Ministry of Science and Education of Ukraine
“Dnipro University of Technology”

FACULTY OF CIVIL ENGINEERING

Department of Construction, Geotechnics and Geomechanics

EXPLANATORY NOTE
qualifying work for a bachelor's degree

student<u>**Abdelhafez Mohamed Ashraf Mohamed**</u>
(ПІБ)

academic group <u>**192-17-IC**</u>
(шифр)

specialties 192 Construction and civil engineering
(код і назва спеціальності)

according to the educational and professional program Construction and Civil Engineering
(офіційна назва)

on the topic «<u>Milk plant in Cairo City (Egypt)</u>»
(name by order of the rector)

Leaders	**Surname, initials**	**Score on scale**		**Signature**
		Rating	**institutional**	
qualification work, sections				
Architectural and construction				
Reinforced concrete structures				
Technology and organization of construction				
Construction economics				

Reviewer				

Normocontroller				

Dnipro
2021

APPROVED:
Head of Department
of Construction, Geotechnics and Geomechanics

____
(signature) (surname, initials)

«__»_______________2021year

TASK
for qualifying work
master's degree

student **Abdelhafez Mohamed Ashraf Mohamed** **academic group** **192-17-IC**
(signature) (surname, initials)
specialties 192 Construction and civil engineering
according to the educational and professional program Construction and Civil Engineering
(official name)
on the topic «Milk plant in Cairo City (Egypt)»,
approved by the order of the rector of NTU "Dnieper Polytechnic" from __.__. 2021 № _____

Section	**Content**	**Term implementation**
Architectural and construction	Brief description, spatial planning decisions and purpose of the survey object	
Reinforced concrete structures	Constructive decisions of elements of object of inspection	
Technology and organization of construction	technological solutions for the production of construction works	
Construction economics	Economic justification of construction production	

Task issued _________________**Nechitailo O.Ye.**
(signature of the head) (surname, initials)

Date of issue _______________

Date of submission before the examination of the committee _______________

Accepted for execution ______________**Abdelhafez Mohamed Ashraf Mohamed**
(signature of the head) (surname, initials)

ABSTRACT

Qualifying work: 154 pp., 28 tables, 41 Figure, 3 supplement, 88 sources.

INDUSTRY BUILDING, FACILITY BUILDING, DESIGN, TECHNOLOGY AND ORGANIZATION OF WORKS.

Object of work - plant for the production of dairy products in cairo city (Egypt).

The purpose of the project to design an industrial building, namely a plant, using progressive methods of construction production.

Results and their novelty. Selected and substantiated basic design and construction solutions. The calculation of the roof enclosure structures was performed. The design of the construction scheme, the collection and calculation of loads. The calculation of the coating plates, the beams on which they are supported and the columns was calculated. The rational scheme of combination of technological processes is chosen. The project of work execution and corresponding technological maps is developed. The analysis of thermotechnical features of the calculation of the inversion roof was performed.

Interconnection with other works - continuation of innovative activity of the Department of Civil Engineering, Geotechnics and Geomechanics of NTU "Dnipro university of technology" in the field of industrial and civil engineering and civil engineering.

Scope - industrial engineering construction technology.

The practical importance of the work is to increase the technical, economic and cultural-social aspects of industrial construction.

CONTENT

INTRODUCTION

The theme of the diploma project is the design of a Factoryfor the dairy products, located on the territory of a dairy plant in cairo city EGYPT.

The building of the Factorycontains not only production and storage facilities, but also administrative and domestic ones. According to the technological solution, the Factoryhas two main production facilities, a Factoryof condensed milk and butter.

The project provides for all necessary measures to ensure fire safety, internal fire alarm, measures for corrosion protection. Telephony of the Factoryis provided from external telephony networks by cable input, radio broadcasting of the Factoryfrom external radio broadcasting networks, introduction into the Factoryis made through a radio stand installed on the roof.

Ventilation system of the Factoryand auxiliary premises - supply and exhaust with mechanical and natural motivation. Supply air for Factoryis supplied from ventilation chambers with recirculation and provides compensation for heat loss by the premises during working hours at the design temperature of the indoor air. Removal of air from the upper zone is carried out by roof fans. In other rooms, the supply air is supplied to the upper area of the premises. In the event of a fire in rooms equipped with a fire alarm system, it is assumed that the ventilation systems will be switched off.

Heating system of condensed milk and butter Factoryand auxiliary rooms, two-pipe, with lower dilution and associated movement of the coolant. Removal of air from the system is carried out through air valves installed in the upper plugs of heating devices. Pipelines laid in underground channels are insulated.

To meet the drinking, production and fire needs of the project, the project provides water supply to the Factoryfrom the existing external network.

