontal and straightness of surfaces and masonry sites;

◦ the correctness of the smoke and ventilation ducts;

◦ availability of installed mortgage details - connections and anchors for the project;

◦ ensuring the diversion of surface waters from the building and protecting them from basements and foundations.

The main criterion for the quality of installation work is welding and sealing joints, as well as the accuracy of installation of structures.

At stone works check verticality of surfaces of walls and corners, thickness of filling of seams with a solution.

Acceptance of completed stone structures should be accompanied by a check:

◦ the correctness of ligation, filling and thickening of seams, verticality, horizontal and straightness of surfaces and masonry sites;

◦ the correctness of the smoke and ventilation ducts;

◦ availability of installed mortgage details - connections and anchors for the project;

◦ ensuring the diversion of surface waters from the building and protection from them.

For the cases of acceptance of stone works erected in the winter, the log of works should reflect the conditions for the erection and maintenance of the structure, for which it is daily to mark:

◦ outdoor temperature during the period of work;

◦ presence of precipitation;

◦ temperature of the solution at the time of installation;

◦ types and brands of solutions used;

◦ the amount of additives added to the solution.

The quality of materials, semi-finished products and factory-made products used in stone structures must satisfy certificates and passports of manufacturing plants, as well as data of control laboratory tests produced by construction organizations.

The quality of the elements is checked several times: in the warehouse, during installation, sealing of joints and after final fastening. At the end of the installation all works are accepted according to the act, in which they indicate whether they are installed in accordance with the project, determine the quality of the installation works and draw a conclusion about the readiness of the building.

The following documentation should be provided for acceptance inspection:

◦ executive drawings with the deviations made (if any) by the manufacturer of the structures, as well as by the montage organization coordinated with the design organizations-developers of the drawings, and documents on their coordination;

◦ factory technical passports for steel, reinforced concrete and wooden structures;

◦ documents (certificates, passports), certifying the quality of materials used in the manufacture of construction and installation works;

◦ acts of survey of hidden works;

◦ acts of intermediate acceptance of responsible structures;

◦ executive geodesic schemes for the position of structures;

◦ work logs;

◦ documents on quality control of welded joints;

◦ acts of testing of structures (if tests are provided by additional rules of these rules and regulations or working drawings);

◦ other documents specified in additional rules or working drawings.

3.17 Requirements for the finished concrete and reinforced concrete structures or parts of structures

Parameter	Limit deviations	Control (method, volume, type of registration)
1. Deviation of the lines of the planes from the vertical or the design slope to the entire height of structures for walls and columns supporting monolithic coatings and overcoatings	15 mm	Measuring, each constructive element, work log
2. Deviation of horizontal planes along the entire length of the area to be verified	20 mm	Measuring, at least 5 measurements for every 50-100 m, work log

3. Local unevenness of the surface of concrete when checking with a two-meter-long rail, except for supporting surfaces	5 mm	Measuring, at least 5 measurements for every 50-100 m, work log
4. Length or span of elements	±20 mm	Measuring, each element, work log
5. Size of the cross-section of the elements	+6 mm; –3 mm	Measuring, each element, work log
6. Markings of surfaces and embedded products serving as supports for steel or prefabricated reinforced concrete columns and other prefabricated elements	–5 mm	Measuring, each supporting element, an executive circuit
7. Slope of the supporting surfaces of the foundations when supporting steel kolons without gravy	0,0007	The same, every function, the execution scheme
8. Location of anchor bolts:	5 mm 10 mm +20 mm	The same, each foundation bolt, the executive circuit

in terms of the contour of the support out of contour Height 9. Difference in height marks at the junction of two adjacent surfaces	3 mm	Same, every joint, executive circuit

3.18 Admissible deviations in the installation of reinforced concrete elements.

Deviation from the horizontal of the laid slabs: of inactivated unrepresented	 8mm 5mm
Deviation from the symmetry (half the difference in the depth of support of the ends of the element) with the installation of the plates of overlapping in the direction of the overlapping span with the length of the element, m: up to 4 St. 4 to 8 St. 8 to 16 St. 16 to 25	 12mm 15mm 20mm 25mm
The difference in marks of the support surfaces of the wall panels and partitions within the area to be verified (block) along the top of	

the leveling layer of the solution	10mm
Permissible displacement of the axes of the elements relative to the centering axes on supporting structures	±5mm
The difference in the marks of the lower surface of two adjacent elements of the floor of residential buildings	4mm
The difference in the elevations of the upper surface of the overlap elements within the verifiable area	20mm
Deviation from the alignment of the foundations of the foundation blocks and the foundations of the foundations with the risks of the centering axes	12mm
Difference in the marks of the upper surface of two adjacent elements of the ceiling of residential buildings	8mm

3.19 Deviations in the size and position of stone structures.

№	Checked constructions (details)	Limit Deviations	
		стен	pillars
1	Thickness of structures made of bricks	± 15	± 10
2	Markings of support surfaces	- 10	- 10
3	Width of piers	+15	-
4	Opening width	+ 15	+ 20
5	The displacement of the vertical axes of the window openings from the vertical	20	-

6	Offset axes of structures from the center	10	10
7	Deviation of surfaces and masonry angles from vertical to one floor	10	10
8	On building more than two floors	30	30
9	Thickness of horizontal joints	-2;+3	-2;+3
10	Thickness of vertical masonry seams	-2;+2	-2;+2
11	The deviation of the rows of masonry from the horizontal by 10 m of the length of the wall	15(15)	-
12	Irregularities on a vertical surface, detected when a 2 m long strip is applied	10	5
13	Sectional dimensions of ventilation ducts	±5	-

3.20. Safety in the manufacture of stone-installation works

All works in the field of stone-and-assembling operations are carried out in strict accordance with the requirements of SNiP III-4-80 "Safety in construction" (in the current part) and SNiP 12-03-2001 "Safety in the construction industry: Part 1. General requirements".

Lift the brick on the scaffold by a crane followed by packages on pallets using a gripping device included in the standard set.

Use cases for bricks without devices that do not allow their spontaneous deployment and loss of transported bricks through walls or bottoms during lifting and moving, is prohibited. Empty empty pallets and cases from the scaffolding should be lowered by lifting mechanisms.

It is forbidden to spread the wall standing on it. When masonry is carried out in hazardous locations (erection of external walls at the level of overlap, eaves, etc.), bricklayers should use safety belts.

On the scaffolding between the wall, folded materials and installed equipment should leave a passage width of at least 60 cm.

Before the installation of carpentry, window and door openings of laid out walls must be fenced with special fences included in the standard set.

The laying of walls (borts) at the level of overlap, installed from prefabricated reinforced concrete slabs, should be made from the scaffoldings of the underlying floor.

Do not install slabs without a previously laid out bricks on the brick two rows above the level of the slabs to be laid.

The first slab must be installed from the site for the installer, which is included in the standard set.

The filling of the voids of the slabs must be carried out before they are fed to the floors.

The outside joints of the brickwork must be cut from the ceiling or scaffolds after laying two rows. Workers during this operation are not allowed to be on the wall.

When laying walls from internal scaffoldings, it is necessary to arrange external protective inventory access to the entire perimeter of the building in the form of a deck on brackets hung on steel hooks that are embedded in the masonry as it is erected no more than 3 m apart from each other.

Over the entrances when laying walls from the internal scaffolding should be arranged awnings the size of the plan at least 2x2 m.

It is forbidden to leave materials and tools on the walls during a break in the laying.

It is forbidden to perform installation works with a wind of more than 6 points.

The following requirements must be met in the manufacture of installation work:

On the site where the installation works are carried out, other works and the presence of unauthorized persons are not allowed.

When erecting buildings and structures, it is forbidden to perform work related to finding people in one section on floors above which the movement, installation and temporary fixing of components of prefabricated structures or equipment is carried out. When erecting single-section buildings or structures, simultaneous execution of installation works on different floors is allowed if there are reliable intermediate floors between them after a written order from the chief engineer after carrying out measures to ensure the safe conduct of work and provided that the specially appointed persons responsible for the safe manufacture of installation and movement of goods by cranes, as well as for monitoring the performance of the crane operator, the lanyard alschikom and signalers of industrial instructions for labor protection.

The methods of slinging the structural elements and equipment must ensure their supply to the installation site in a position close to the design one.

It is forbidden to lift prefabricated reinforced concrete structures that do not have mounting loops or marks, which ensure their proper slinging and assembly.

Cleaning of the structural elements to be assembled from dirt and ice should be carried out before they are lifted.

Stroepovku designs and equipment should be produced by means of gripping means, providing the possibility of remote passtepovki from the working horizon in cases where the height to the lock of the load-lifting equipment exceeds 2 m.

Elements of mounted structures or equipment during the movement must be kept from swinging and rotating by flexible braces.

Do not stay people on the elements of structures and equipment during their ascent or moving.

During breaks at work, it is not allowed to leave the raised elements of structures and equipment on weight.

For the transition of installers from one design to another, inventory ladders, transition bridges and ladders with fencing should be used.

It is not allowed to perform installation work at an altitude in open spaces at a wind speed of 15 m / s or more, with an ice sheet, thunder or fog, which excludes any visibility within the front of work.

It is not allowed to find people under the mounted elements of structures and equipment before installing them in the design position and fixing.

When installing the equipment in an explosive atmosphere, tools, fixtures and accessories must be used to prevent the possibility of sparking.

When installing the equipment, the possibility of spontaneous or accidental switching on it must be excluded.

When dismantling structures and equipment, the requirements for installation work should be met.

The dismantling of monolithic sections should be carried out with the permission of the foreman after the concrete has reached strength, which ensures the safety of the surfaces and edges of the corners.

Electric arc welding is carried out by persons who have the appropriate certificates for the right to produce welding works of this class.

Welding transformers and lighting fixtures must only be connected to an electrician on duty. The wires of the temporary electrical network must be isolated and suspended at a height of 2.5 m above the workplace; 3 m - above the aisles; 5 m - above the thoroughfares.

To turn transformers on, use closed-type closures. The length between the supply network and the transformer must not be more than 15 m.

Electric welding in the open air during unfavorable weather conditions (storm wind, thunderstorm, precipitation) is prohibited.

Designing a Routing Chart

on the device of the roof of metal.

3.21 . Organization and technology of basic construction works.

Works envisaged by the map.

The device is a vapor-permeable hydro-windproof insulation on the outside of the rafters.

Arrangement of the battens on the outside of the rafters.

The device covering the roof.

In the manufacture of roofing works, it is necessary to follow SNiP II-26-76 "Roofing", SNIP 3.04.01-87 "Insulation and finishing coatings", as well as the manufacturer's installation instructions.

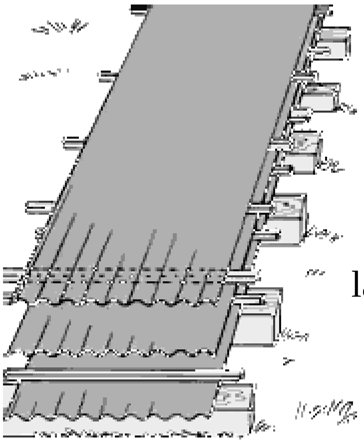
3.22 Execution of the base under the roof.

Work begins with a device of hydro-wind insulation in the form of a waterproofing membrane at the top of the rafters (overlapping from the ledge to the ridge with gluing the places of overlap with adhesive tape). The membrane is pressed by blocks 50x50 along the rafter feet (along the legs).

Next, the crate is made for roofing sheets. The cornice is sewn with solid boards 25x100 by 600mm. Next - from the bar 60h50 (h) through 250mm.

Technology of handling and mounting of metal.

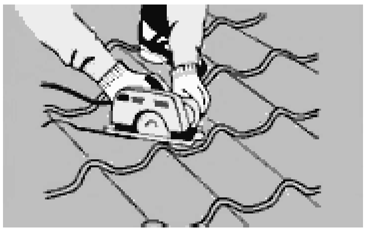
STORAGE



Profiled tin with a coating can be stored in the original packaging for 1 month, laying flattened under the packing of the beams about 20 cm in steps of about 0.5 m. If the roofing is planned later, the sheets should be laid with racks.

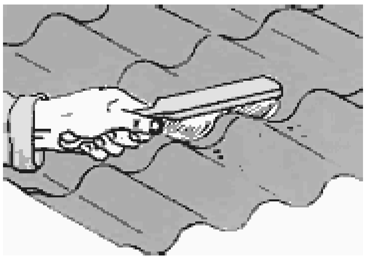
Sheets should be transferred, taking the edges along the length. You need to be careful not to cut your hands on the sharp edges of the sheets.

ADDITIONAL TREATMENT (cutting).



The profiled sheets must be cut manually. The length of the sheet should be cut with a metal hacksaw or scissors. If it is necessary to make a bevel or to shorten a sheet, then a manual electric saw with carbide teeth is used for this. In order not to damage the coating of the sheets, it is necessary to refrain from using cutting tools with abrasive cutting wheels (saws - "Bulgarian", etc.)

CARE OF THE SHEET



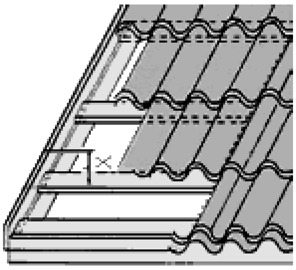
Formed when trimming the sheet or when drilling sawdust, it is necessary to sweep the brush carefully, otherwise the metal crumb will rust and spoil the coating.

If the surface of the sheets is dirty during installation, the dirt can be easily washed off with a mild detergent. Especially strong cleaning agents can damage the plastic coating layer.

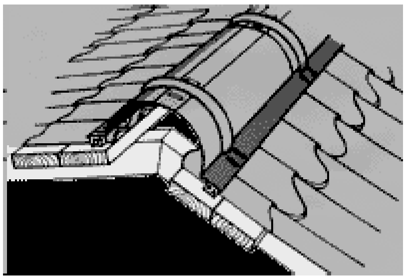
PAINTS

If during the installation the metal tiles were subjected to heavy loads and scratches formed on the surface, then the protective zinc layer under the plastic coating protects the sheet from rusting, and possible scratches can easily be painted with the paint of the same tone (ask the seller for an aerosol can with paint). It is necessary that a layer of paint is applied to all places of the cut, especially in the areas where the profile wave is bent and where the sheet is cut off at the place.

For proper installation and complete roofing, it is necessary that:

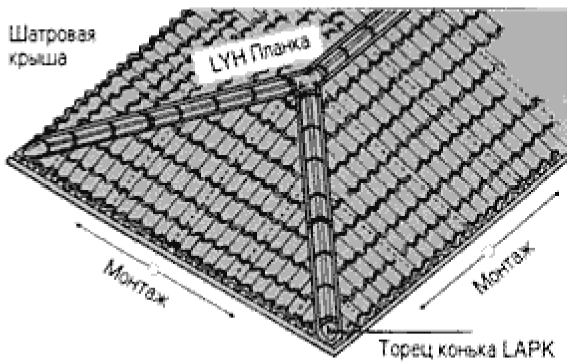


the end bar was higher than the crate on the height of the profile sheet - for "CASCADE" - 45 mm. The boards of the crate are nailed to the rafters with galvanized nails.



The ridge bar must be well fixed, two additional boards are nailed on either side of it.

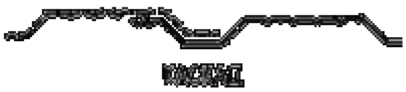
The curtain rod RLC is fixed before the sheets of the roof. For the overlap, 100 mm is enough. The bar is fixed with galvanized nails with a distance of 300mm. To cut the sheet, use scissors on the tin.



Installation of sheets must be started on the roof hood, the sheets are installed and secured from the highest point of the ramp on both sides.

The capillary groove of each sheet should be covered with the next sheet. For CASCADE sheets, the capillary groove is on the left edge of the sheet.

The edge of the sheet is set on the eaves, and is fastened with a ledge from



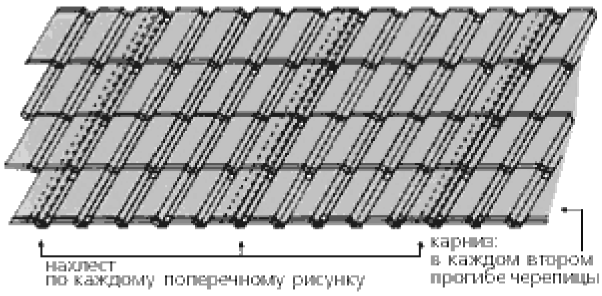
the eaves to 40 mm.

To facilitate the work, first three or four sheets should be fixed with a single screw on the ridge, align them strictly on the ledge, and then fasten completely along the entire length. The first sheet is installed and attached by one screw at the ridge. Then the second sheet is stacked so that the bottom edges make an even line. Fix the overlap with one screw at the top of the wave under the first transverse fold. If it now appears that the sheets "do not fit together," you should first lift the sheet from the other, and then, slightly tilting the sheet, moving from the bottom up, lay the crease behind the fold and fasten the screw along the top of the wave under each transverse fold. Having thus secured 3-4 sheets between each other, the resulting even lower edge must be aligned strictly along the cornice. And only then fasten the sheets permanently to the crate.

It is possible to do otherwise: overlaps align on the bottom, sheets - among themselves, then the picture is fastened to the crate.

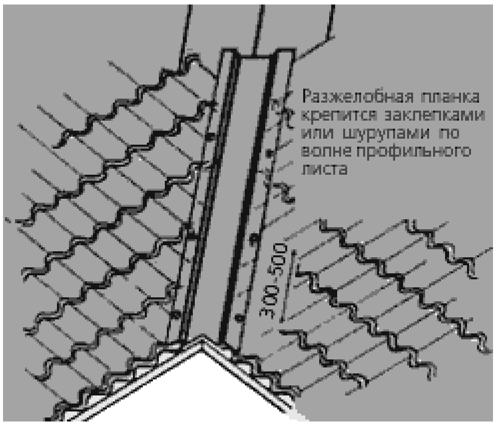
On the profile it is necessary to walk neatly in shoes with a soft sole and to step only in the places of the crate and into the deflection of the wave.

LENGTH OF WIDTH IN THE WIDTH



Fixation with screws 8 pcs. on sq.m. "zigzag" on the whole pattern of tiles. Make sure that the sheet is attached exactly to the place.

Profile plates are attached only with screws. For work with screws, an electric drill (screwdriver) with a special nozzle (bit-hexahedron) is very convenient. Self-tapping screws SW-4,8x28 with sealing washer are screwed into

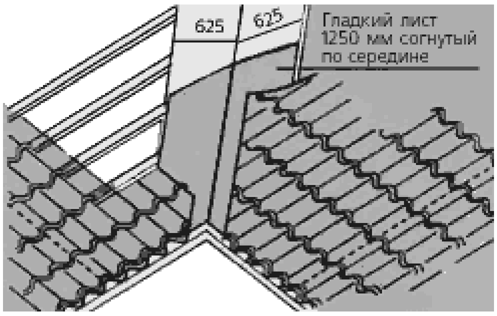


the deflection of the profile wave under the transverse wave, perpendicular to the sheets - 8 pcs. on 1m. square.

LENGTH OF LENGTH

In such places, sheets are installed on a cross-sectional drawing) and fastened as indicated above. In the place of the lapping the fastening is made in every second wave under the cross pattern.

L = length of the ramp, L1 = (number of cross-sectional drawings x by the length of the cross pattern) + 200 mm, L2 = L - (number of transverse patterns x by the length of the cross-section)



INTERIOR POST

The internal joint on the roofs, having the shape of the Latin letter L, is made of a smooth sheet. First, a solid wooden structure with a waterproofing is installed, the height of which is the same as that of the crate, and then a smooth sheet is installed.

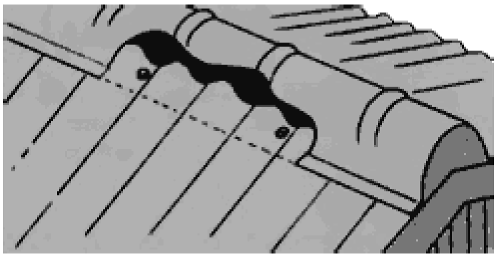
The sealing of the gap between the roofing sheet and the internal joint is carried out using a special seal.

On the inner joint it is possible to mount the LSPL valley cover plate. It is fastened without seals, rivets or screws on the top of the profile wave with a distance of 300 - 500 mm.

THERMAL PLANE

The LPT-250 faceplate is fixed to the wooden base with screws. When the base is executed correctly, then the end strip easily covers the end over the profile wave.

BRIDGE PLANE



The roof ridge is closed only when all the roofing sheets have already been installed and fixed, and the sealing tape under the ridge bars is already nailed. Make sure that all the first screws holding the sheet and sealing tape are covered with a ridge strip.

The roof ridge bars are attached to each second profile wave with screws, and the ends to the ridge are fixed either with screws or rivets.

BORDER OF THE FORM "Y" ON THE TENT-ROOF.

On the roofs of this form, the gable planks bifurcate from the ridge with a special "Y" shaped bar and the same plank covers the formed corner. Fastening with screws.

The end of such a bar is installed in the inside of the ridge and from above is fastened with screws.

SEALING TAPES

When installing metal roofing, sealing tapes are used only under the ridge and at the joints of the roofs of the hipped form. If the roof base has already been made with waterproofing material, no sealing tapes are required, other than internal joints. In the places of overlapping seams and through-outs for sealing, silicone mass or other similar sealant can be used.

Sealing tapes are neatly nailed by small nails to the profile, only then the ridge or the joint is covered with slats.

Instructions for handling the roof:

It is prohibited to store finished profiled products on the street in unventilated stacks.

After the installation, the steel shavings must be carefully removed. Remaining on the roof of steel chips can rust and change the color of the surface of the sheets.

Flooded needles on the roof, leaves and debris in autumn and spring must be cleaned.

The state of products from thin steel sheets and their fastenings should be checked by an external inspector at least once a year.

Contaminated coatings should be cleaned with a soft brush and rinsed with running water or a pressure washer (max pressure 50 bar) from top to bottom.

Do not use solvents or other chemically active substances, which can damage the polymer coating.

Strongly soiled areas should be washed with a diluted soap solution. Remains of detergents should be thoroughly washed. Clean the snow from the roof carefully, without damaging the cover.

When installing, make sure that the sheets do not scratch. each other. On profiled sheets it is forbidden to walk in dirty shoes.

Damages that occur during installation, and other defects of pokrytiya are restored with the help of repair paint, sold by Rannila and suitable for the specified type of poly-dimensional coating.

By rapid repair of defects, further development of damage is excluded.

If the scratch does not pass through the zinc layer, one coat of thorough coloring is sufficient; if the tsarapina reaches the steel, the paint should be produced in two layers, using a primer.

Rust from scratch should be removed before painting. Before the restoration, the damaged area should be cleaned with white spirit.

Paints should only be applied to the places of scratches, without expanding the repair area. Thus, formation of a noticeable color difference between the over-colored and the original surfaces is prevented.

3.23 Material and technical resources.

The roof area and the area covered by the crate is 212.08 meters. A waterproofing foil is laid along the same area. Two pyramidal umbrellas are installed for smoke and ventilation systems.

3.24 . The statement of labor costs and wages (calculation).

Calculation of labor costs and wages for roofing works.

№	Name of works	Unit. amend. by ENIR	Scope of work	ENIR, table number, row, column number	Time of normal person-hour.		Labor costs for the whole volume, Tn				Composition of the link according to ENIR			Rates, UAH		Wage fund, UAH.		
					Mounting (Nvr.month)	Machinists (Nvr.Mash.), Machine-hour.	Mounting (Nvr.month)		Machinists (Nvr.Mash.), Machine-hour.		Profession	Discharge	amount	Installers	Engineers	Installers (Zmont)	Machinists (Zmash)	The Sumerian (Zobshch)
							person-hour.	person-days	person-hour.	person-days								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Waterproofing device	On 100 m2	2,02	E6-9-1, г,пр-2	6,7	-	13,53	1,69	-	-	Insulator	32	12	4-49	-	9-07	-	9-07

2	Sheathing device	On 100 m2	2,02	E6-9-1, E	13,5	-	27,27	3,41	-	-	A carpenter Ancillary Worker	4 3 2 1	1 1 2 1	9-07	-	18-32	-	18-32
3	Roof covering with metal tile	On 1 m2	202	E7-5-4, Б	0,19	-	38,38	4,79	-	-	Roofer	4 3	1 1	0 - 142	-	28-68	-	28-68
4	Assembly and installation of rainwater grn	1 meter	70	E1-6-17, е-г	0,33	-	23,1	2,9	-	-	Roofer	4 3	1 1	0-261	-	18-27	-	18-27
5	Feeding materials with a gantry crane	100 t	0,1	E1-6-17, е-г	42,2	21,2	4,22	0,53	2,12	0,27	Driver Rigging on installation	6 2	1 2	27-04	2-71	22-35	2-24	4-95

5. Quality control.

In the manufacture of roofing works, the following are subject to mandatory control: preparation of the substrate, quality of the vapor barrier, heat insulation, screed, priming, lining of the junction points, quality of the roofing materials. The quality of the work is checked both during the execution and after all the roofing works are completed.

Materials used to perform roofing work must meet the requirements of existing standards.

The surface of the substrate must be flat. When superimposed on the control three-meter rail, the gaps between the base under the roof and the rail must not exceed 5 mm along and 10 mm across the ramp. It is permissible not more than one lumen per 1 m of length.

Complete drainage of water along the entire surface of the roof should be carried out through the external and internal gutters without stagnation of water. It is determined by technical inspection.

The adhesion to the base of the roofing carpet should be strong. This is determined by measurement (five measurements per 120□150 m2 of the surface of the coating). When the glued materials are ruptured, detachment should not be observed.

Compositions of mastics should correspond to design. Departure from the project - 5%. It is determined by technical inspection.

The arrangement of the panels of their joints must correspond to the design ones. The correctness of the location is determined by technical inspection.

Bubbles, blisters, air bags, ruptures, dents on the surface of the coating are not allowed.

The increase in the moisture content of the bases of the intermediate elements should not exceed 0.5%. is determined by measurement (five measurements per 50□70 m2 of the coating surface). Quality control is carried out in accordance with SNiP 3.04.01-87.

3.25. Safety in the manufacture of roofing works.

Workers engaged in the preparation of bituminous mastic and the device of the roof of rolled materials must be instructed on safety.

Workers engaged in the preparation of bitumen mastic and its use must be provided with overalls and individual protective equipment.

It is forbidden to perform roofing works during the ice, thick fog, a wind of 6 points or more, a rain shower, a thunderstorm and a heavy snowfall.

It is forbidden to dump materials and tools from the roof.

Boilers for heating bituminous mastics should be in good order and have tightly closed fireproof covers. Filling of boilers is allowed no more than on their capacity. The filler loaded into the boilers must be dry. When installing a bitumen boiler in the street above it, a fireproof canopy is arranged. Near the digester should be a set of fire fighting equipment, fire extinguishers, shovels, dry sand.

The maximum temperature of heating of bitumen mastic should be no more.

Smoking in the workplace is prohibited.

Before starting work, it is necessary to check the serviceability of gas burners, hoses and cylinders.

Elements of gutters and troughs should be fed to the roof in assembled condition.

In case of interruptions in work, technological devices and materials should be removed from the roof.

For more detailed safety instructions, see the part related to safety and health and safety at work.

4. The economic part

4.1 The economic part

Estimated documentation is prepared using:

1) Rules for determining the cost of construction [26];

2) Consolidation of the direct cost estimates of the cost of 1 buildings, structures, objects, dwellings in current prices for labor and material and technical resources, according to the average data of the State Building of Ukraine as of 2019-2020.

In the summary estimate, after summarizing Chapters 1-12, the following are determined: estimated profit, administrative expenses, funds to cover the risk, funds to cover the costs associated with inflationary processes, taxes and fees, return amounts.

1. Generation costs are determined according to the calculation;

2. Average indicator of limit of funds for erection and dismantling of titular temporary buildings and structures [26] supplement 6 -2,25%;

3. Cost index for the risk coverage of all construction participants [26] Annex 14 Table 2;

4. The average annual construction inflation index, K-1.0515 (calculation). Costs related to inflation-related costs, calculated taking into account the beginning of 2019 and the completion of construction in 2019;

5. The average indicator of the size of the estimated profit, [26] supplement 13 - 6.20 UAH. people. year;

6. Administrative costs 0, 90 n. people. year;

7. The municipal tax rate is 10%.

To complete the economic part of the diploma - determine the estimated cost of construction, perform calculations for general construction work, object estimates and summary estimates of construction. The calculations are performed according to the consolidated standards and rules for determining the cost of construction [26].

After completing all the calculations in the estimate documentation for the construction of a fifteen-storey building with underground parking in Uzhgorod, we can conclude that this project is economically feasible. All calculations were made in accordance with [26] "Rules for determining the cost of construction".

Total consolidated estimate - UAH 12 258,985 thousand.

Including:

- - Estimated cost – 7740,607 UAH.
- - Estimated labor costs for the object – 30, 6927 thousand people-hours
- - Estimated salary on the object – 1626,673 thousand UAH.

According to the resource elementary estimates (RECN) the level of salary for construction works as of October 20, 2019 is from 8527,52 UAH. at an average discharge of 3.8.

3.2 CONSOLIDATED ESTIMATED COST OF CONSTRUCTION OBJECT NO.

Projerct of a sport complex with gym. A gym and a swimming pool with the study of three-dimensional structures

№	Numbers estimates and estimated calculations	Names of heads, houses, buildings, structures, linear objects engineering transport infrastructure, works and costs
1	2	3
		Chapter 2. Objects of primary purpose
1	2-1	Projerct of a sport complex with gym. A gym and a swimming pool with the study of three-dimensional structures
		--
		Total Chapter 2:
		Together for Chapters 1-7:
		Chapter 8. Temporary Buildings and Structures

2	DSTU B E.1.1-1: 2013 § 5.8.11	Funds for the erection and dismantling of temporary buildings and structures
		--
		Total Chapter 8:
		Together for Chapters 1-8:

Projerct of a sport complex with gym. A gym and a swimming pool with the study of three-dimensional structures
26/10-19

3.3 Local estimate for construction works No. 2-1-1

at Projerct of a sport complex with gym. A gym and a swimming pool with the study of three-dimensional structures

Projerct of a sport complex with gym. A gym and a swimming pool with the study of three-dimensional structures

Basis:	Estimated cost	7740,607 thousand UAH.
drawings (specifications) №	Estimated complexity	30,6927 thousand

man-h.

Estimated salary 1626,673 thousand UAH.

The average category of work 3,3 discharge

№	Justification-tion (code norms)	Name of works and expenses	Unit measurement	Keel-bone	Unit cost, UAH		Total cost, UAH			Labor costs workers, man-hours.	
					Total	exploitation machines	Total	earnings - no fee	exploitation machines	not employed service machines	
					earnings - no fee	in that the numbers for-working pay			in that the numbers for-working pay	those who serve cars	
										of one-this one	total
1	2	3	4	5	6	7	8	9	10	11	12
		Chapter 1. Preparatory work									

1	E1-203-1	Cutting thick bushes and shredding in	ha	4,255	3045,51	3045,51	12959	-	12959	-	-
		soils			-	654,70			2786	9,8379	41,86
		with natural brush cuttings on a									
		tractor of 79									
		kW [108 hp]									
2	E1-145-1	Mechanized Planning, Soil Group 1	1000m2	2,35	687,46	687,46	1616	-	1616	-	-
					-	131,39			309	1,9166	4,5

1	2	3	4	5	6	7	8	9	10	11	12
		Total construction work, UAH. _ **All in section 1**					**15856** **15856**				
		Chapter 2. Earthworks									
3	E1-18-1	Development of soil with loading on dump trucks by excavators single-bucket diesel on a track with a ladle of 0,4 [0,35-0,45] m3, soil group 1	1000m3	3,171	21001,67 1023,54	19978,13 5756,00	66596	3246	63350 18252	24,1400 96,9391	76,55 307,39
4	E1-162-1	Manual soil development with trenching up to 2 m wide, up to 2 m deep, soil group 1	100m3	0,9513	9628,38 9628,38	- -	9159	9159	- -	212,5000 -	202,15 -

		Total construction work, UAH.					**89972**				
		– –									
		All in section 2					**89972**				
		Chapter 3. Arrangement of foundations									
5	EH6-1-1	Arrangement of concrete preparation	100m3	0,78	194989,91 6703,14	1527,06 628,42	152092	5228	1191 490	150,7000 10,6641	117,55 8,32
6	*E7-42-1*	*Installation of blocks of basement walls up to 0.5 t*	*100pie.*	*1,12*	*84059,51 2675,68*	*9500,44 3404,23*	*94147*	*2997*	*10640 3813*	*56,0000 55,3704*	*62,72 62,01*
7	E1-27-1	Backfilling of trenches and ditches with 59 kW [80 hp] bulldozers with ground movement up to 5 m, soil group 1	1000m3	0,308	3798,66 -	3798,66 881,25	1170	-	1170 271	- 15,1575	- 4,67

1	2	3	4	5	6	7	8	9	10	11	12
		Total construction work, UAH .					**254156**				
		All in section 3					**254156**				
		Chapter 4. Installation of the steel frame of the first, third block									
8	*E7-5-1*	*Installed columns of straight-line cross-cutting at the basement wake-up bucket with glybin; embedded columns up to 0.7 m, mass columns up to 1 t*	*100pie.*	*0,12*	*4208831,96* *30825,41*	*32164,24* *11624,85*	*505060*	*3699*	*3860* *1395*	*600,3000* *181,5485*	*72,04* *21,79*
9	*E7-12-9*	*Installed in single-top awnings of croquant beams and trusses with a run of up to*	*100pie.*	*0,14*	*4711598,53*	*132556,72* *44942,5*	*659624*	*13468*	*18558* *6292*	*1725,5000* *716,066*	*241,57* *100,25*

		18 m, weight up to 10 t, when the slabs are finished up to 6 m, with a wake-up time of up to 25 m			*96196,63*	*2*				*3*	
10	*EH10-1-3*	*Installation of beams with a run of 9 m, volume up to 0.5 m3*	*pie.*	*54*	*850,10* *417,63*	*161,55* *59,67*	*45905*	*22552*	*8724* *3222*	*8,5300* *0,8967*	*460,62* *48,42*
11	*E9-43-1*	*Mounting half-timbered*	*m*	*10,6*	*15110,49* *2224,78*	*2192,07* *622,65*	*160171*	*23583*	*23236* *6600*	*40,4800* *9,7100*	*429,09* *102,93*
		Total construction work, UAH.					**1409457**				
		_ _									
		All in section 4					**1409457**				

1	2	3	4	5	6	7	8	9	10	11	12
		Chapter. Installation of the steel frame of the second block									
12	*E7-5-1*	*Installed columns of straight-line cross-cutting at the basement wake-up bucket with glybin; embedded columns up to 0.7 m, mass columns up to 1 t*	*100pie.*	*0,06*	*4208831,96* 30825,41	*32164,24* 11624,85	*252530*	*1850*	*1930* 697	*600,3000* 181,5485	*36,02* 10,89
13	*E7-12-9*	*Installed in single-top awnings of croquant beams and trusses with a run of up to 18 m, weight up to 10 t, when the slabs are finished up to 6 m, with a wake-up time of up to 25 m*	*100pie.*	*0,06*	*4711598,53* 96196,63	*132556,72* 44942,52	*282696*	*5772*	*7953* 2697	*1725,5000* 716,0663	*103,53* 42,96
14	*EH10-1-3*	*Installation of beams with a run of 9*	*pie.*	*18*	*850,10*	*161,55*	*15302*	*7517*	*2908*	*8,5300*	*153,54*

		m, volume *up to 0.5 m3*			*417,63*	*59,67*			*1074*	*0,8967*	*16,14*
		Total construction work, UAH.					**560471**				
		_ _									
		All in section 5					**560471**				
		Chapter 6. The device of a monolithic overlap and a bath under the pool									
15	E46-52-1	Installation and removal of inventory ladders and riser tubular forests	m2	2640	352,55 179,76	24,09 7,17	930732	474566	63598 18929	3,9300 0,1149	10375,2 303,34
16	*EH6-51-1*	*Assembling and disassembling the volume-adjustable ["tunnel"] overlay formwork*	*m2*	*946,1*	*117,43* *67,05*	*39,44* *16,23*	*111101*	*63436*	*37314* *15355*	*1,2200* *0,2754*	*1154,24* *260,56*
17	*EH6-57-*	*Installation of reinforcing nets and*	*m*	*1*	*55461,9*	*87,64*	*55462*	*1018*	*88*	*20,5200*	*20,52*

	17	frames			0	36,06			36	0,6120	0,61
		manually, element weight up to 20 kg			1017,59						
18	EH6-22-7	Arrangement of overlappings on steel	100m3	1,0696	424609,	11213,5	454162	87878	11994	1678,09	1794,89
		beams			59	4			4387	00	75,1
		and monolithic sections at the precast			82159,2	4101,98				70,2113	
		concrete floor covering up to 5 m2,			9						
		reduced to									
		100 mm thick									

1	2	3	4	5	6	7	8	9	10	11	12
		Total construction work, UAH.					**1913465**				
		_ _									
		All in section 6					**1913465**				
		Chapter 7. The device of the roof of the first, third blocks									
19	*E12-12-4*	*Arrangement of roofs of tents from a metal profile with the arrangement of lats and counter*	*100m2*	*10,8*	*29959,16* *7293,16*	*297,17* *88,57*	*323559*	*78766*	*3209* *957*	*156,6400* *1,4775*	*1691,71* *15,96*
20	E12-20-3	One-layer lining paired insulation	100m2	10,8	3952,38 544,00	70,29 23,61	42686	5875	759 255	10,9700 0,4017	118,48 4,34
21	EH11-11-1	Installation of cement screed 20 mm thick	100m2	10,8	5989,53 2619,00	63,70 55,93	64687	28285	688 604	56,2500 1,0323	607,5 11,15
22	*E12-18-3*	*Insulation of coatings of mineral wool*	*100m2*	*10,8*	*15847,8*	*319,03*	*171157*	*35743*	*3446*	*63,6700*	*687,64*

		or perlite			*8*	*112,15*			*1211*	*1,8756*	*20,26*
		on bituminous mastic in one layer			*3309,57*						
23	EH11-4-1	Arrangement of waterproofing with	100m2	10,8	12576,8	10,27	135830	29012	111	51,1000	551,88
		bituminin			2	9,02			97	0,1665	1,8
		mastic, first layer			2686,33						
24	*E12-12-4*	*Arrangement of roofs of tents from a*	*100m2*	*2,21*	*29959,1*	*297,17*	*66210*	*16118*	*657*	*156,640*	*346,17*
		metal			*6*	*88,57*			*196*	*0*	*3,27*
		profile with the arrangement of lats			*7293,16*					*1,4775*	
		and counter									
25	E12-20-3	One-layer lining paired insulation	100m2	2,21	3952,38	70,29	8735	1202	155	10,9700	24,24
					544,00	23,61			52	0,4017	0,89
26	EH11-11-	Installation of cement screed 20 mm	100m2	2,21	5989,53	63,70	13237	5788	141	56,2500	124,31
	1	thick			2619,00	55,93			124	1,0323	2,28
27	*E12-18-3*	*Insulation of coatings of mineral wool*	*100m2*	*2,21*	*15847,8*	*319,03*	*35024*	*7314*	*705*	*63,6700*	*140,71*
		or perlite			*8*	*112,15*			*248*	*1,8756*	*4,15*
		on bituminous mastic in one layer			*3309,57*						
28	EH11-4-1	Arrangement of waterproofing with	100m2	2,21	12576,8	10,27	27795	5937	23	51,1000	112,93
		bituminin			2	9,02			20	0,1665	0,37
		mastic, first layer			2686,33						

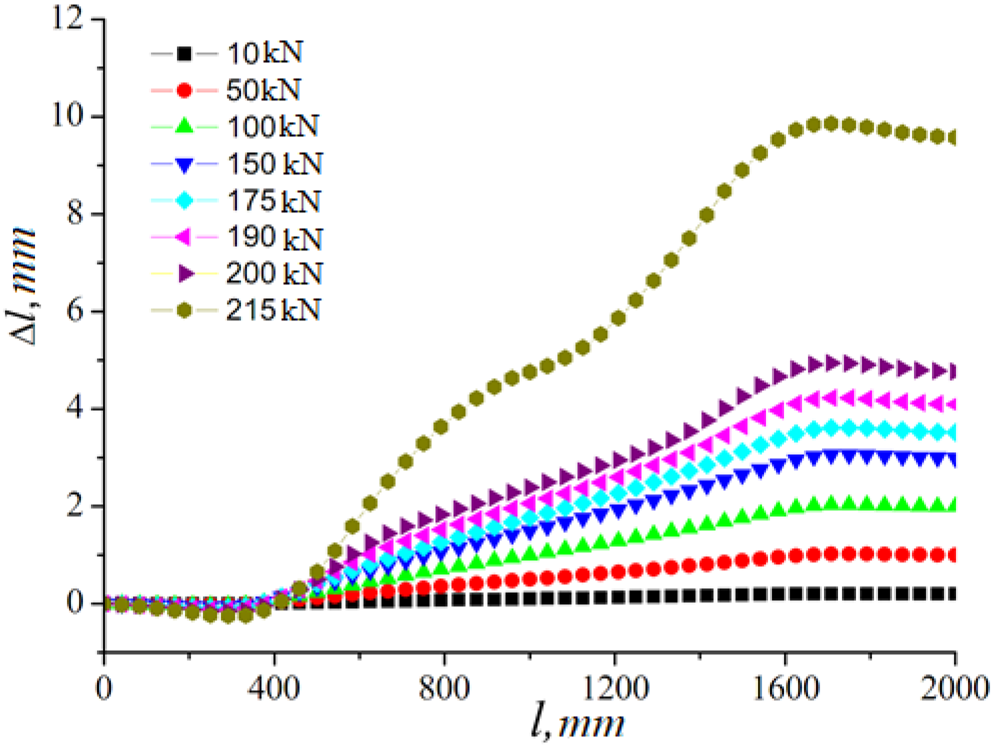
	3	4	5	6	7	8	9	10
-	Lime painting of facades from scaffolding with surface preparation	100m2	26,4	676,05 459,20	3,42 3,01	17848	12123	90 79
	Total construction work, UAH.					**2202553**		
	_ _							
	All in section 7					**2202553**		
	Chapter 8. Internal work							
-15-	Arrangement of concrete coverings 30 mm thick	100m2	12,29	9058,15 2689,44	95,89 84,20	111325	33053	1178 1035
-12-	*Laying a log on slabs of overlappings*	*100m2*	*10,08*	*7186,08* *1863,84*	*5,48* *4,81*	*72436*	*18788*	*55* *48*
-36-	Arrangement of coverings from boards of parquet on concluded logs	100m2	10,08	99106,03 3108,22	23,97 21,05	998989	31331	242 212
-	*Simple painting of walls on plaster and concrete with an adhesive solution with preparation of surfaces indoors*	*100m2*	*29,12*	*2073,86* *467,63*	*0,68* *0,60*	*60391*	*13617*	*20* *17*
	Total construction work, UAH.					**1294680**		

Scientific part 5

4.1 Investigation of the stress-strain state of a physical model of a weldless farm with no braids at static loads by a computer simulation experiment

The design calculation of the behavior of a welded truss under the action of static loads was performed by a computer simulation experiment using the ANSYS Workbench 14.5 software package, which is algorithmically based on the finite element method.