Drainage of domestic, industrial and rainwater is provided in the existing external networks.

Power supply of the Factoryis provided by two cable entries from external networks with a voltage of 380/220 V. Regarding the reliability of electricity supply, the electrical receivers of the Factory belong to the consumers of the II category.

SECTION 1. ARCHITECTURAL AND CONSTRUCTION SECTION

1.1 General information and source data

Characteristics of the construction area:

• construction area of cairo city EGYPT;

• average temperature of the period with the average daily air temperature

• less than + 25 ° C;

• the average duration of the period with an average daily air temperature less than + 25 ° C, Zht = 221 days;

• predominant loam soils;

• groundwater level 2.5 m;

• the terrain is calm with a slope.

1.2 Description of the functional process in the factory

The condensed milk and butter production plant is designed to receive 12.5 tons of whole milk per day, processing it into skimmed condensed milk and butter.

Delivery of whole milk to the factory is carried out according to the schedule of technological processes:

• duration of milk intake 2.5 hours per shift;

• duration of change is 8 hours;

• the number of changes in the year is 256.

The equipment is provided for the production of finished products:

- for the production of condensed milk "Vacuum-evaporating unit A2-00B-2»;

- for the production of butter "Automated line for the production of butter P8-0LF".

Productivity of the plant:

- for condensed milk - 2000 kg / shift;

- for butter - 500 kg / shift.

Production technology is maximally automated, automation of pumps, refrigeration machines, ventilation equipment is provided. Equipment management is carried out both locally and remotely from the operator's office. Washing of technological equipment is carried out with a solution of soda ash and solutions of acid and alkali, which enter the tank of the installation B2-0U2-B for further neutralization in it. Acidity control in the tank of the washing machine is carried out by means of the P-210 converter.

As the refrigerating machine the installation 1MKT-28-2-0 working in an automatic mode depending on work of pumps of ice water №1 and №2 is applied. The cooling tower fan works in an automatic mode depending on temperature of cooling water. Control of ice water pumps, circulating water supply and cooling tower fan is performed by box Я5000К. Automatic switching on of the reserve pump at a stop of the worker is provided. Also for ice water pumps the blocking is made that prevents start of pumps at empty accumulator tanks. Solenoid valves are used as shut-off valves on the ice water supply to the process equipment, which are controlled by means of switches installed in the service rooms in accordance with the equipment operation schedule.

Table 1.1. - Explication of premises

N п/п	Наименование	Площадь, м²	Категор. помещения	N п/п	Наименование	Площадь, м²	Категор. помещения
1	Приемно – моечное отделение	99,02					
2	Приемное отделение	71,58		30	Венткамера	29,92	
3	Цех по производству сливочного			31	Венткамера	35,43	
	масла	281,07		32	Венткамера	30,72	
4	Баклаборатория	17,37		33	Постирочная	11,56	
5	Бокс	4,28		34	Гладильная	5,54	
6	Склад упаковочного материала	13,56		35	Мужской гарберов уличной		
7	Холодильная камера	12,87			и домашней одежды	9,19	
8	Машинное отделение	10,93		36	Мужской гардероб сепециальной		
9	Тамбур	10,04			одежды	11,97	
10	Цех по производству сгущенного			37	Женский гарберов уличной		
	молока	210,42			и домашней одежды	16,27	
11	Отделение централизованной мойки	43,43		38	Женский гардероб специальной		
12	Склад дезосредств	11,52			одежды	23,0	
13	Подготовительная	20,68		39	Помещение для сушки одежды и		
14	Склад сахара	16,38			обуви	10,32	
15	Склад сгущенного молока	32,06		40	Кладовая чистой одежды	4,21	
16	Помещение для приема тары	16,38		41	Кладовая грязной одежды	4,21	
17	Кладовая уборочного инвентаря	6,33		42	Коридор	48,39	
18	Помещение мойки и хранения			43	Мужской туалет	5,27	
	чистой тары	20,45		44	Женский туалет	3,45	
19	Помещение для хранения и			45	Кладовая уборочного инвентаря		
	обработки затравки	5,13			для уборки комнаты личной		
20	Комната персонала	15,19			гигиены и туалетов	2,64	
21	Тепловой пункт	28,69		46	Кладовая уборочного инвентаря		
22	Помещение для холодильных машин	65,59			для уборки остальных бытовых		
23	Операторская	11,29			помещений	2,64	
24	Тамбур	14,52		47	Душевые	4,86	
25	Коридор	23,46		48	Преддушевая	2,70	
26	Химическая лаборатория	18,88		49	Комната личной гигиены женщин	2,70	
27	Кабинет заведующей производством	21,24		50	Антресоль (коридор)	53,40	
28	Электрощитовая	16,95		51	Комната мастера	14,63	
29	Помещ. для приготовл. сахарного сиропа	47,38		52	Комната главного инженера	35,80	

1.3 General plan of the construction site

The projected production is located on the territory of the dairy. Delivery of raw materials is carried out by road. Finished products are delivered to the warehouse by road.

The designed structure is tied to the coordinate grid of the site horizontally, and vertically to the surrounding buildings, taking into account the upper planning.

Storm drains are organized by slopes to roads and slopes of roads of 1,5% to receiving lattices of the storm sewer.

Landscaping of the adjacent territory is organized. The main elements of landscaping are deciduous trees, shrubs along the sidewalks, also provides for the organization of lawns and flower beds.

table 1.3.1 - Technical and economic indicators of the master plan

№ п/п	Name	unit of measurement	quantity
1	Area of the Territory	$м^2$	
2	Building area	$м^2$	
3	Building Coefficient	-	
4	Area of roads, sidewalks, squaers	$м^2$	
5	Landscaping area	$м^2$	
6	Landscaping Coefficient	-	

1.4 Spatial planning solution

The building of the factory contains not only production and storage facilities, but also administrative and domestic ones. According to the technological solution, in the frame part of the building there are two main production facilities, a condensed milk plant and butter plant.

The designed building has a rectangular shape in plan with dimensions in the axes of 18 x 63 m and a height in the production premises of 7.2 m to the bottom of the load-bearing rafter structures. The designed building is heated.

The following were taken into account when making spatial planning decisionsrequirements:

• optimal placement of the projected building in the allotted area;

• ensuring the technological process;

• providing natural light;

• providing facilities for staff.

Domestic service of the working personnel is provided in the block of sanitary and household premises attached to factory, as a part: laundry; ironing; men's and women's wardrobes for street, home and special clothing; room for drying clothes and shoes; pantries of clean and dirty clothes; men's and women's toilets; pantry for cleaning equipment; showers and personal hygiene room for women.

Main production facilities: reception and washing department, butter factory, packaging material warehouse, refrigeration chamber, condensed milk production factory, centralized washing department, disinfectant warehouse, sugar warehouse, finished goods warehouse and container reception room.

The room of the master and the chief engineer, the chemical laboratory, the office of the production manager are located on the second floor of the mezzanine in the frame part of the building.

Three stairs have been designed for the connection between the floors in the building, one located in the block of sanitary facilities, two others in the production premises (condensed milk production plant and oil mill), also two steel stairs from the outside of the building to the second floor, and placed in the block of sanitary facilities and in the frame part of the building.

Techno-economic indicators of large-scale planning:

- back area of the building for = 1134 m2
- the area of the zvnishnikh stin C = 1539 m2
- alarm volume of alarm VCTP = 10773 m3
- volumetric efficiency K2 = VCTP / For = 9.5
- efficiency of compactness of building K3 = VCTP / C = 7
- efficiency of the economy of the forms K4 = Po / VCTP = 0.105

1.5 Architectural and constructive decision

1.5.1 Constructive scheme of the building

The projected building has a rectangular shape in plan with dimensions in the axes of 63x18 m. in axes 1-3 with a height of the first floor of 4.5 m and the second 3.0 m.

The building is designed with rigid transverse frames, consisting of prefabricated reinforced concrete columns and rafters. Laying of columns in the base is rigid, and the combination of rafter designs and columns is hinged. The rigidity of the structure is provided by the horizontal disk of the coating and the rigidity of the transverse frame. In the built-in mezzanine on the axis 4/1 in the axes В-Гand on the axis В in the axes 3 / 1-4 / 1 are the stiffness diaphragms on the ground floor and at the mark 4.800 are located in the axes 4/1 - 9/1 connecting plates . The designed building in the frame part has a number of columns of 6 m and a number of rafter structures of 6 m.