The computer simulation experiment showed a visual dependence of longitudinal deformation along the lower belt of the farm at different loading levels.

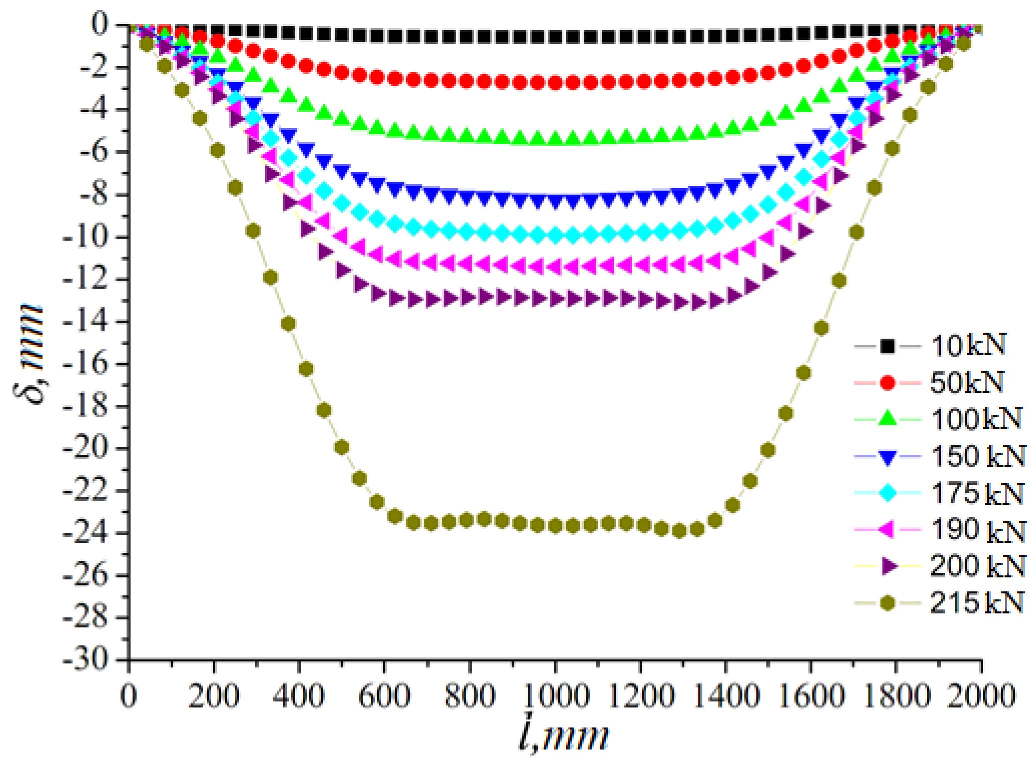


Picture 1 - Diagram of longitudinal deformation along the lower belt of the farm at different loading levels

The diagram shows that the highest intensity of longitudinal deformation along the lower belt occurs in the area from 400 to 1600 mm, ie between the extreme nodes on the belt. From the diagram it is also obvious that with increasing load on the farm from 200 to 215 kN, the intensity of the strain in the mentioned section of the lower belt goes beyond the linear.

According to the results of the farm calculations using the ANSYS Workbench 14.5 software package, the dependence of the transverse deformations (deflection) of the farm under study along its lower belt at different loading levels was visualized.

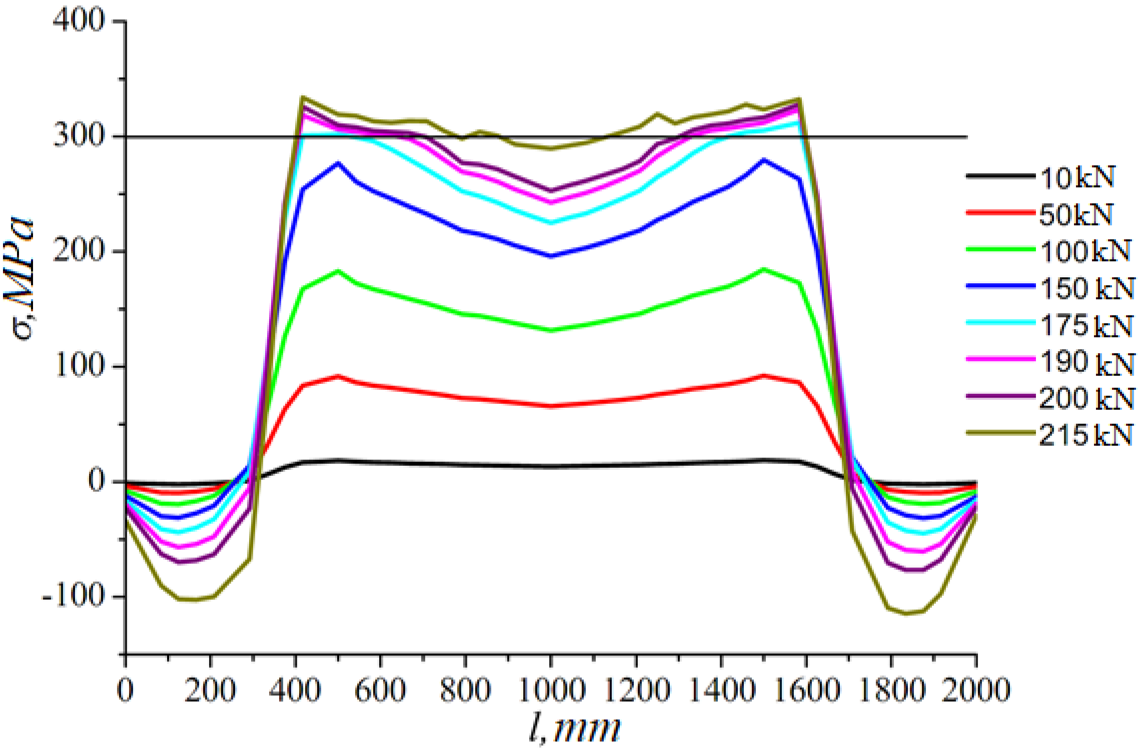
It is obvious that the most intensive deflection of the farm occurs in the area from 600 to 1400 mm, that is, around the central node of the truss farm.



Picture 2 - Diagram of the transverse deformation (deflection) of the farm along the lower belt at different load levels

As in the case of longitudinal deformation, the critical deflection of the farm begins with an increase in load from 200 to 215 kN. Obviously, in this case, there is also a transition from the elastic deformation of the investigated structure to the plastic one.

In Pic. 3. shows the voltage along the lower belt of the farm at different load levels. It is obvious that the critical stress concentration at the lower belt of the truss is at the axes of the extreme nodes, that is, at 400 and 1600 mm. Moreover, the intensity of growth of these stresses with increasing load is significant already in the initial section of the power range (10, 50, 100 kN).

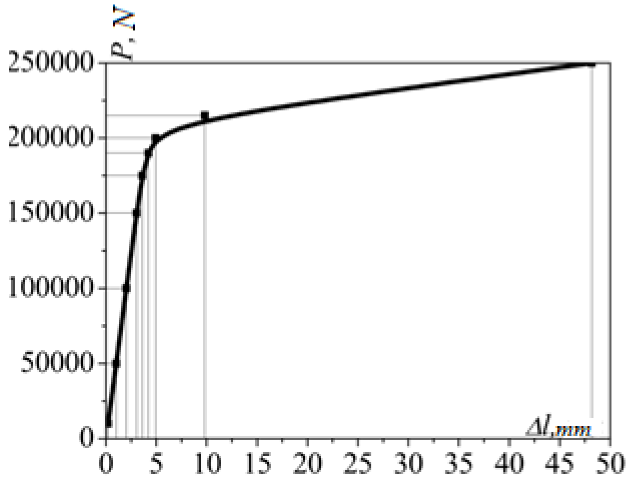


Picture 3 - Diagram of stresses along the lower farm belt at different load levels

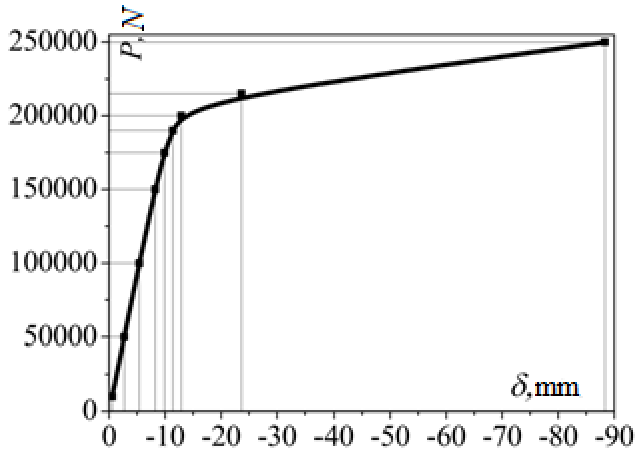
In addition, in the diagram of stresses along the lower farm belt (Pic. 3), one can see sections of the lower belt that undergo tensile stresses (σ> 0) and which contractions (σ <0). The magnitude and direction of stresses are important enough to determine the method of amplification and local areas for the installation of additional amplifying elements.

The potential features of the ANSYS Workbench 14.5 software package make it possible to construct deformation diagrams for the welded truss for maximum elongation of the lower trunk of the truss and maximum deflection of the lower trunk of the truss (Pic. 4).

In addition, the numerical values of maximum longitudinal and transverse deformations along the lower belt of the farm and the stresses that occur at the respective farm nodes, depending on the load level (Table 1), were obtained..



a)



b)

Picture 4 - Diagrams of deformation of a physical model of a welded farm obtained by a computer simulation experiment:

a) maximum deformation of the elongation of the lower belt of the farm;

b) maximum deflection deflection of the lower belt of the farm

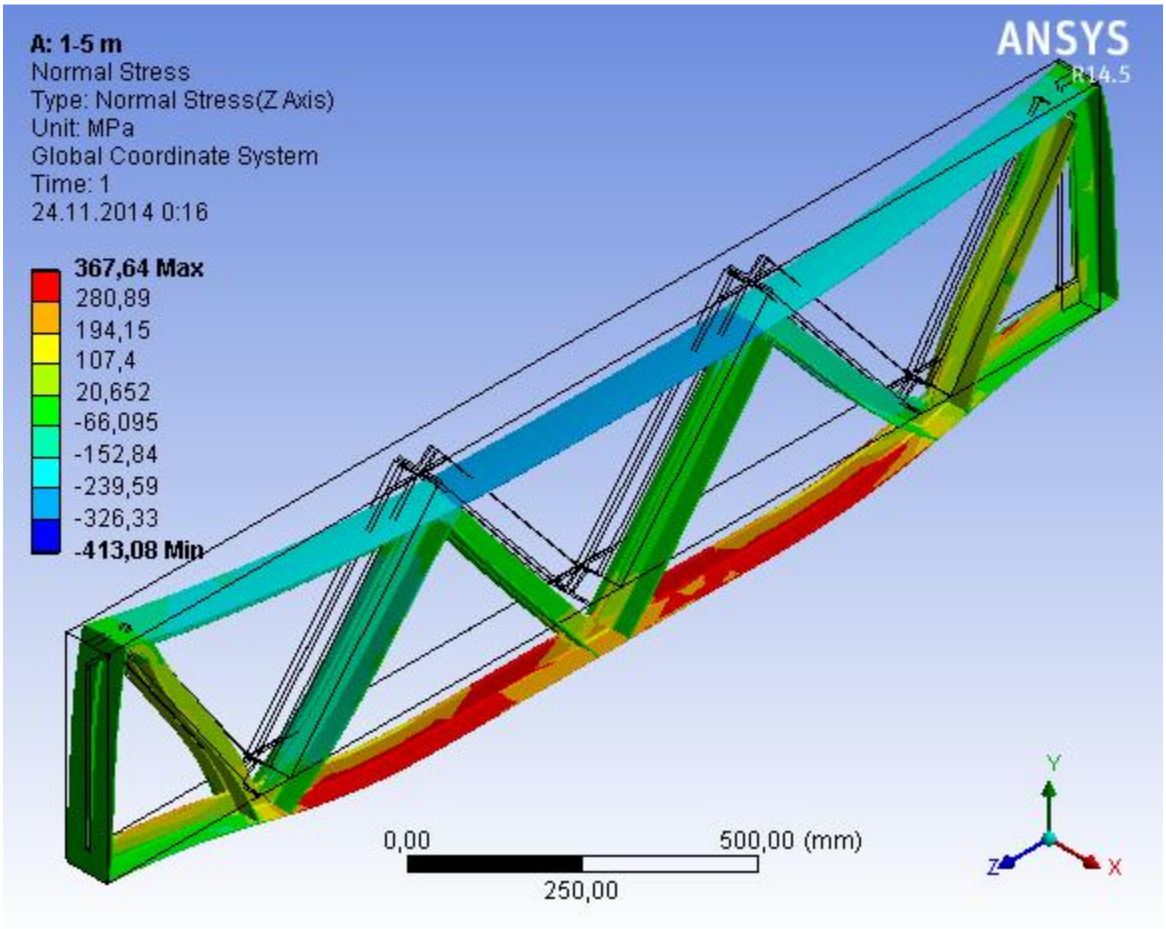
Table 1 - Weld farm SSS parameters obtained by a computer simulation experiment

№	Load P, N	Tension σ, MPa	Elongation, lower belt Δl, mm	Bend of the lower belt δ_{estim}, mm
1	10000	18,816	0,20776	-0,55471
2	50000	92,478	1,0204	-2,7213
3	100000	184,58	2,0366	-5,4353
4	150000	279,56	3,06	-8,2413
5	175000	315,65	3,6141	-9,9111
6	190000	347,95	4,2247	-11,4
7	200000	367,64	4,932	-12,902
8	215000	397,04	9,8334	-23,656

9	250000	780,23	48,173	-88,35

In the future, this information will be used to identify quantitative comparative characteristics for different design warrants of the units.

According to the results of the calculations, a visualization of the behavior of the deformed welded trunk at loads at the limit state level was shown (Pic. 5).

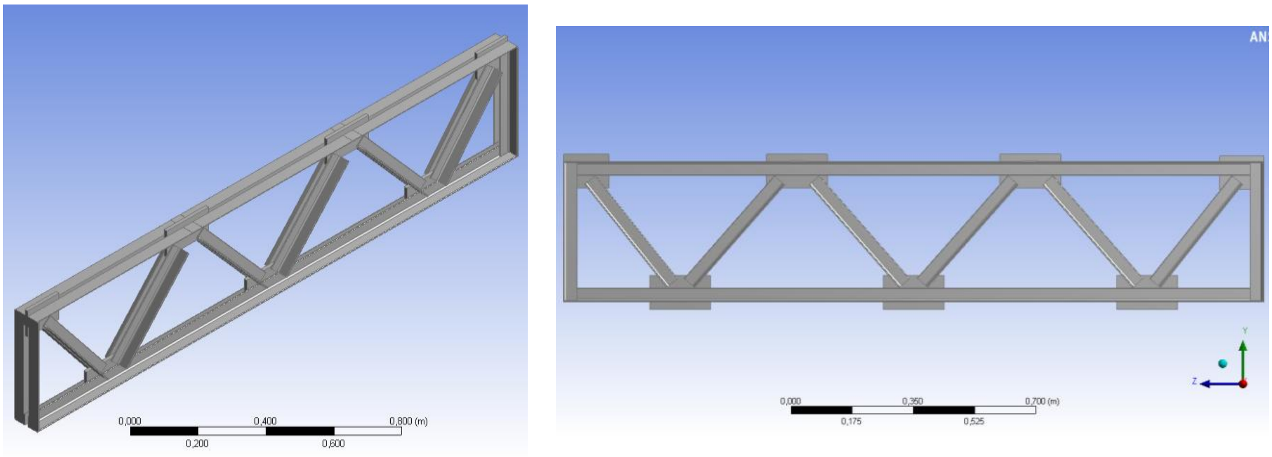


Picture 5 - Deformed Weld Farm Behavior Obtained by a Computer Modeling Experiment at Limit State Load

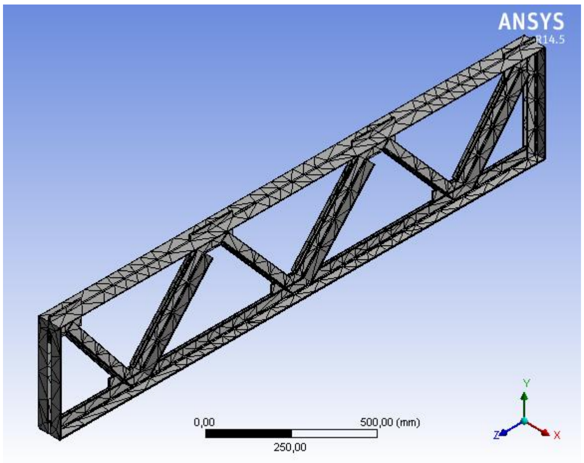
The loss of durability of the farm without scythes of 2000 × 400 mm from the paired angles of the 40 × 40 × 4 mm profile according to the results of a computer simulation experiment occurred at a load P_{max} = 200 kN, and plastic deformation of the structure according to the results of calculations occurred already with the efforts of 175 kN.

Investigation of the stress-strain state of a physical model of a welded farm with braids and rectangular cutting of braces at static loads by a computer simulation experiment

The ANSYS Workbench 14.5 software package simulates the behavior of a truss, a finite element grid model of which is shown in Picture 6.



a)

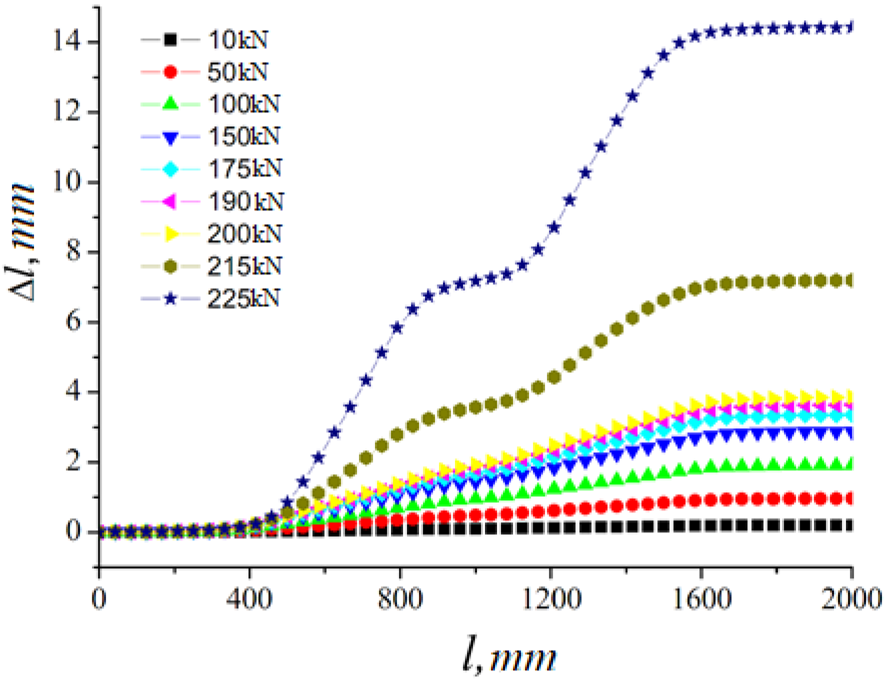


b)

Picture 6 - Farm with dimensions 2000 × 400 mm: a) CAD - geometric model; b) CAE is a finite element grid model.

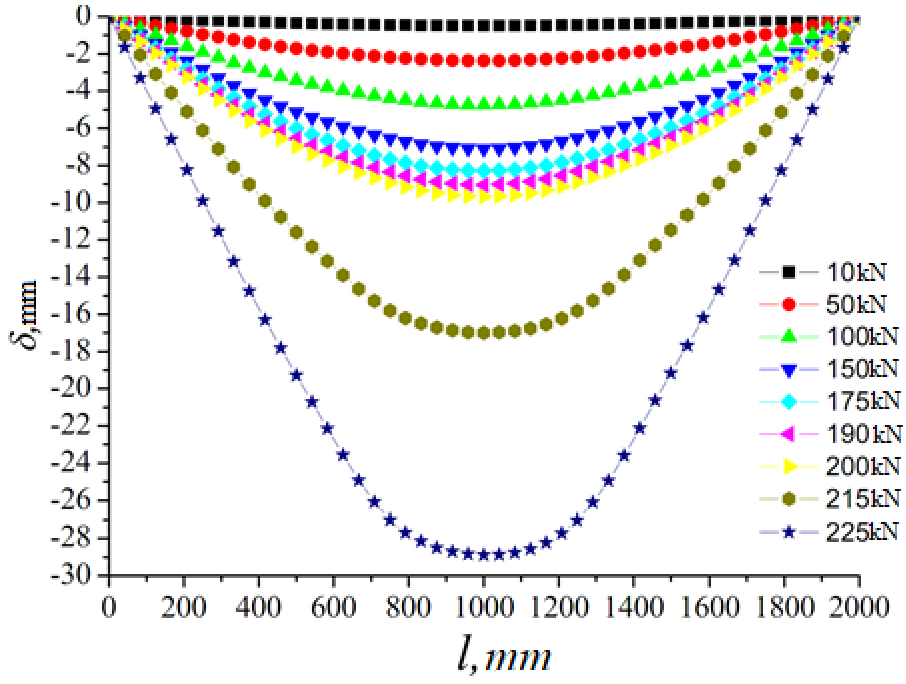
The results of a computer simulation experiment with ANSYS Workbench 14.5 yielded a longitudinal deformation along the lower farm belt under different external load values.

As with the previous design of the nodes, the obvious fact here is the violation of the linearity between the external load and the elongation of the lower belt in the power range between 200 and 215 kN.



Picture 7 - Strain diagram of elongation of the lower farm belt under different load levels

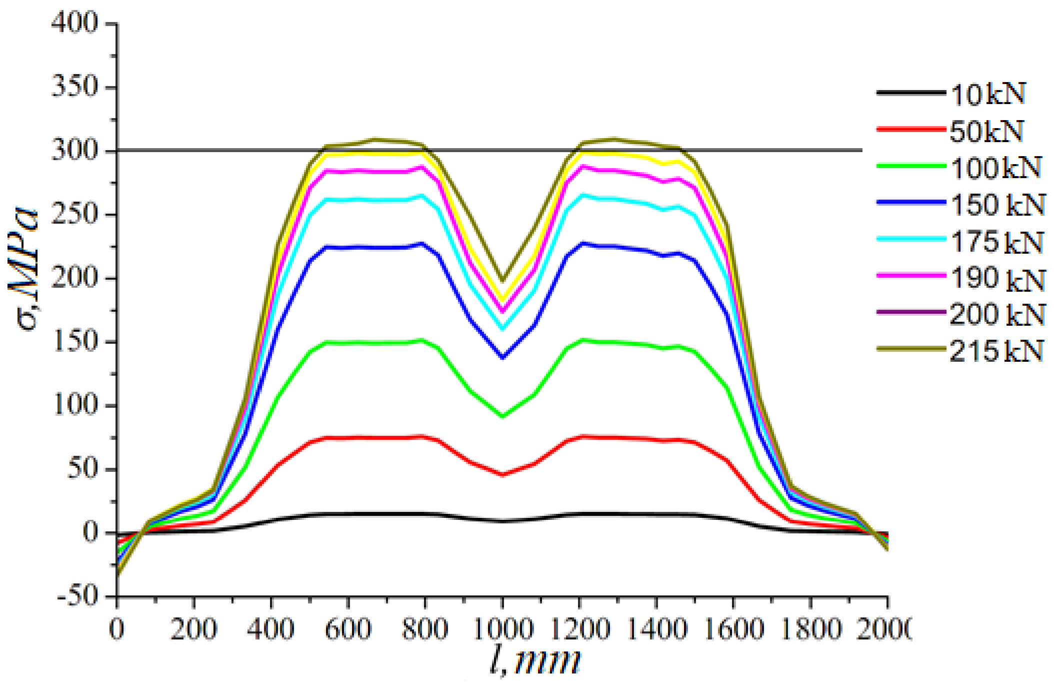
Noteworthy is the obtained diagram of the deflection of the lower belt of the farm at different values of the external load (Pic. 8). The safe power range, as in the case of longitudinal deformation of the lower belt, is limited by an external load of 200 kN. When the load is increased, there is a violation of linearity, and therefore there will be plastic deformation of the structure. Such loads are especially dangerous in the presence of a cyclic component in the power spectrum, since they will initiate the origin and propagation of cracks of small-cycle fatigue damage.



Picture 8 - Fracture deflection diagram of the lower farm belt

at different load levels

The obtained diagram of stresses along the lower belt of the farm at different levels of load (Pic. 9).



Picture 9 - Diagram of stresses along the lower farm belt at different load levels

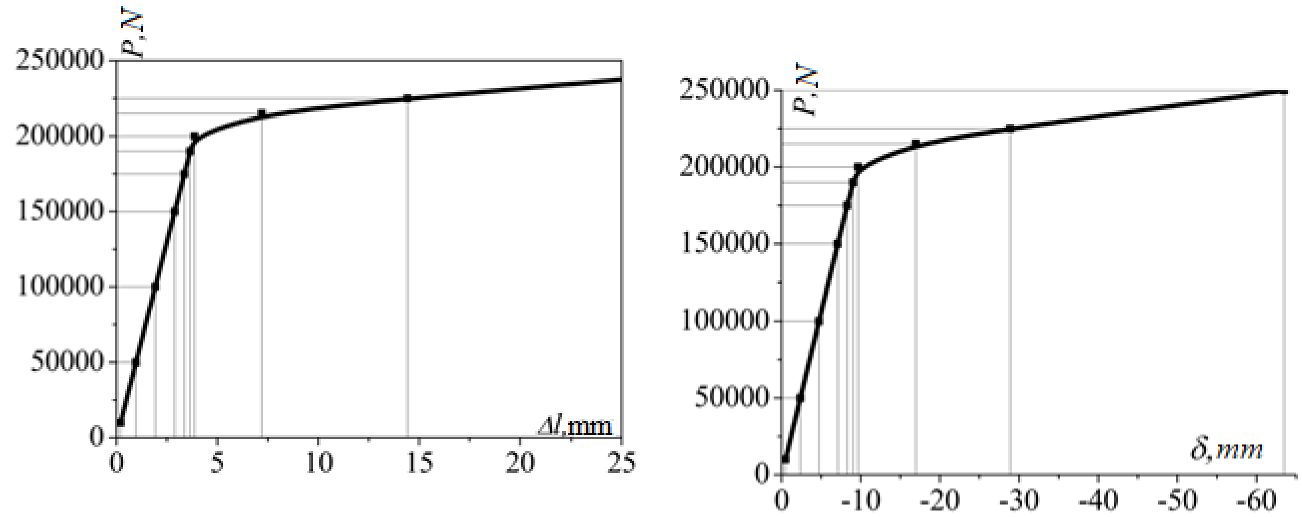
Compared to a similar diagram for a farm with no-go nodes, the stresses here do not have such sharp fluctuations in the localized sections of the lower belt, which means that the working conditions of the structural members are softer.

Numerical values of maximum elongations and deflections of the lower farm belt were obtained depending on the load level. The results are summarized in Table. 2.

Table 2 - Weld load loading and deformation results obtained from a computer simulation experiment

№	Load P, N	Tension σ, MPa	Elongation, lower belt Δl, mm	Bend of the lower belt δ_{estim}, mm
1	10000	15,919	0,19639	-0,48468
2	50000	78,1	0,96315	-2,3737
3	100000	155,82	1,9216	-4,7351
4	150000	233,54	2,8804	-7,1002
5	175000	272,36	3,3603	-8,2936
6	190000	295,69	3,649	-9,0412
7	200000	308,89	3,864	-9,6711
8	215000	318,75	7,2029	-16,988
9	225000	341,8	14,424	-28,889
10	250000	401,75	35,676	-63,488

According to the numerical results obtained, the diagrams of deformation of the physical model of the welded truss for deformation of the elongation (Pic. 10a) and the deflection (Pic. 10b) of the lower belt of the truss, which more clearly show the load, which cause the loss of elasticity of the truss and the transition of deformation into the plastic area.



a) b)

Picture 10 - Diagrams of deformation of a physical model of a welded farm obtained by a computer simulation experiment:

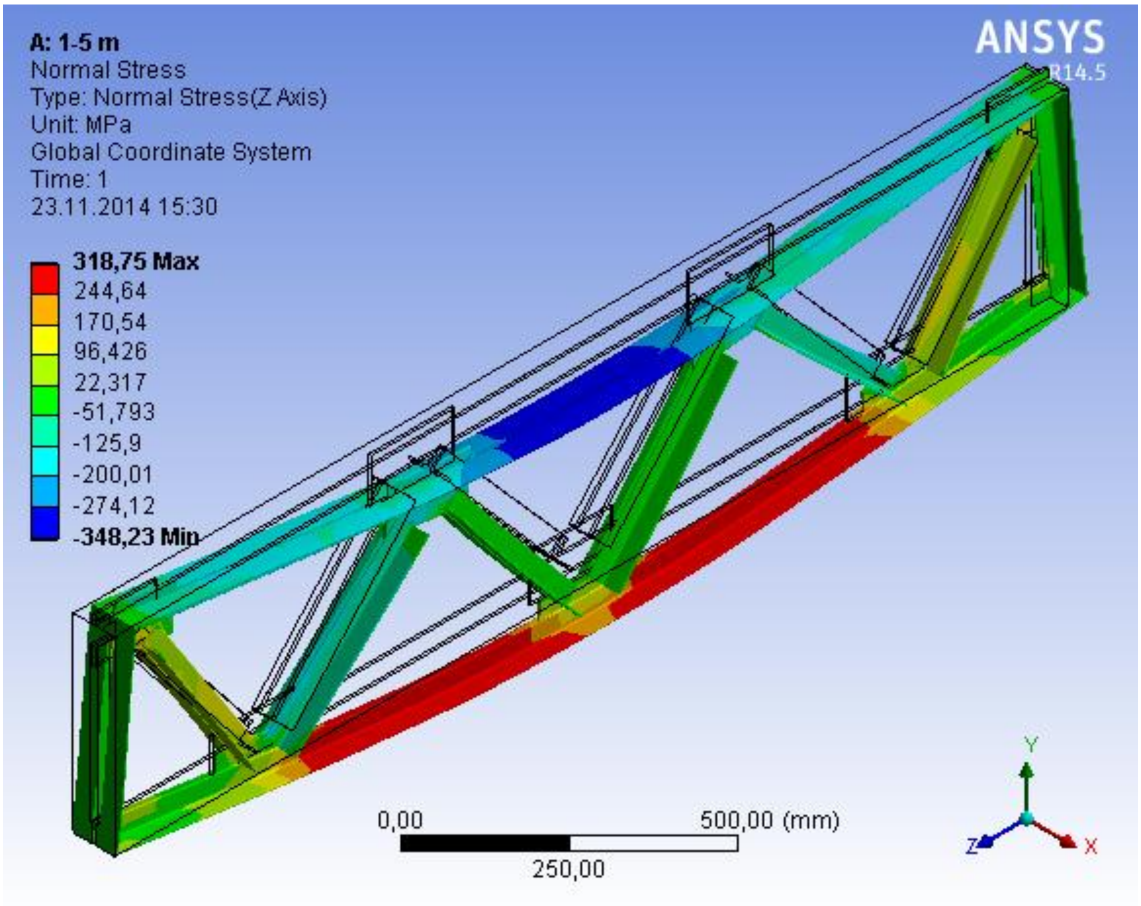
a) maximum elongation of the lower belt of the farm;

b) maximum deflections of the lower belt of the farm

As for the previous type of nodes in the subroutine farm, visualization of the change of the farm configuration at the load level at the limit state level was performed (Fig. 11). In the color image of the picture is markedly the area of the lower belt with maximum tensile stresses. This area is located in the central part of the belt between the far farm nodes. Such stress distribution is also revealed in the stress diagram given in Pic. 11.

Visualization according to fig. Fig. 11 gives an opportunity to detect the level of stresses in all elements of the farm, not just the lower belt, which is the main focus of the previous diagrams. Such information is useful for choosing options for reinforcing a welded farm.

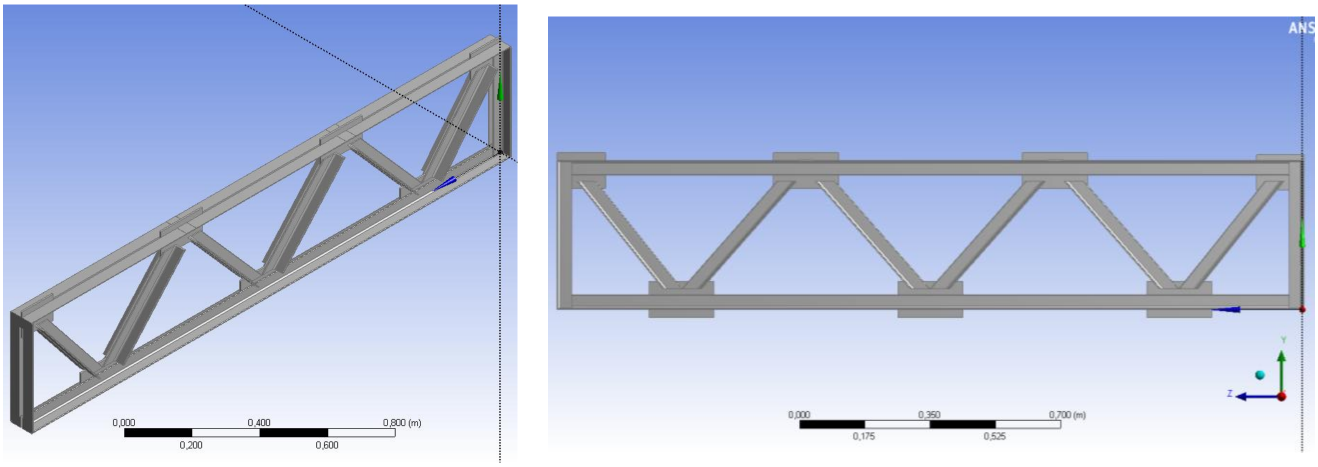
Loss of farm rigidity 2000 × 400 mm from twin angles of profile 40 × 40 × 4 mm with kerchiefs and rectangular cutting of the brakes according to the results of a computer simulation experiment occurred at loading Pmax = 215 kN, and plastic deformation of the structure on the results of calculations occurred at the external at the level of 190 kN.



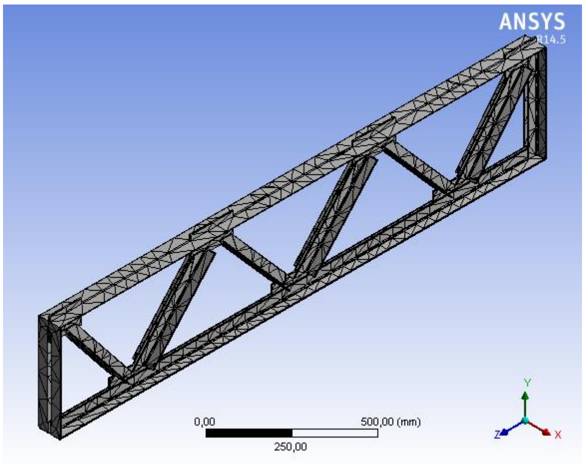
Picture 11 - Welding farm deformation diagram obtained by a computer simulation experiment at the level of the design limit state

Investigation of the stress-strain state of a physical model of a welded farm with pigtails and crosscutting of braces at static loads by a computer simulation experiment

The ANSYS Workbench 14.5 software package performs a computer simulation experiment, which involves the detection of indices of the stress-strain state of a physical model of a 2000x400 mm welded truss. (Pic. 12). Its difference from the previous designs consists in the implementation of knots with braids and crosscutting of slanting angles. The direction of cutting angles parallel to the belts of the farm



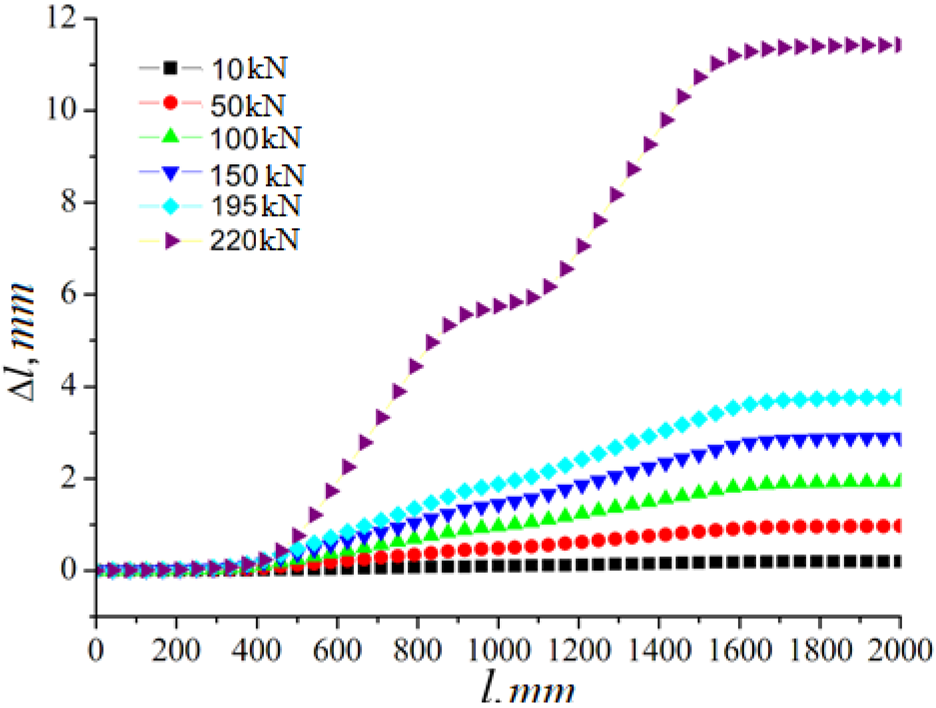
a)



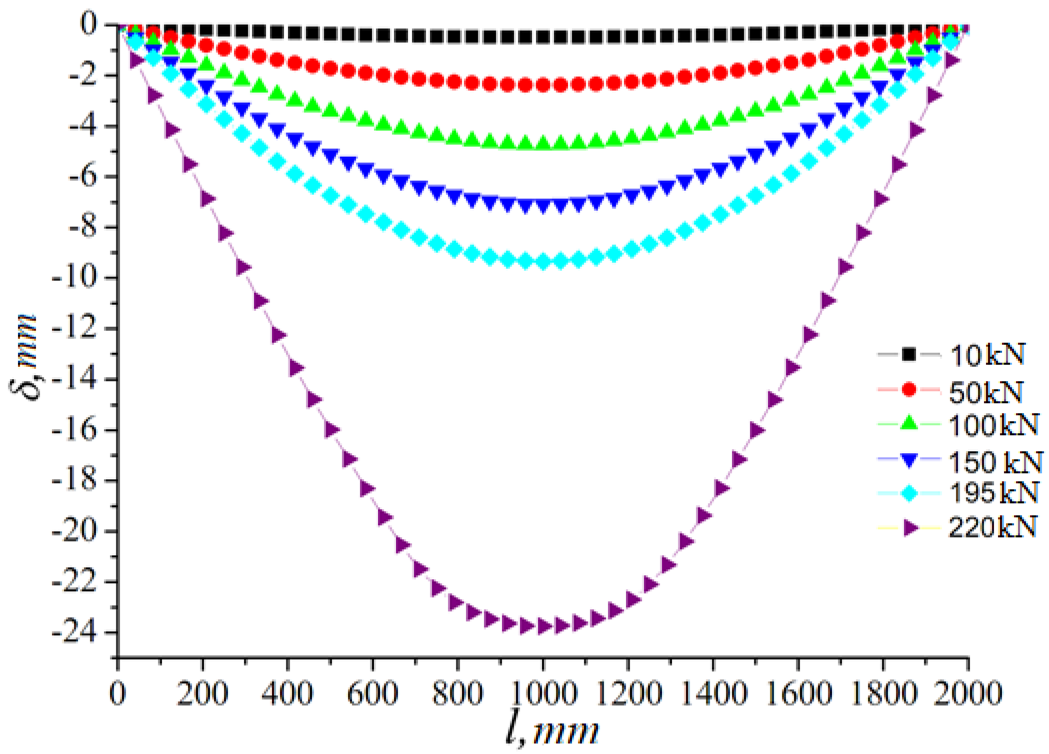
b)

Picture 12 - Farm with dimensions 2000 × 400 mm: a) CAD - geometric model; b) CAE is a finite element grid model.

According to the results of computer simulation experiment, we obtained the value of longitudinal deformation and deflection of the lower belt of the farm, as well as the stress in it under the influence of specific loads both graphically (Pic. 13… 15) and in numerical (Table 3).



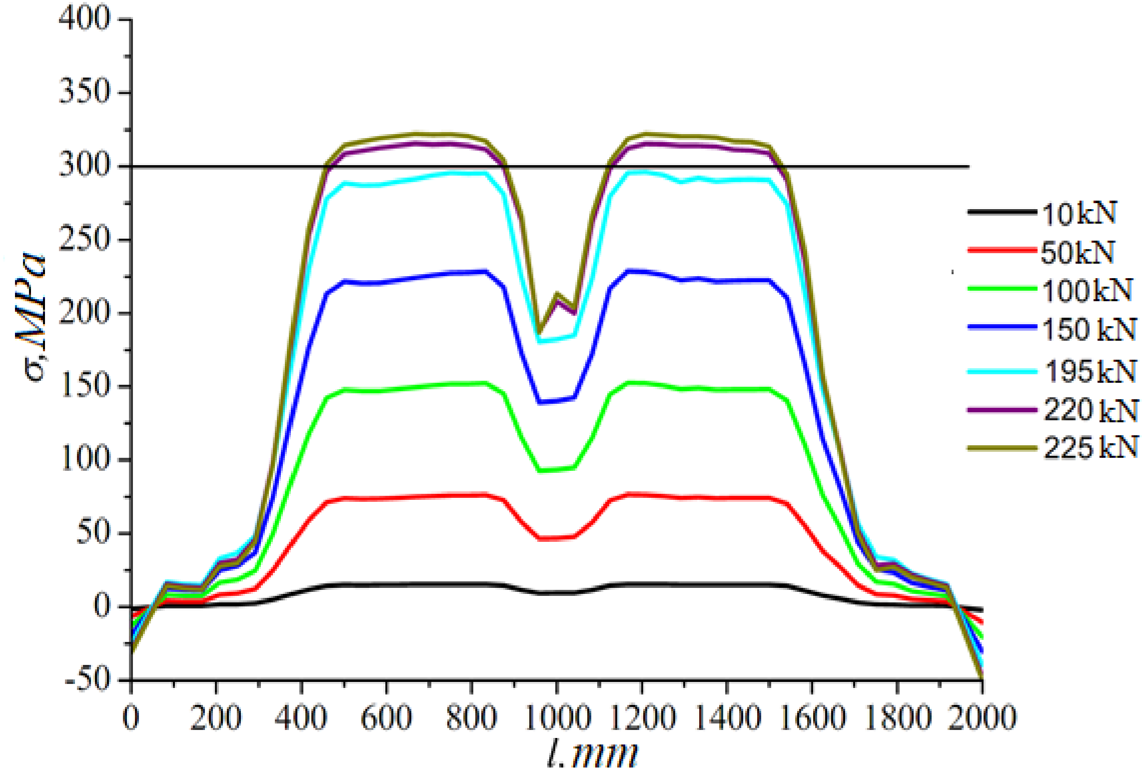
Picture 13 - Diagram of elongation of the lower belt of the farm at different load levels



Picture 14 - Bending curve of the farm's lower belt at different load levels

In both diagrams, the limiting load of 195 kN is evident, after which intensive plastic deformation, which is incompatible with the structural durability, begins.

Such a permissible load level can also be determined by the diagram of stresses along the lower belt of the farm with different efforts (Pic. 15).



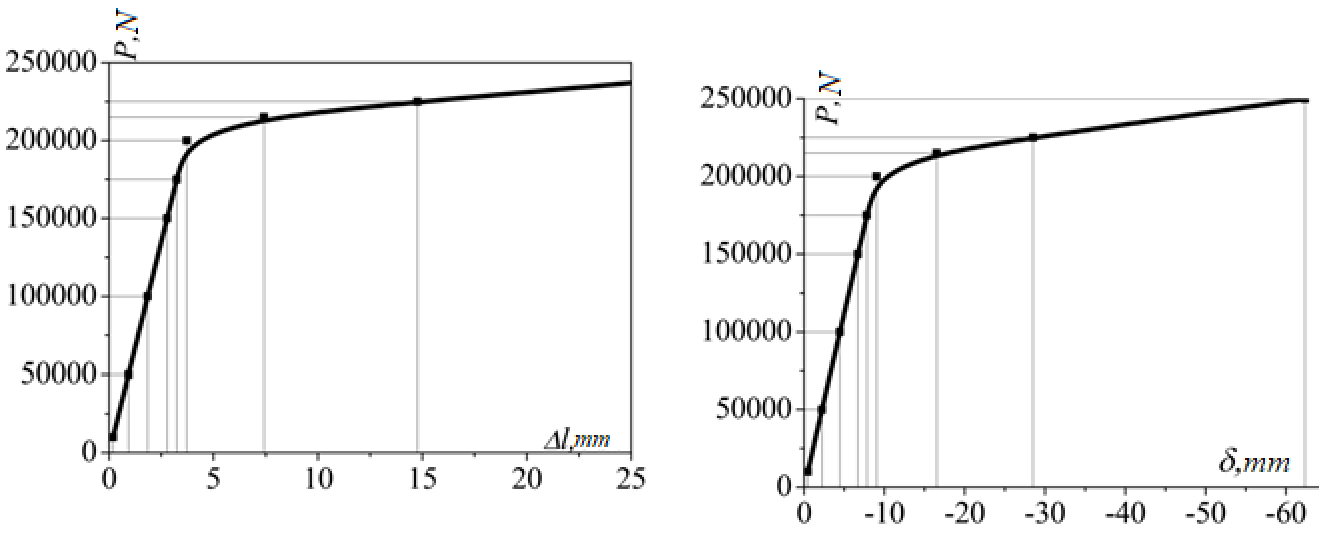
Picture 15 - Diagram of stresses along the lower farm belt under different load levels

It is these loads that most closely approximate the stresses in the lower belt structure to the maximum permissible, not exceeding them.

The obtained numerical parameters of the SSS in the elements of the welded truss, depending on the load level are summarized in Table. 3. On the basis of these indicators the diagrams of deformation of the physical model of the welded truss were constructed for maximum elongations and deflections of the lower belt of the truss.

Table 3 - SSS parameters of a lower welded farm belt with kerchiefs and cross-cutting of beveled angles obtained by a computer simulation experiment

№	Load P, N	Tension σ, MPa	Elongation, lower belt Δl, mm	Bend of the lower belt δ_{estim}, mm
1	10000	15,636	0,19723	-0,48419
2	50000	76,967	0,9675	-2,3717
3	100000	153,63	1,9304	-4,7314
4	150000	230,3	2,8942	-7,0942
5	195000	291,17	3,775	-9,3446
6	200000	302,41	3,8914	-9,6923
7	220000	319,12	11,43	-23,753
8	225000	321,12	15,404	-30,226



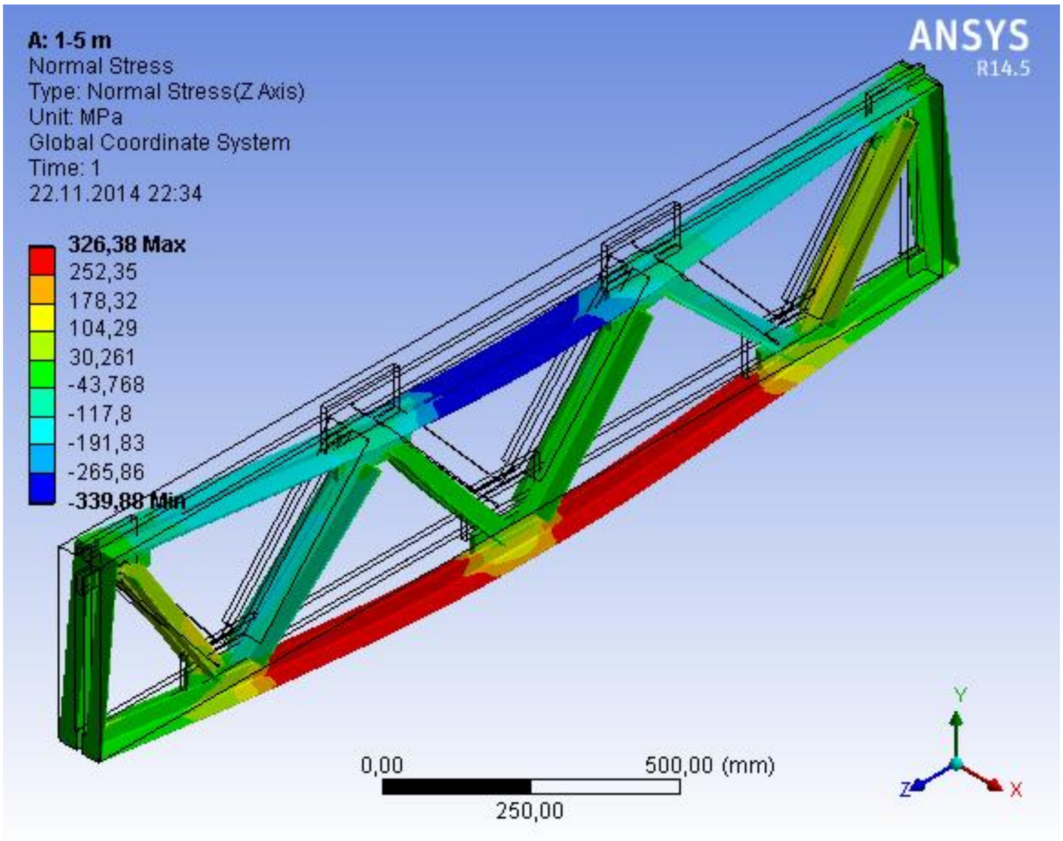
a) b)

Picture 16 - Diagrams of deformation of the physical model of the welded farm:

a) maximum elongation of the lower belt of the farm;

b) maximum deflections of the lower belt of the farm

The behavior of the welded farm at loads at the limit state level is visualized (Pic. 17). Visualization revealed that the highest tensile stresses occur in the lower truss belt between the middle node and the two adjacent nodes.



Picture 17 - Weld farm deformation diagram obtained by a computer simulation experiment at loads at the limit state

So the loss of trussiness of the farm size 2000 × 400 mm from the paired angles of profile 40 × 40 × 4 mm with kerchiefs and crosscutting of the beams according to the results of a computer modeling experiment came at a load P_{max} = 220 kN, and plastic deformation of the structure according to the results of calculations already occurred at efforts of 195 kN.

Chapter 5

Labor and environment protection

1. Introduction

Tasks in the field of labor protection:

Labor protection in construction is a system of interrelated legislative, socio-economic, technical, hygienic and organizational measures aimed at protecting people's health from industrial hazards and accidents and providing the most favorable conditions conducive to higher labor productivity and quality of work. Labor protection sets the task - to minimize the likelihood of injury or illness working with simultaneous provision of comfort with maximum labor productivity.

The discipline "Labor protection in construction" is an applied technical science that studies and identifies production hazards and hazards, develops methods for preventing or reducing them with the aim of eliminating accidents at work, occupational diseases, accidents and fires.

The main object of her research is the person in the process of labor, the working environment and the environment, the relationship of a person with industrial equipment, technical processes, the organization of labor and production, she develops a system of measures that constantly raise the level of labor safety in construction.

The current system of labor protection (labor legislation, industrial sanitation and safety engineering) ensures proper working conditions for construction workers, raising the production culture, safety of work and their relief, which contributes to higher labor productivity. The creation of safe working conditions in construction is closely related to technology and the organization of production.

The organization and execution of works in the construction industry is carried out under the observance of the legislation of the Russian Federation on labor protection, as well as other norms containing state regulatory requirements for labor protection:

- building codes and codes of rules for design and construction;
- intersectoral and industry rules and standard instructions on labor protection;
- safety rules, rules for the device and safe operation, safety instructions;
- state sanitary and epidemiological rules and standards, hygienic standards, sanitary rules and norms.

Responsibility for the safety of work is entrusted in legislation to technical managers of construction sites - chief engineers and engineers for labor protection, foremen and foremen. Construction supervisors are obliged to organize planning of measures for labor protection and fire prevention measures, as well as to ensure the implementation of these activities within the established deadlines. compliance with labor protection regulations, implementation of safety and industrial sanitation measures;

- - development of long-term plans and agreements of collective agreements for the improvement and improvement of working conditions;
- - provision of workers with overalls, special footwear, personal protective equipment;
- - conduct of briefings and training of workers in safety regulations;
- - organization of propaganda of safe labor methods, provision of building objects with posters, warning inscriptions, etc .;
- - organization of training and annual testing of knowledge, rules and norms of labor protection of engineering and technical personnel;
- - medical examinations of persons engaged in work with increased danger and harmful conditions;
- - investigation of all accidents and occupational diseases that occurred in the workplace, as well as their accounting and analysis
- - maintenance of documentation and verification of established reporting on labor protection; the publication of orders and orders on labor protection issues.

The admission to work of newly accepted workers is carried out after passing by them the general instruction on safety precautions, and also instructing directly on the workplace. A worker's knowledge of safety is checked annually.

All measures for labor protection are carried out under direct state supervision of special authorized inspections (sanitary, technical, fire, labor, etc.).

1.2 A common part

The organization of a construction site, participants in work and workplaces should ensure the safety of workers at all stages of work. Activities that are carried out for this purpose:

The building site must be fenced (wooden), $h_з$ = 2м (GOST 23407-78); to establish the gate for entry, exit and mark the signs on the territory, set the sign of the speed limit of vehicles V = up to 5 km / h. To establish the scheme of traffic of cars on a construction site.

The storage areas should be leveled out temporarily and carefully (with a slope of up to 5%). Storing of structures to produce in full accordance with the construction plan. Between the stacks of structures leave the walkways at 1 m.

It is not allowed to lean materials or structures against the fence and elements of temporary and capital structures.

The boundaries of hazardous areas are located at a distance:

- 5 m from the building under construction;
- 7 m from the places of movement of goods;
- 1.5 m of non-insulated electrical installation parts.

All danger zones should be marked with appropriate signs, signs. Ensure uniform lighting of the construction site, passageways, passageways in the dark. Zagorazhivat passages and driveways are not allowed.

According to the degree of fire resistance, the building belongs to the third degree. The building is not considered to be an explosive hazard category. According to the functional fire hazard the building belongs to the class Φ1.4.

Some issues of labor protection are considered in the architectural, design, technological and organizational-economic parts of the project.

In the architectural part the following issues are solved:

- the location of the building, taking into account the normalized values of aeration, insolation of the internal space;
- necessary for the norms of thermal insulation of the building envelope;
- Ensuring the stability and spatial rigidity of the building by creating rigid frames in the transverse and longitudinal direction (interconnected, overlapped in the bearing walls).
- on the master plan, the issue of landscaping and improvement of the territory was solved, fire trucks were provided to the building.

In the computational-structural part, the elements are calculated and satisfy the strength and deformability conditions for the I and II groups of limiting states.

The technological part reflects the safety issues in the installation of masonry and installation work and in the work on the construction of the roof. The consistency of the installation ensures the stability of the structure of the building.

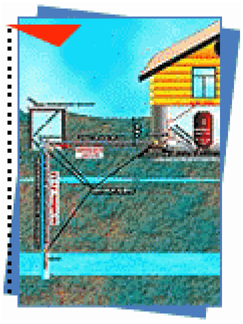
In the organizational and economic part of the construction plan, inventory buildings are taken, open warehouses are calculated, the calculation of the illumination of the construction site is given.

1.3 Measures for engineering support of the building.

Due to the fact that the projected building is a manor located far from populated areas with a centralized water supply, sewerage and heating system, the task is to select and design the engineering support of the building.

1.4 Designing and installation of water supply system.

Criteria for selection of the pump



The source of water for the water supply system on the estate can be Well, well, or other source from which the liquid is fed by a pump. In our concrete project it is proposed to use a well.

There are several basic diagrams of water supply systems for cottages using pumps. The most popular are two of them.

The first, the so-called "dacha" scheme, presupposes the installation above the highest point of water extraction of an unpressurized storage tank equipped with a level sensor. The sensor controls the pump that automatically replenishes the tank as the water is consumed. For the operation of such a system it is sufficient that the pump has a head at least slightly exceeding the head of the vertical column of water between the upper level in the tank and the level at the source. At the same time, the feed parameter is practically insignificant. Such a scheme has a number of significant drawbacks. Here are the main:

• the presence of a large container at the top, occupying space, requiring insulation, ventilation;

• the need for regular cleaning;

• stagnation of water, as a result of which harmful microorganisms reproduce in humans;

• weak pressure;

• difficulties with water treatment due to insufficient pressure to overcome the resistance of the filter;

• Pile-up of pipelines and extra costs for the installation of pipelines, which usually exceed the cost of a powerful pump;

• inconvenient location of water heaters.

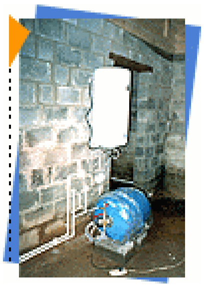
This option will not be considered in the future because of its defectiveness. The most popular scheme in modern cottages is the AC AS system consisting of:

• a sufficiently powerful pump capable of providing the necessary head pressure at the end points of the water distribution;

• control devices for this pressure and pump control - in most cases this is a two-threshold pressure switch;

• Pressure stabilization devices - accumulator;

• pump protection devices - often combined with the above.



It is recommended to choose a pumping unit with a capacity equal to or greater than the maximum one-time and hourly flow.

Pumps differ in several types: submersible centrifugal, submersible vortex, submersible membrane, surface suction and surface ejector.

The most unpretentious are submersible pumps. When the vortex pump is operating, it is possible to include sand and dirt in the initial water. Centrifugal pumps can be lowered to almost any depth, up to three hundred meters or more. Vortices can descend to fifty meters. Membrane pumps are characterized by low productivity and fall to a depth of up to twenty meters. Surface suction can not lift water from a depth of more than nine

meters due to the appearance of a vacuum. Ejector pumps work at a depth of up to fifty meters, but are whimsical, both in work, and in maintenance and installation, so they have a relatively low price. These are the so-called "stations", consisting of a hydraulic accumulator (receiver) with a pump attached on top.

As a rule, a hydraulic accumulator is installed after the pump. This is a membrane expansion tank to compensate for hydraulic shocks that occur when the shut-off and start-up automatics are triggered and to avoid unnecessarily frequent pump starts that reduce their lifespan and lead to over-consumption of electricity.

At zero water leveling in a tank the certain volume of water is stored. At the same time, the pressurized gas located on the other side of the membrane maintains a pressure in the system that does not exceed the cut-off threshold of the pump, but not below the switching threshold. A small amount of water is compensated for by the contents of the tank, and the pressure in the system gradually decreases until it reaches the pump start threshold. After it is switched on, due to the elasticity of the gas, the pressure also starts to increase smoothly until it reaches the pump cutoff threshold. In this way, hydraulic shocks destructive for the system and, in general, sudden pressure fluctuations that cause the jet to "beat" at the outlet from the point of draw-off are prevented. In autonomous water supply systems, an important role is played by devices such as a pressure switch, a dry current sensor, a float switch and a thermostatic mixing valve. Pressure switch - a device designed to automate the on / off of the water supply pump, depending on the decrease / increase of pressure.

The pressure switch has a built-in diaphragm that moves the contacts of the pump supply or shunt lines of the pump motor depending on the pressure change.

The hydraulic accumulator in this system performs several functions: compensates for the hydraulic shock at the moment of starting the pump (the timing of engine starts is excluded, the sharp "spittles" are excluded from the tap); provides a supply of water during a power outage; provides a time delay between opening / closing the crane and starting / stopping the pump (the number of engine starts is limited); keeps the pressure in the water pipe while the pump is not working.

The dry current sensor is a device designed to shut off the pump in case of complete emptying of the water source (well, well, reservoir).

The dry current sensor has a built-in diaphragm that opens the contacts of the supply or shunt motor connection lines when the water in the water pipe is gone.

An analogue to the function of the dry current sensor is a float switch - a device designed to automate the on / off of the pump, depending on the lowering / rising of the water level in the tank (well, tank, drainage system, etc.). With the help of the float switch it is possible to provide protection against dry running of the pump, automatic filling or emptying of various containers. The float switch closes / opens the contacts of the supply or shunt motor connection lines when the set water level is reached.

Thermostatic mixing valve with burn protection is designed for temperature regulation on hot water supply devices and for local adjustment in the area adjacent to the points of local water distribution. The thermostatic mixing valve works as follows: a highsensitivity thermal element located at the outlet of the valve controls a plug that regulates the ratio of the cold and hot water flows in accordance with the selected temperature control of the mixed hot water.

If the pressure in the network can become too high for the system or individual devices, the pressure reduction valves should be used. The purpose of the pressure reduction valves is to reduce the pressure of the incoming flow to the outlet pressure set for this case and to maintain this value continuously regardless of the flow rate.

Hot water supply

SNIP recommend that for centralized DHW systems with autonomous heat sources the temperature should not exceed 50 ° C. According to European standards, the water temperature in the DHW system is assumed to be 46 ° C.

In systems where the total length of the pipeline from the water heater to entering the bathroom does not exceed 10 m, DHW circulation is not provided. For longer distances, it should be borne in mind that heat losses in metal-plastic pipes are many times less than in steel pipelines. Experience shows that in cottages with a total area of up to 600 m2, and with a water level of no more than three, which is the projected building, DHW circulation is not required.

To heat water, many heating devices are used, such as flow and storage water heaters.

A flow-through water heater heats the water only at the time of consumption, and this is the most economical approach in terms of fuel consumption, because heat is consumed only to the extent that it is consumed. This category includes gas columns, electric heaters, plate heat exchangers.

Flowing water heaters have the additional advantage that the heating of water is carried out immediately, in full and for as long as it is necessary without reducing the productivity.

The storage water heater (boiler) differs from flowing with a large volume of water stored inside it. Heating the water to the set temperature in this case occurs in advance and, as a rule, using relatively low power. Hot water is constantly present in the boiler, and as it is consumed it enters a cold water and is heated to the desired temperature. Heat insulation is used to prevent heat loss through the boiler body.

In cases where a storage water heater is installed to compensate for the thermal expansion of water during heating, it is necessary to install an expansion diaphragm tank.

To ensure heating in the projected building, a heating device will also be used, and it will be economical to propose to combine the functions of hot water heating and heating in a single heating device.

1.5 Warming of external pipelines

To ensure protection against possible condensation or possible corrosion effects within the floor or concrete, in order to acoustically isolate the flow noise, as well as the temperature effect on the finish, the pipes operating in both cold and hot temperature conditions must be laid in insulation from foamed polyethylene . The thickness of the insulation supplied by the manufacturer is 4 or 9 mm.

1.6 Water purification systems

In centralized urban water supply systems, there are water purification systems that ensure the removal of harmful impurities from water and its chlorination, which ensures that the water from the faucet is not contaminated with microorganisms. In autonomous systems, due to the high content of impurities, in particular iron, hardness salts, and also bacteria that can exist not only in cold but also in hot water, plumbing is out of order, hot water circuits, boilers and boilers are quickly clogged, and water has a yellowish tinge, an unpleasant aftertaste and a smell. To prevent this, a filter system is put.

The best option is a preliminary chemical analysis of the composition of the water from the well, from which the intake for the water supply is carried out. It is better to produce it in a specialized firm, which besides the analysis offers the selection and installation of equipment for water treatment. The results of the analysis are compared with GOST and a conclusion is made about the quality of water. If the content of any impurities exceeds the permissible standards, a filter is selected and removed.

1.7 Designing and installation of sewerage system.

Autonomous sewage systems serve a single-family dwelling in urban or rural areas or an estate with outbuildings. To an autonomous sewage system should be attributed all the facilities of water disposal and treatment of domestic wastewater, which have after

release from the house.

A secondary sewerage systems have a number of advantages over centralized (for the whole settlement) sewage systems:

• the possibility of short-term implementation, regardless of the construction of other facilities;

• low initial costs;

• simplification of the solution of all issues of construction and operation, due to their concentration in the hands of one owner.

Autonomous systems on the principle of wastewater treatment are divided into the following types:

• Pre-treatment of sewage and treatment of sludge:

◦ septic tank;

◦ two-level settling tanks; anaerobic bioreactors with a nozzle;

• facilities for biological treatment of wastewater of underground filtration:

◦ with the diversion of treated sewage into the pond: sand and gravel filters, trench filters;

◦ with waste water discharge into the ground: filtering wells, underground filtration fields, filter cassettes;

◦ biological wastewater treatment plants under natural conditions (bioproducts);

• Biological wastewater treatment plants with activated sludge and biofilm attached to the nozzle:

◦ aerotanks with activated silt, aeration tanks combined with activated sludge and packing, aerobic bioreactors with a nozzle;

◦ biofilters;

◦ constructions are used with secondary settling tanks;

• construction of physico-chemical and biological-chemical wastewater treatment (use of chemical reagents at different stages of wastewater treatment).

In addition, various auxiliary facilities can be used to support the operation of these systems: pumping installations for supplying sewage for cleaning, distribution chambers, pumping systems for discharging treated effluents, metering wells, etc. All these facilities can be subdivided according to the construction principle into on-site facilities and installations factory-made.

The choice of the optimal, for the specific construction conditions, of the autonomous system depends on a number of factors:

• type of soil in the construction site;

• the level of groundwater;

• the nature of the use of the upper aquifer that comes into contact with wastewater absorbed by the soil;

• availability and degree of accessibility of the reservoir of the waste water;

• the available area of the site for construction and its relief;

• climatic conditions of construction;

• financial capabilities of the customer;

• Requirements for the degree of wastewater treatment by local environmental authorities and the State Sanitary and Epidemiological Supervision Service.

1.8 Sewage draining system in the ground

The most economical and easy to implement is an autonomous sewage system based on underground filtration facilities with waste water draining into the ground. The possibility of its application depends on the filtering properties of the soil and the level of groundwater. Such a system consists of a septic tank and the construction of an underground filtration: for sandy and sandy loamy soil - a filter well or underground filtration fields; for light loamy soils - a filter cassette. At the same time, the groundwater table must be at least 1 m deeper than the bottom of the structure (filter well and cassette) or the irrigation pipe tray (underground filtration fields).

Usually, the upper aquifer is not used for drinking water supply. However, it can have a message through sections with filtering grounds with lower aquifers protected by watertight roofs (clay soils) that are used for drinking water supply: shaft and tubular (wells) wells. Establishment of such a connection can only be done with hydrogeological research, which is available only to a limited number of homeowners.

1.9 Filtration systems with water withdrawal into the reservoir

To facilities of underground filtration with the removal of treated sewage in the reservoir, the requirements for the degree of purification are required, corresponding to the "Rules for the Protection of Surface Water from Pollution", "Sanitary Rules and

Standards for the Protection of Surface Waters from Pollution" (SanPiN 4630-88), and the "Generalized List maximum allowable concentrations (MPC) and roughly safe levels of exposure (OBUV) of hazardous substances for water in fishery water bodies. "

Since in autonomous sewerage systems it is a question of household wastewater, the composition and calculated concentration of contaminants in them are determined in accordance with SNiP 2.04.03-85., Table 25 and SNiP 2.04.01-85, Appendix 3. It should be borne in mind that in The process of biological purification, which takes place in underground filtration facilities, also releases nitrogen of ammonium salts contained in domestic sewage, oxidizing, mainly to nitrogen of nitrites and nitrates, which is also limited by discharge into water bodies. The maximum permissible concentrations of contaminants in water in fishery water bodies (most of them include water bodies) are:

• BOD - 3 mg / l;

• Suspended substances - increase due to wastewater discharge by no more than 0.25 mg / l;

• nitrogen of ammonium salts - 0.4 mg / l;

• nitrogen of nitrites - 0,02 mg / l;

• nitrogen of nitrates - 9 mg / l;

• phosphates (by P2O5) - 0.5 mg / l;

• surfactants - 0.1 mg / l.

These concentrations should not be exceeded after mixing wastewater with water in the reservoir. In practice, many reservoirs are polluted and the already existing ("background") concentrations of contaminants in their water are equal to or above MAC. In this case, the concentration of pollutants in treated wastewater should not be higher than the maximum permissible concentration of river water

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<u>1.10 Purification systems with a sand filter</u>

If the soil on the site is impenetrable and groundwater is very high, then, on the one hand, it turns out that sewage can not pass through the soil for final cleaning. On the other hand, the distance between the drainage pipe and the groundwater mirror must be at least 1.5 m. This is a guarantee that the sewage entering the groundwater will be completely cleaned. In this case, it is necessary to raise the drainage so as to obtain at least 1.1 m of the filter bed and at the same time provide the required distance to the groundwater. A mound is needed in which the drainage along with the wells is laid. Sewage in this case is pumped from the settler into the system by means of pumps.

The sand filter is designed for heavy loads and can successfully replace low-capacity ground drainage, and also be used instead of it in case of complex hydro-geological conditions. It is like a layered pie with a filling of drainage pipes in two floors. With the filter device, a layer of natural soil is removed and sand with gravel is put in place. Sewage from the pipes of the upper floor pass the filter, and already cleaned out through the drainage of the lower floor into the receiving well. From here the pump drives the purified water into a ditch.

1.11 Purification systems using a biological filter

The option of using a biological filter is possible. Biological filter is convenient in many respects. It can be used not only in the case of a high level of groundwater and clay soils, but also in the absence of space for cumbersome drainage treatment systems. The biological filter is compact and can be placed in a reservoir, the construction of which resembles a septic tank. The principle of operation is based on the already known scheme of cleaning under aerobic conditions.

The capacity of the biofilter is filled with a so-called charge (a porous light material), as which each firm uses something of its own. Usually used keramzit, pozzolan (volcanic rock), coke and even fringed kapron cords. This is both a filter and a haven for aerobic microorganisms. Sewage, previously cleaned in a septic tank, is evenly distributed on the loading surface and passes, filtering, to the bottom. Purified water is collected in a receiving well, from which the pump is discharged into a ditch.

If the contaminated expanded clay is to be replaced, the pozzolana and strips of capron after cleaning the clogged pores restore the filtering properties.

The pre-cleaning container can consist of one, two or three chambers. It is called in different ways: a septic tank, a separator and even a reactor.

To activate the decomposition of organic substances in the initial stage of sewage treatment, biological additives are often used. These are specially selected stamps of anaerobic bacteria. Their use makes it possible to achieve an almost complete disintegration of organic contaminants into gases, substances dissolved in water, and an insoluble precipitate; It is less necessary to call a sewage machine to clean these systems.

Ideal when the cleaning process goes by itself, without the use of compressors for ventilation and pumps for pumping sewage. Therefore, a huge role is played by the fact that the sewers are arranged in the mansion itself. It is the level (in terms of height) of the outlet of sewage from the house that determines the depth of installation of the septic tank, and then drainage or biological filter, that is, the entire purification purpose. It is best when gravity flow of sewage is ensured.

We must not forget that the local cleaning station requires supervision and proper operation. It should be taken into account that the operation of the plants depends entirely on the viability of the bacteria. If they die, the normal operation of the system is disrupted. This can occur if toxic substances, such as active chlorine, contained in some kinds of bleaching, washing and disinfecting agents enter it.

An objective comparison of the treatment plants offered for sale is possible only if the project is received and the full estimated cost of the equipment, installation and other necessary work. For economic reasons, a variant of one local treatment plant for a group of neighboring areas is proposed. This option will reduce costs for both design and installation, as well as operation of the sewerage system.

Designing and installation of heating system.

1.12 Characteristics of heating systems

Heating systems solve only one of the tasks of creating an artificial indoor climate. They serve to maintain a specified temperature in the interior of buildings during the cold season.

The heating system is a complex of elements necessary for heating the premises. The main elements are sources of heat, heat pipes, heating appliances. Heat transfer is carried out with the help of heat carriers - heated water vapor or air. When determining the heat load of heating systems, special consideration is given to the thermal conditions of the premises.

Requirements for heating systems:

• Sanitary and hygienic. Heating systems must provide a specified air temperature inside the room, uniform in the volume of the working area of the room. The temperatures of the internal surfaces of the outer fences and heating appliances must be in the limits of the norm.

• Economic. Heating systems should provide a minimum of the given costs for construction and operation. Indicators of profitability are also the consumption of material, labor costs for manufacturing and installation. The economy of the system is determined by the technical and economic analysis of the variants of various systems and the equipment used.

• Construction. Heating systems must correspond to the architectural and planning solution of the premises. The location of the heating elements must be linked to the building structures.

• Mounting. Elements of heating systems should be manufactured mainly in the factory, the details are unified, labor costs are minimal.

• Operational. The heating system must be reliable in maintaining the specified air temperatures. Reliability of the system is determined by its durability, reliability, ease of control and repair. The system must be safe and quiet in operation. It should ensure the least contamination with harmful emissions of premises and atmospheric air.

1.13 Classification of heating systems

In the case of our projected building, we will use a local heating system due to the lack of a central source (boiler, CHP) near the cottage. Local systems include stove heating, gas heating (when burning fuel in a local device) and electric.

By type of coolant heating systems are divided into systems of water, gas, steam, air and electric heating.

In water and steam systems, the coolant-water or steam-is heated in a heat generator and transferred through pipelines to heating devices. In air systems, heated air enters directly into the room.

By the way the coolant is moved, central heating systems are divided into systems with natural circulation and systems with mechanical motivation (forced circulation).

When choosing a coolant, it is necessary to take into account sanitary and hygienic, technical, economic and operational indicators.

Water has a large heat capacity and density, which allows the transfer of large amounts of heat with a small volume of heat carrier. This ensures small pipe sizes and relatively low heat losses. Allowed by the sanitary and hygienic standards, the temperature of the heating devices is easily achieved, however, energy transfer requires energy expenditure.

Steam during condensation in heating appliances gives off a significant amount of heat due to the latent heat of vaporization. As a result, the mass of steam for a given heat load decreases compared to other heat carriers. However, steam as a heat carrier in heating systems is inferior to water, as the temperature of the devices will be above 100 ° C, which leads to the sublimation of organic dust settling on the instruments and to the release of harmful substances and unpleasant odors into the room, in addition, systems can be sources of noise, steam at low pressures (used in heating systems) has a significant specific volume, which leads to an increase in the cross-section of pipelines.

Experience in the operation of water systems showed their best hygienic and performance indicators. Water heating systems have the highest reliability, are silent, simple and convenient to use, can have a significant range of operation horizontally. Vertically, the range of the system is determined by the hydrostatic pressure. Electric heating by economic indicators is much inferior to water heating, which has now become the most widespread due to its advantages over other heating systems. This applies to the practice of low-rise construction, so we will focus on the option of water heating.

1.14 Radiator heating systems\

Water radiator heating has now become the most widespread. Experience in the operation of water radiator systems showed their high hygienic and operational performance. Radiator systems of water heating have high reliability, noiseless, simple and convenient to operate.

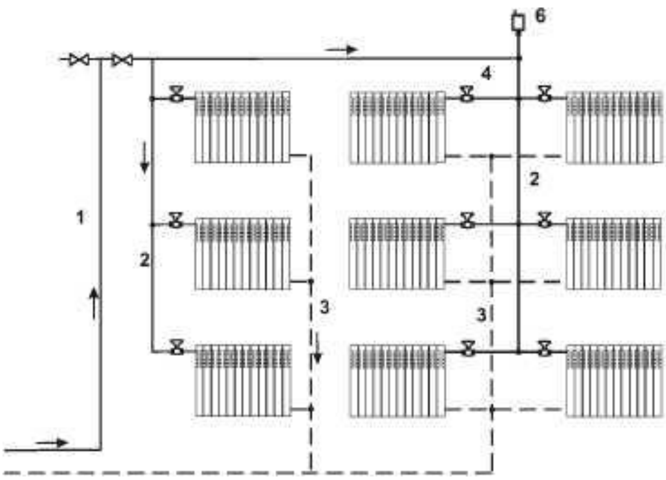
Systems of water heating radiators are classified according to several features. By the way of creating circulation, the water radiator systems are divided into systems with natural circulation (gravitational) and with artificial circulation (pumping). In systems with natural circulation, the movement of water is carried out due to the difference in the densities of the hot water entering the system and the cooled water after the heating devices. In systems with artificial circulation the movement of water occurs due to the pressure difference created by the pump.

Depending on the scheme of connection of pipes with heating appliances, water heating systems are divided into two-pipe and one-pipe systems. In a two-pipe system, each heating device is connected to two pipes: one is supplied with hot water, and the other leaves chilled water, while all the heating appliances are fundamentally parallel and equal in relation to each other. In single-tube heating systems, the heating devices of one branch are connected by one pipe so that the water flows sequentially from one device to another.

Depending on the location of the main pipelines, the systems are divided into systems with top wiring, if the hotline is laid above the heating devices, and systems with lower wiring, when the hot and return lines lie below the appliances.

By the arrangement of the pipes connecting the heating devices, the systems are divided into vertical ones, when the devices are connected to the vertical riser, and horizontal (Figure 5.6), when the devices are connected to horizontally located pipelines.

The figure shows the scheme of a vertical two-pipe heating system with an upper wiring with a one-way and two-way connection of heating appliances. Hot water from the heat point is fed to the main riser, then along the horizontal line it is diverted to the risers and from them to the heating devices. The cooled water from the heating devices is collected in a common return riser and then flows through the return line to the heat point. The horizontal lines are laid with a slope of 0002. The slopes of the horizontal pipes must ensure the air outlet from the system to the upper points, where it will be removed through the air vent.



1 - hot water main;

2 - risers of hot water;

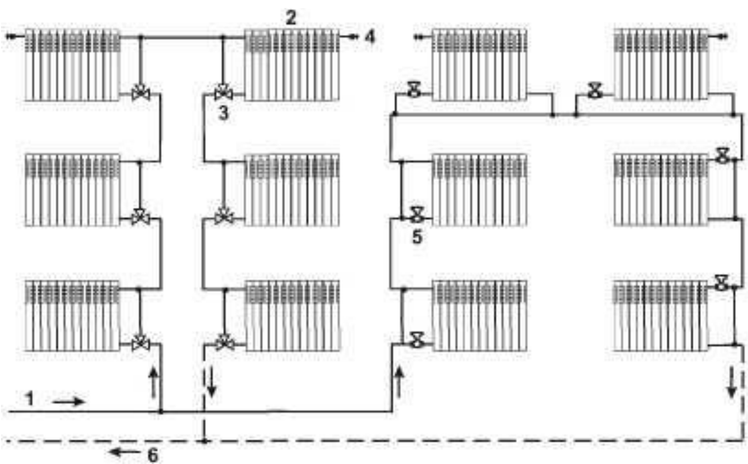
3 - risers of reverse water;

4 - cranes for appliances;

5 - heating devices;

6 - air outlet;

7 - return line.



In a system with a lower wiring, the backbone is located at the bottom of the system. Movement of water along the risers occurs from the top up. Removal of air from the system is carried out through air valves installed on top heating appliances, or by means of automatic air outlets installed on the risers or on special air lines.

This scheme is a single-tube heating system with a lower wiring and U-shaped risers.

1 - hot water main;

2 - heating device;

3 - a three-way tap;

4 - air outlet;

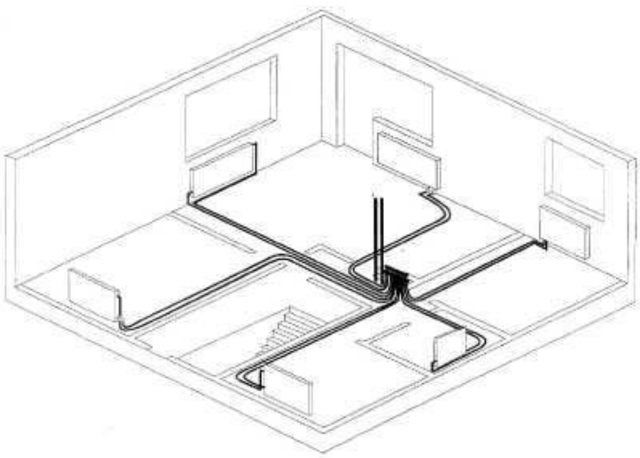
5 - control valve;

6 - return water main.

Single-pipe systems are currently used very widely, especially in high-rise buildings. In comparison with two-pipe systems, the pipe length of a single-pipe system is 70-75%. Single-pipe systems are made with upper and lower wiring. In addition, they are divided into three types, depending on the method of connecting the instruments: flow, flow with an unregulated bypass and flow with an adjustable bypass. Air is discharged at the upper points of the system through automatic air vent or hand cranes.

Horizontal schemes are used in buildings of a large extent. The horizontal circuits are laid in convenient places, usually in auxiliary rooms. Horizontal systems are single-tube and two-tube systems.

The diagram shows a horizontal two-pipe collector heating system.



Systems with artificial circulation can be performed according to several schemes, depending on the source of heat supply.

The design temperature of hot water in heating systems is assumed to be 95 ° C, the return water temperature is usually 70 ° C.

Widely used are the metal-plastic pipelines, which are most fully realized with the lower wiring, with the pipes, as a rule, hiding in the construction of the floor or skirting, which in this case perform protective and decorative functions.

When choosing a system scheme, preference is given to the collector floor wiring, as well as its combinations with a single-tube (less often two-pipe). It is practically mandatory to create forced circulation in the system, which is achieved by installing one or more circulating pumps. This makes it possible to reduce the temperature difference of the coolant at the inlet and outlet of the system network and thereby improve the efficiency and control of heating, as well as to avoid unnecessary material consumption, simplify the system, and make it more compact. When calculating heaters, it must be remembered that the use of decorative shields reduces the effective heat output by an average of 10%.

When installing the equipment of heating, water supply and sewerage systems in the premises, it is necessary to observe the correct positioning of the elements in the space. There are generally accepted norms regulating the appropriate size. It is preferable to follow them in all cases when special conditions are not specified in advance, usually associated with original design decisions or the customer's insistent desire.

The distribution cabinets of the heating system are usually located at the floor level of the corresponding floor (the lower edge) - except for the cabinet installed in the boiler room, which usually rises above the boiler level.

1.15 Features of the application of thermostatic valves.

Recently in Russia, automatic radiator heating systems (COPs) have been widely used, with the use of thermostatic valves.

The use of thermostatic devices is not a whim and a tribute to fashion. In addition to creating comfortable conditions, it is also a tangible saving in operating costs.

Thermostatic devices are installed in the heating system of the building directly on the heating device, or in front of it, on a pipe supplying the coolant into it. After installing the thermostats, there is no need to open the windows to regulate the temperature in the rooms. Thermostats will constantly maintain the set temperature with an accuracy of +/- 1 ° C.

Excluding the supply of "excessive" heat from the heater, the thermostat prevents the room from overheating, providing a comfortable temperature in the room. In the case of a cottage with an individual boiler, thermostats allow saving up to 40% of the energy consumed for heating buildings, ensuring a reduction in the consumption of energy consumed and thereby reducing environmental pollution.

Since the process of thermal control flows smoothly, without threshold switching on and off, the system becomes much more economical and regulates itself. At the same time, there is no need to equip boilers with expensive electronic control units, and the comfort of heating is incomparably better. There is an opportunity to arrange in each regulated zone its microclimate, as well as reduce energy consumption, by reducing the temperature in unused areas and optimizing the use of heat in the premises.

Since 01.17.1994, in Russia, the amendments to SNiP 2.04.07-86 * and SNiP 2.04.05-91 * have been put into effect in accordance with which design and construction organizations, when designing, should provide for the equipping of heating devices for water heating systems of buildings (excluding stairways cells, vestibules, transitions) by automatic temperature controllers.

1.16 Connection of heated towel rails

The principle of installation of heated towel rails depends on the type and design of the heating systems and on the availability of an individual heating unit or boiler house.

In cases where the heating system completely stops for the summer period, towel warmers are usually installed on a hot water recirculation system. In those cases where the heating system is in operation year-round, the floor heaters should be considered as specific radiators of bathrooms, so they are in most cases.

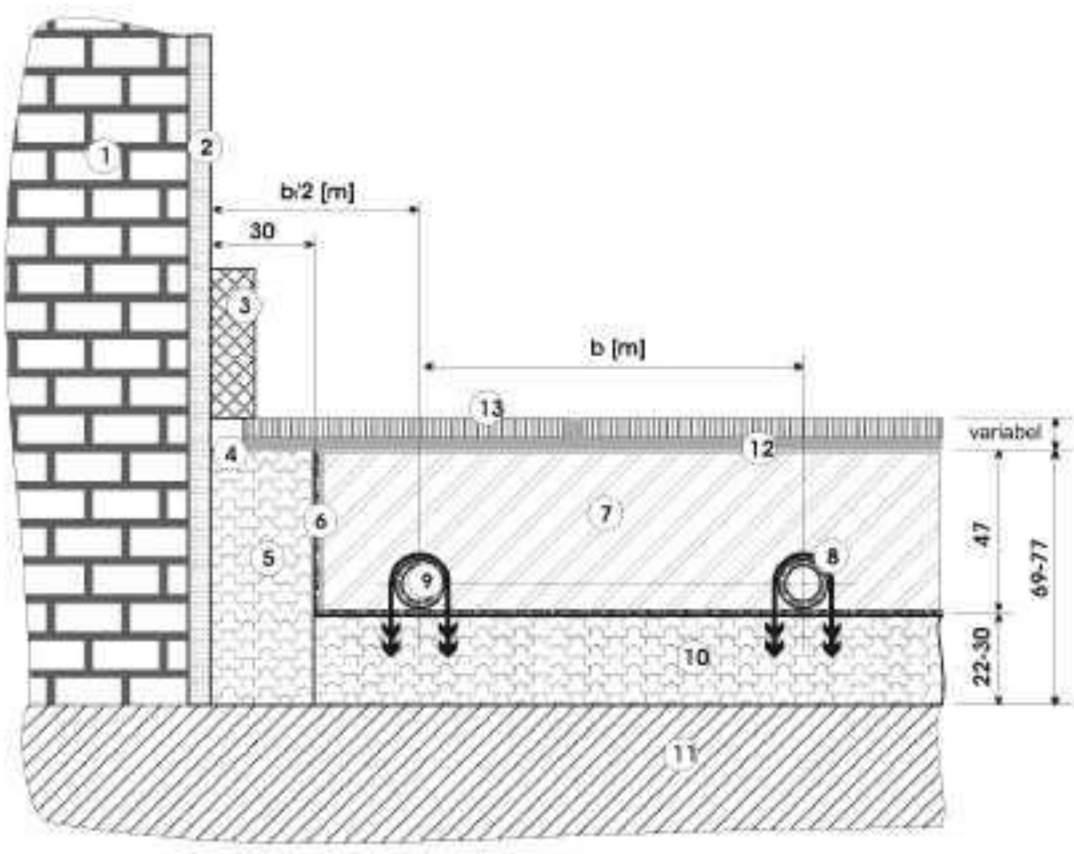
1.17 Floor heating systems

Heating systems pop (SOP) are rapidly developing in recent years and were able to win universal recognition as an ideal heating system.

The use of modern energy-saving technologies for heat production with the use of low-temperature heaters leads to appreciable energy savings. No other type of heating except floor heating is able to provide such a high level of comfort, aesthetics and energy savings combined with an almost unlimited lifespan. SOP in comparison with radiator or convector systems, allows to save from 25% to 40% of operating costs. The specific value depends on the design decisions of the house and the qualification of the designer.

On the basis of thermophysical studies of the human body, an ideal curve of the distribution of temperature over the height of the room was constructed, corresponding to the maximum thermal comfort. Comparison of the temperature distribution charts for different heating methods shows that the temperature graph of the heating systems in the floor most closely matches the ideal curve, as compared to other heating systems. An obvious advantage of heating the floor is the lack of visible heating devices, removing all sorts of restrictions from the style solutions of the interior.

The heating element in the heating system is the floor that is thermally isolated from the inefficient heat leakage (down and to the sides), usually a concrete plate heated by a coil in it, in which a hot heat carrier circulates.



The design of the floor heating in the section

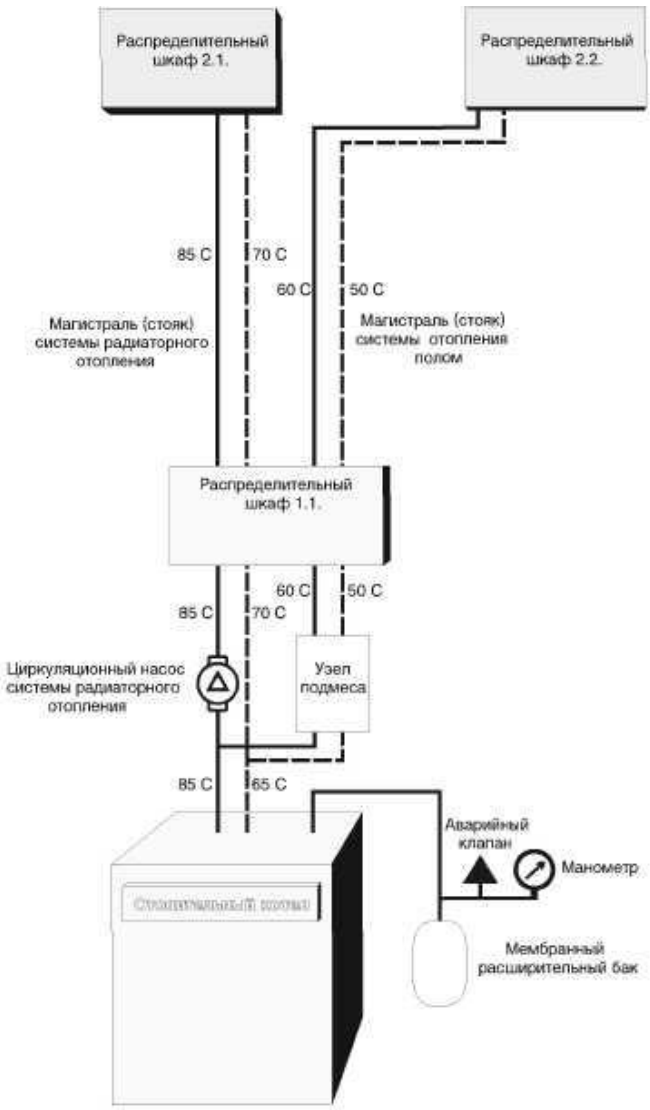
1. Wall
2. Plaster
3. Plinth
4. Elastic slit putty
5. Insulating plinth
6. Polyethylene film
7. Flooring
8. Anchor fasteners
9. Metal-Plastic Pipe 16x2
10. Heat insulating flooring
11. Bearing flooring
12. Mortar for thin flooring
13. Thin flooring (Coating)

The basis for any calculation of the heating system is the calculation of the heat losses of the room, performed in accordance with regulatory procedures. The basis for this calculation are: large-scale floor plans, vertical sections, data on materials used and building structures, data on the desired or corresponding SNiP indoor temperature and climatic zone in which the building is located, as well as on the availability and thermal power of additional and parasitic heat sources , if their influence is significant.

There are cases when in case of insufficient warming of the premises or a small effective area it turns out that floor heating can not completely cover all the heat losses, and additional heaters are required. Usually this is due to a violation of design or construction standards. In this situation, the floor heating system works in conjunction with other heat sources. It is possible to use the heating of walls and interior partitions, which allows achieving the desired result.

<u>1.18 Combined heating systems</u>

Depending on the design and design decisions of a particular building, the functional purpose of individual rooms, the types of heat consumers, the requirements for the level of comfort and simply the customer's desire in one common heating system of a building with an individual boiler room or a heat point, it may be necessary to combine independent heating circuits with different designs .....



The necessity of dividing the heating system into separate circuits with individual pumps and control automatics can arise for the following reasons: differences in the functional purpose and management principles, strong differences in the hydraulic parameters of these circuits, the need to maintain the temperature of the coolant individually, keep the circuit in operation while completely disconnecting the other, The additional contour can be determined by the fact that in separate rooms with the selected structure and heating the entire building can not achieve either the necessary level of comfort, or maintain the heat balance of the room, or the normalized temperature of the internal surfaces of external thermal fences. Such situations are often determined by the combination in one heating room of the floor and the heating by radiators.

As described in the previous chapters, floor heating is the most preferred type of room heating in all respects. However, not in all cases, specific rooms can only be heated with heating floors.

The need to create an additional heating circuit by radiators is determined by the fact that in individual rooms during floor heating it is impossible to keep the heat balance of the room or the normalized temperature of the internal surfaces of external thermal fences.

In some rooms, the useful area can be so small that even with the maximum permissible floor surface temperature, it is impossible to cover the heat loss of these rooms. Such a situation can arise in swimming pools, in rooms heavily crowded with stationary furniture, in rooms with very high ceiling heights, in rooms with solid glazing, etc.

1.19 Selection of boiler equipment.

The boiler output is selected taking into account all possible heat losses of the building. The boiler output is usually composed of a number of components:

• The power required to heat the building's premises and fully compensate for heat losses through the enclosing structures.

• The power required to heat the boiler room and compensate for heat loss on the mains, if the boiler is stand-alone.

• power consumed by heating hot water. It should be taken into account that the boiler does not heat hot water constantly, but as necessary.

• power consumed by other heat-consuming circuits, such as a pool heat exchanger, forced ventilation system, dehumidification, heating of greenhouses, etc.

It should be borne in mind that in the presence of a water heater connected to the boiler, which has the ability to heat domestic water in flow mode in a sufficiently large volume, the boiler output can not be less than, at least, the capacity of the water heater at the maximum flow rate. At that, for every 12 liters per minute with a water temperature difference of 35 ° C, the hot water circuit consumes approximately 20 kW. If the boiler power required for heating exceeds the needs of the water heater, then it is sufficient to select a boiler with a reserve equal to 50% of the capacity of the hot water circuit.

When choosing a boiler with a built-in hot water circuit, one should take into account the fact that the productivity of hot water is indicated from the calculation that all boiler output goes to heating of the domestic water. In this case, most often the automation is installed, so that when the hot water is consumed, the boiler for this time partially or completely stops working for heating. Wall-hung gas boilers have a similar design. If such a boiler is installed on a private house for one family, then the short-term consumption of hot water can not affect the temperature in the premises. However, if there is a significant need for the time of use of the water heating circuit, it may even require a twofold increase in the boiler output.

There are various types of fuel, such as electricity, diesel, solid fuel, gas, the cheapest type of fuel at the moment. Its use is most advantageous in spite of significant one-off costs for the supply. In a particular case of ours, we can not use gas because of the lack of a close source of the resource.

The use of plate heat exchangers for hot water is one of the most effective ways of preparing domestic hot water. The plate heat exchanger is an indirect heating device for domestic hot water of the flow type through the heating medium of the building's heating system.

On the face all the advantages of running water heating: a significant reduction in energy consumption, in contrast to storage type heaters; instantaneous heating of water in the required volume, as well as for as long as necessary; Insignificant sizes at very high power of heating; the possibility of working in combination with various heat sources.

When using plate heat exchangers with individual heating systems, it is necessary that these boilers have a certain internal volume according to the heat exchanger's power. Otherwise, frequent starts / stops of the boiler can occur in a very short period of time and sudden changes in the temperature of the hot water.

There is a clear relationship between the temperature of domestic water heating inside the boiler and the final performance of the hot water supply system. It means that at a higher water temperature you can get more water.

Almost all manufacturers of heating equipment represent the range of boilers with integrated hot water circuits. This solution saves space and money for the boiler house arrangement, and also in most cases allows the entire capacity of the boiler to be used to heat the domestic water.

1.20 Recommended project.

In general, for heating, water supply and sewerage systems for a projected building, this equipment and structure can be recommended.

1. General Provisions

The project of the heating, water supply and sewerage system of an individual residential building was made on the basis of architectural and construction drawings of the assignment.

The minimum design ambient air temperature is -26 ° C.

The nominal temperature of the air inside the heated rooms is + 18 ° C - + 22 ° C.

As a heat source, a universal two-circuit boiler CTC 1100 Maxi (77kW; 18kW electric batteries) was used for the B-20 liquid fuel.

Steel radiators "HENRAD" are used as heating devices.

All pipelines are made of metal-plastic pipes "HENCO".

The heating medium in the heating system is a low-freezing Argus-Haddip liquid with a temperature of + 85 ° C on the return line and + 70 ° C in the return heating system, respectively, in the heating system: + 60 ° C to + 50 ° C.

The circuit of the system allows automatic differential regulation and maintenance of the temperature by means of HERZ thermostats installed in each main room, as well as the general programming of the building's temperature regime using the electronic boiler controller.

2. Design features

The system is closed, with forced circulation.

The system provides the possibility of pouring through a drain cock on the boiler and makeup from the water pipe (thus automatically eliminating the possibility of liquid from the system into the water pipe).

The wiring is carried out according to a tree-like scheme (with a decrease in the diameter of the pipelines with successive branching).

The bottom piping to the radiators is used.

Horizontal sections of pipelines are laid in the construction of the floor.

Vertical and sloping sections of pipelines are laid in the construction of walls (in fines) or on walls (in this case the pipe should be fixed to the wall with the help of locks located at a distance of 0.4-1.0 m, depending on the diameter and location of the pipe)

3. Recommended installation sequence

Preparing the floor in rooms heated by the floor (finishing screed with a tolerance of no more than ± 5mm).

Preparation of niches for distribution cabinets, fines and openings in wall and ceiling structures.

Assembling the radiators.

Assemblage of distributive collectors.

Installation of distribution cabinets, laying of central highways.

Installation of radiators, installation of distribution manifolds in cabinets.
Laying and connection of radiator heating branches.

Installation of remote heating sensors floor.

Installation and connection of heating surfaces.

Installation and connection of the boiler.

Fill and start the system.

Checking the tightness and adjustment of the system (air removal, installation of manual adjustments).

Shutting down the system and filling the screeds of the heating planes (the coils must be cold and pressurized).

Installation of thermal heads on radiators (preferably after finishing the premises).4. Technical requirements

For horizontal sections of pipelines, bends ("waves") that are convex upwards (in order to avoid zvozdushivaniya) are inadmissible.

The horizontal sections of the connection to the coils of the heating planes of the floor must be located at the level of the coils themselves.

Each coil should be made from one pipe cut without articulations.

The maximum permissible radius of bending of pipes is not less than 5 diameters (when using bending springs - not less than 3). For H026 pipes, the corresponding figures are 8 and 4.

The contour of the heating plane should curve the protruding sewer pipes, attached to the "black" floor of the sanitary equipment support, and so on.

Capillary tubes of remote thermosensors should be isolated from heat sources (pipelines, heating planes, etc.).

At the intersections with walls and ceilings, pipelines must be protected by a corrugated plastic pipe.

Pipeline sections laid in cold floors (ground floor floors, floors above non-heated rooms, etc.), as well as passing through non-heated rooms, must be insulated to avoid excessive heat losses. Important areas are additionally indicated in the diagrams.

It is also necessary to insulate the central lines connecting the boiler with the distribution cabinets.

Distribution distributors of the lower floor should be located above the level of the circulation pump. The reverse slope of pipelines in the boiler-distributor section is inadmissible.

Safety part

PROFESSIONAL SAFETY

1.21. Effects of electromagnetic radiation on the human body

Introduction

A large body of literature exists on the response of tissues to electromagnetic fields, primarily in the extremely-low-frequency (ELF) and microwave-frequency ranges. In general, the reported effects of radiofrequency (RF) radiation on tissue and organ systems have been attributed to thermal interactions, although the existence of nonthermal effects at low field intensities is still a subject of active investigation. This chapter summarizes reported RF effects on major physiological systems and provides estimates of the threshold specific absorption rates (SARs) required to produce such effects. Organ and tissue responses to ELF fields and attempts to characterize field thresholds are also summarized. The relevance of these findings to the possible association of health effects with exposure to RF fields from GWEN antennas is assessed.

Nervous System

The effects of radiation on nervous tissues have been a subject of active investigation since changes in animal behavior and nerve electrical properties were first reported in the Soviet Union during the 1950s and 1960s.1 RF radiation is reported to affect isolated nerve preparations, the central nervous system, brain chemistry and histology, and the blood-brain barrier.

In studies with in vitro nerve preparations, changes have been observed in the firing rates of Aplysia neurons and in the refractory period of isolated frog sciatic nerves exposed to 2.45-GHz microwaves at SAR values exceeding 5 W/kg.2,3,4 Those effects were very likely associated with heating of the nerve preparations, in that much higher SAR values have not been found to produce changes in the electrical properties of isolated nerves when the temperature was

controlled.5, 6 Studies on isolated heart preparations have provided evidence of bradycardia as a result of exposure to RF radiation at nonthermal power densities,7 although some of the reported effects might have been artifacts caused by currents induced in the recording electrodes or by nonphysiological conditions in the bathing medium.8,9,10 Several groups of investigators have reported that nonthermal levels of RF fields can alter Ca2+ binding to the surfaces of nerve cells in isolated brain hemispheres and neuroblastoma cells cultured in vitro (reviewed by the World Health Organization11 and in Chapters 3 and 7 of this report). That phenomenon, however, is observed only when the RF field is amplitude-modulated at extremely low frequencies, the maximum effect occurs at a modulation frequency of 16 Hz. A similar effect has recently been reported in isolated frog hearts.12 The importance of changes in Ca2+ binding on the functional properties of nerve cells has not been established, and there is no clear evidence that the reported effect of low-intensity, amplitude-modulated RF fields poses a substantial health risk.

Results of in vivo studies of both pulsed and continuous-wave (CW) RF fields on brain electrical activity have indicated that transient effects can occur at SAR values exceeding 1 W/kg.13,14 Evidence has been presented that cholinergic activity of brain tissue is influenced by RF fields at SAR values as low as 0.45 W/kg.15 Exposure to nonthermal RF radiation has been reported to influence the electroencephalograms (EEGs) of cats when the field was amplitude-modulated at frequencies less than 25 Hz, which is the range of naturally occurring EEG frequencies.16 The rate of Ca2+ exchange from cat brain tissue in vivo was observed to change in response to similar irradiation conditions.17 Comparable effects on Ca2+ binding were not observed in rat cerebral tissue exposed to RF radiation,18 although the fields used were pulsed at EEG frequencies, rather than amplitude-modulated. As noted above, the physiological significance of small shifts in Ca2+ binding at nerve cell surfaces is unclear.

A wide variety of changes in brain chemistry and structure have been reported after exposure of animals to high-intensity RF fields.19 The changes include decreased concentrations of epinephrine, norepinephrine, dopamine, and 5-hydroxytryptamine; changes in axonal structure; a decreased number of Purkinje cells; and structural alterations in the hypothalamic region. Those effects have generally been associated with RF intensities that produced substantial local heating in the brain.

Extensive studies have been carried out to detect possible effects of RF radiation on the integrity of the blood-brain barrier.20,21 Although several reports have suggested that nonthermal RF radiation can influence the permeability of the blood-brain barrier, most of the experimental findings indicate that such effects result from local heating in the head in response to SAR values in excess of 2 W/kg. Changes in cerebral blood flow rate, rather than direct changes in permeability to tracer molecules, might also be incorrectly interpreted as changes in the properties of the blood-brain barrier.

Effects of pulsed and sinusoidal ELF fields on the electrical activity of the nervous system have also been studied extensively.22,23 In general, only high-intensity sinusoidal electric fields or rapidly pulsed magnetic fields induce sufficient current density in tissue (around 0.1-1.0 A/m2 or higher) to alter neuronal excitability and synaptic transmission or to produce neuromuscular stimulation. Somewhat lower thresholds have been observed for the induction of visual phosphenes (discussed in the next section) and for influencing the electrical activity of Aplysia pacemaker neurons when the frequency of the applied field matched the endogenous neuronal firing rate.24 Those effects, however, have been observed only with ELF frequencies and would not be expected to occur at the higher frequencies associated with GWEN transmitters. Recent studies with human volunteers exposed to 60-Hz electric and magn

Electromagnetic radiation can be classified into two types: ionizing radiation and non-ionizing radiation, based on the capability of a single photon with more than 10 eV energy to ionize oxygen or break chemical bonds. Ultraviolet and higher frequencies, such as X-rays or gamma rays are ionizing, and these pose their own special hazards: see radiation and radiation poisoning. By far the most common health hazard of radiation is sunburn, which causes over one million new skin cancers annually.

1.22 . Types of hazards

Electrical hazards

Very strong radiation can induce current capable of delivering an electric shock to persons or animals.[citation needed] It can also overload and destroy electrical equipment. The induction of currents by oscillating magnetic fields is also the way in which solar storms disrupt the operation of electrical and electronic systems, causing damage to and even the explosion of power distribution transformers,[2] blackouts (as occurred in 1989), and interference with electromagnetic signals (e.g. radio, TV, and telephone signals).

Fire hazards

Extremely high power electromagnetic radiation can cause electric currents strong enough to create sparks (electrical arcs) when an induced voltage exceeds the breakdown voltage of the surrounding medium (e.g. air at 3.0 MV/m). These sparks can then ignite flammable materials or gases, possibly leading to an explosion.

This can be a particular hazard in the vicinity of explosives or pyrotechnics, since an electrical overload might ignite them. This risk is commonly referred to as Hazards of Electromagnetic Radiation to Ordnance (HERO) by the United States Navy (USN). United States Military Standard 464A (MIL-STD-464A) mandates assessment of HERO in a system, but USN document OD 30393 provides design principles and practices for controlling electromagnetic hazards to ordnance.

On the other hand, the risk related to fueling is known as Hazards of Electromagnetic Radiation to Fuel (HERF). NAVSEA OP 3565 Vol. 1 could be used to evaluate HERF, which states a maximum power density of 0.09 W/m^2 for frequencies under 225 MHz (i.e. 4.2 meters for a 40 W emitter)

Biological hazards

See also: Mobile phone radiation and health § Non-thermal effects

The best understood biological effect of electromagnetic fields is to cause dielectric heating. For example, touching or standing around an antenna while a high-power transmitter is in operation can cause severe burns. These are exactly the kind of burns that would be caused inside a microwave oven.[citation needed]

This heating effect varies with the power and the frequency of the electromagnetic energy, as well as the distance to the source. A measure of the heating effect is the specific absorption rate or SAR, which has units of watts per kilogram (W/kg). The IEEE and many national governments have established safety limits for exposure to various frequencies of electromagnetic energy based on SAR, mainly based on ICNIRP Guidelines, which guard against thermal damage.

There are publications which support the existence of complex biological and neurological effects of weaker non-thermal electromagnetic fields , including weak ELF magnetic fields and modulated RF and microwave fields. Fundamental mechanisms of the interaction between biological material and electromagnetic fields at non-thermal levels are not fully understood.

1.23 Lighting

Fluorescent lights

Fluorescent light bulbs and tubes internally produce ultraviolet light. Normally this is converted to visible light by the phosphor film inside a protective coating. When the film is cracked by mishandling or faulty manufacturing then UV may escape at levels that could cause sunburn or even skin cancer.

LED lights

High CRI LED lighting

Blue light, emitting at wavelengths of 400–500 nanometers, suppresses the production of melatonin produced by the pineal gland. The effect is disruption of a human being's biological clock resulting in poor sleeping and rest periods.

EMR effects on the human body by frequency

Warning sign next to a transmitter with high field strengths

While the most acute exposures to harmful levels of electromagnetic radiation are immediately realized as burns, the health effects due to chronic or occupational exposure may not manifest effects for months or years.[citation needed]

Extremely-low frequency

High-power extremely-low-frequency RF with electric field levels in the low kV/m range are known to induce perceivable currents within the human body that create an annoying tingling sensation. These currents will typically flow to ground through a body contact surface such as the feet, or arc to ground where the body is well insulated.Shortwave

Shortwave (1.6 to 30 MHz) diathermy heating of human tissue only heats tissues that are good electrical conductors, such as blood vessels and muscle. Adipose tissue (fat) receives little heating by induction fields because an electrical current is not actually going through the tissues.

Radio frequency fields

See also: Mobile phone radiation and health

This designation of mobile phone signals as "possibly carcinogenic to humans" by the World Health Organization (WHO) (e.g. its IARC, see below) has often been misinterpreted as indicating that of some measure of risk has been observed – however the designation indicates only that the possibility could not be conclusively ruled out using the available data.

In 2011, International Agency for Research on Cancer (IARC) classified mobile phone radiation as Group 2B "possibly carcinogenic" (rather than Group 2A "probably carcinogenic" nor the "is carcinogenic" Group 1). That means that there "could be some risk" of carcinogenicity, so additional research into the long-term, heavy use of mobile phones needs to be conducted. The WHO concluded in 2014 that "A large number of studies have been performed over the last two decades to assess whether mobile phones pose a potential health risk. To date, no adverse health effects have been established as being caused by mobile phone use.

Millimeter waves

Recent technology advances in the developments of millimeter wave scanners for airport security and WiGig for Personal area networks have opened the 60 GHz and above microwave band to SAR exposure regulations. Previously, microwave applications in these bands were for point-to-point satellite communication with minimal human exposure. Radiation levels in the millimeter wavelength represent the high microwave band or close to Infrared wavelengths.

Infrared

Infrared wavelengths longer than 750 nm can produce changes in the lens of the eye. Glassblower's cataract is an example of a heat injury that damages the anterior lens capsule among unprotected glass and iron workers. Cataract-like changes can occur in workers who observe glowing masses of glass or iron without protective eyewear for many hours a day.[citation needed]

Another important factor is the distance between the worker and the source of radiation. In the case of arc welding, infrared radiation decreases rapidly

1.24 . Conclusion

Since the adoption of the 2001 opinion, extensive research has been conducted regarding possible health effects of exposure to low intensity RF fields. This research has investigated a variety of possible effects and has included epidemiologic, in vivo, and in vitro research. The overall epidemiologic evidence suggests that mobile phone use of less than 10 years does not pose any increased risk of brain tumour or acoustic neuroma. For longer use, data are sparse, since only some recent studies have reasonably large numbers of long-term users. Any conclusion therefore is uncertain and tentative. From the available data, however, it does appear that there is no increased risk for brain tumours in long-term users, with the exception of acoustic neuroma for which there is limited evidence of a weak association. Results of the socalled Interphone study will provide more insight, but it cannot be ruled out that some questions will remain open. Scientific studies have failed to provide support for a relation between RF exposure, lower than the reference values in the present ICNIRP guidelines and neurovegetative symptoms (sometimes referred to as electromagnetic hypersensitivity). Available studies suggest that selfreported symptoms are not correlated to an acute exposure to RF fields, but the limited number of studies does not allow any firm conclusion.

Currently available studies on neurological effects and reproductive effects have not indicated any health risks at exposure levels below guidelines.

Animal cancer studies have not provided evidence that RF radiation could induce cancer, enhance the effects of known carcinogens, or accelerate the development of transplanted tumours. The open questions include adequacy of the experimental models used and scarcity of data at high exposure levels. These questions are addressed by the still ongoing and planned carcinogenicity studies

ECOLOGY part

6.1 The effect of the projected object on the environmental components

During the construction and operation of the projected object, the following environmental components may be affected:

soil and plant complex;

the ground layer of the atmosphere.

Changes in the components of the environment may result from this action.

Actions on the soil and plant complex are manifested in the form of disturbances of the surface of the earth in the strip of alienation around the object of construction. In this case, the following forms of violations are possible: compaction or loosening of soil, trench recesses, roads of temporary roads, grubbing and transplanting of trees. The source of action on environmental components may be construction machinery and equipment.

When performing construction works, soil, groundwater contamination with construction and household waste, debris, fuel and lubricants may be contaminated.

Operation of the projected object is connected with the formation of household and industrial wastewater.

Measures to reduce the negative impact of the projected object on the environment

During the construction and operation of the facility, atmospheric air pollution occurs as a result of road transport emissions of CO, NOx, SO2, CnHm, soot.

Calculation of emissions of harmful substances from automobile engines when working at a construction site.

Automobile engines work in the construction of buildings and structures on different types of fuel: gasoline (4 brands) and diesel fuel. The list of basic machines and mechanisms at the construction site is given in Table 6.1

Table 6.2 - Basic Machines and Mechanisms

№ п/п	Name of machines	Type of fuel	Fuel 100 km	Number of hours worked
1.	Cars dump trucks, cargo. up to 10 t	AI	28	2748
2.	Cranes on track, cargo. 16 t	AI	31	1366
3.	Bulldozer, 96 kW power	DP	30	44,7
4.	Excavators are one-bucket. tracked, 0.65 m3 bucket volume	DP	26	681,8
5.	Irrigation machines, 6 thousand liters	AI	36	41,6
6.	Farm trucks, cargo. 30 t	DP	30	98,2

Calculations of annual emissions of pollutants by motor vehicles required for state or municipal emissions accounting in order to remove payments for environmental pollution and to develop measures to reduce them.

The methodology of calculation of emissions of harmful substances by motor transport is based on the average specific emission by construction mechanisms and cars of separate groups (freight, special, buses, cars, etc.). The emission of harmful substances is corrected depending on the technical condition of the cars, their average age, the influence of natural and climatic conditions.

It is difficult to determine the mileage in km for partially idling cars (truck cranes, excavators, bulldozers, etc.). In this case, the calculation of the maximum one-off emissions, as well as the calculation of the second and annual emissions is made by the formulas:

M j = Cjxx • Acn • aB / t, (9.1)

Cjxx = 1.3 • Q • p • Pxx, (9.2)

where Acn is the number of cars in the j-th group, pc;

aB - average car release coefficient, aB = 1;

Q is the amount of fuel burned, l / km;

p - fuel density, kg / dm3 (for gasoline p = 0.75 kg / dm3; for diesel fuel p = 0.826 kg / dm3);

t - time of the car at the construction site; t = 2 min;

Pxx is a dimensionless factor characterizing the ratio of the mass of emitted pollutants to the mass of fuel burned

(Table 6.2).

1.3 - coefficient for taking into account the average speed of movement and idling.

Annual emissions are calculated using the formula$M_{y.j} = C_j \cdot A_{cn} \cdot AB \cdot T \cdot 10\text{-}6$ (9.3)

where T is the total running time of the car engine per year, hoursAB • T • 10-6 (9.3)

where T is the total running time of the car engine per year, hoursAB • T • 10-6 (9.3)

where T is the total running time of the car engine per year, hoursAB • T • 10-6 (9.3)

where T is the total running time of the car engine per year, hoursAB • T • 10-6 (9.3)

where T is the total running time of the car engine per year, hours.

Table 6.3 - Coefficient

Kind fuel	The P value for				
	C	$C_n N_m$	NO_X	SO_2	soot
The P value for	2,62	1,01	0,27	0,01	-
Diesel fuel	0,27	0,06	0,03	0,03	0,23

The results of the calculation of the seconds and annual emissions of pollutants during the operation of diesel and gasoline powered construction machinery are given in Table 6.3.

The calculations are made only for emissions of construction machinery and vehicles operating at the construction site.

Table 6.4 - Calculation of emissions of harmful substances during the operation of construction machinery and vehicles

Name of machines	number of cars .	type of fuel	fuel rate, kg / h	working hours, hours	Mass emission of substances									
					C		$C_n N_m$		NO_x		CO_2		soot	
					г/с	т/у	г/с	т/у	г/с	т/у	г/с	т/у	г/с	т/у
Dumpers, with a load capacity of up to 10 t	2	AI	28	2748	0,705	13,96	0,27	5,38	0,073	1,44	0,003	0,053	-	-
Crawler cranes, up to 16t	2	AI	31	1366	0,78	7,7	0,3	2,96	0,081	0,79	0,003	0,03	-	-
Bulldozer, 96	1	DP	30	44,7	0,087	0,0000	0,065	0,0001	0,0097	0,00001	0,0097	0,00001	0,074	0,0002

kW power						14		06		56		6		7
Excavators	2	D	26	681,8	0,076	0,37	0,016	0,081	0,019	0,095	0,019	0,095	0,064	0,31
Irrigation machines, 6 thousand liters .	1	AI	36	41,6	0,85	0,128	0,33	0,049	0,088	0,0132	0,003	0,000489	-	-
Farm trucks with a load capacity of 30 t.	1	DP	30	98,42	0,087	0,000307	0,019	0,000068	0,009	0,000034	0,009	0,000034	0,074	0,00262
Accepted for calculation: AI					3,635 0,337		1,403 0,12		1,117 0,0467		0,0144 0,0467		0,286	0,3849
T						23,31		8,898		3,397		0,1919	0,286	0,3849

Special part 8

8.1 Feasibility comparison of transverse frame layout options

1. Mass of farms GFGS series 1.263.2: $G_{bwp} = 24{,}7$ (t.)

2. Mass Farm Unitec Series 1.420.3-36.03: $G_{unitec} =$ 30,9 (t.)

3. Mass of crossbars Unimak series 1.420.3-37.06 : $G_p = 58$ (t.)

$$T_u = AK_c\sqrt{G_0 n_0}\,,$$

where A - empirical coefficient of manufacturability of the structural form

K_c - coefficient taking into account the reduction of labor intensity in the manufacture of structures in series;

n_0 - the number of main parts determined by the drawing, taking into account the location of factory joints;

G_0 - mass of main parts;

G - total weight of the structure

$\psi = G/G_0$ - building mass coefficient

BWP - $T_u = 4{,}2\cdot 1{,}0\sqrt{24{,}7\cdot 276} = 347$ man.-h.

Unitec $T_u = 2{,}9\cdot 1{,}0\sqrt{30{,}9\cdot 516} = 366{,}0$ man.-h.

Unimak $T_u = 8{,}4\cdot 1{,}0\sqrt{58\cdot 84} = 586{,}0$ man.-h.

Cost of structures. The cost of steel structures in the case, which are installed in the design position, is determined by the expression

$$C_D = \left(1+\frac{0{,}15}{\alpha^{/}}\right)\cdot\left[1{,}01\cdot\left(C_I + C_T\right) + C_M\right] + 1{,}23\cdot C_{O.P.}\,,$$

where $\alpha^{/} = 1-\frac{1-\alpha}{\psi} = 1-\frac{1-0{,}91}{1} = 0{,}91$- the coefficient of reduction in the mass of the structure compared to a similar one made in traditional solutions made of steel grade St3;

$\alpha = 0{,}91$- coefficient weight reduction factor;

C_I - factory cost of construction;

C_T - construction transportation cost;

C_M - assembly and installation costs;

$C_{O.P.}$ - the cost of painting, device and disassembling scaffolding for painting.

$$C_I = 1{,}144 \cdot \left(c_{O.M.} G + 3{,}65 T_I + \frac{3{,}54 G}{\alpha^{/}} \right),$$

where $c_{O.M.}$ - cost of basic materials

$$C_T = \frac{c_T G}{\alpha^{/}},$$

where c_T - construction transportation cost, t;

$$C_M = K_P K_M c_M G,$$

where $K_P = 1{,}27$ - coefficient taking into account the area of construction;

K_M - coefficient taking into account the cost of steel construction;

c_M - the cost of assembly and installation 1t design;

$$C_{O.P.} = K_P c_{O.P.} G,$$

where the total cost of painting, device and disassembling scaffolding for painting on 1t of the structure;

Farm from BWP:

$C_I = 1{,}144 \cdot \left(125 \cdot 24{,}7 + 3{,}65 \cdot 347 + \frac{3{,}54 \cdot 24{,}7}{0{,}91} \right) = 5111{,}0$ UAH.

$C_T = \frac{13{,}9 \cdot 24{,}7}{0{,}91} = 377{,}0$ UAH.

CONCLUSION

In the architectural part the main structural elements of the building were considered. The purpose of the designed house, engineering geological and hydrogeological conditions of the construction area, as well as architectural decisions are analyzed. Requirements for fire resistance, fire resistance, lighting, heating and ventilation are also considered. Developed: facades, sections, plans of a typical floor and technical, geological sections.

In the calculation-constructive part were carried out calculations of bearing reinforced concrete structures: monolithic overlappings, prefabricated reinforced concrete staircase march and multi-hollow plate.

In the section on technology and organization of construction production, the definition of the nomenclature and volumes of works, the choice of methods for the execution of works, machines and mechanisms, the determination of the number of vehicles, and the selection of the crane were carried out.

A construction master plan and a grid graph have also been developed and analyzed. Development of a technological map for installation of structures and brickwork.

In the special section a comparative analysis of the combined band and pile foundations was conducted. According to the calculation of the reduced costs of installation of structures, the assembly line is more economical than the pile, so the assembly element is used in the construction.

In the economic part were developed, a record of labor and wages, object estimates for the main building, combined cost estimates of construction costs, which determined the estimated cost in accordance with the procedure for determining the cost of construction and free prices for construction products in the development of market relations .

The main decisions on labor protection and the environment are given.

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