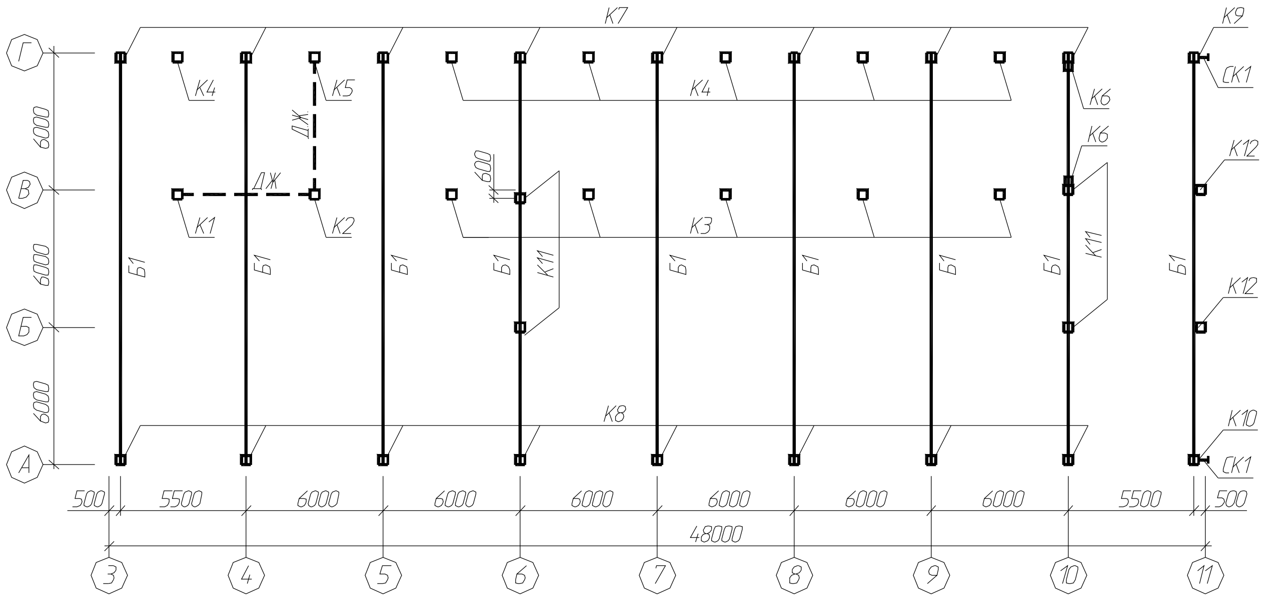


Fig. 1.5.1. Layout of columns and rafters.

In the built-in mezzanine a number of columns of 6 m, shifted by 3 m relative to the columns of the building frame.

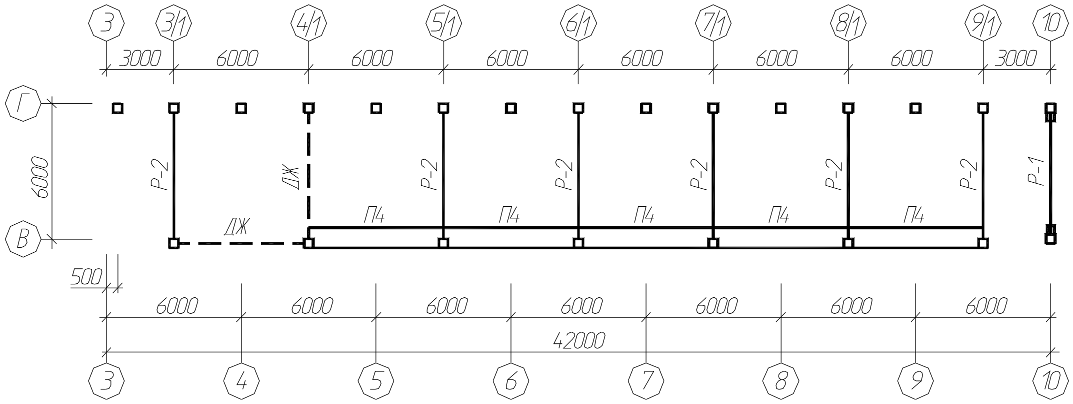


Fig. 1.5.2. The scheme of arrangement of crossbars and elm plates on resp. 4,800 th most common

The two-storey brick industrial and household building is covered with round-hollow prefabricated reinforced concrete slabs, the thickness of the outer load-bearing wall is 640 mm, the thickness of the internal load-bearing walls is 380 mm and the thickness of the partitions is 120 mm.

1.5.2 Structural elements

1.5.2.1 Foundations

In the frame part of the building monolithic reinforced concrete foundations are used under a column section of 400x400 mm and under half-timbered columns with supports for foundation beams. Prefabricated reinforced concrete strip foundations are used in the production and household building.

The depth of the foundations is determined as a result of joint consideration of engineering-geological and hydrogeological conditions of the construction site, seasonal freezing and heaving of soils, structural and operational features of buildings, as well as the size and nature of the load on the foundation. Mark of the edge of the foundation - 0.15 m

Under the mezzanine columns and columns, which are located inside the building, used foundations Ф1 brand Ф-17-4, with a sole size of 1700x1700 mm and a height of 1.25 m. Under the diaphragm of rigidity is a monolithic reinforced concrete foundation Fm4.

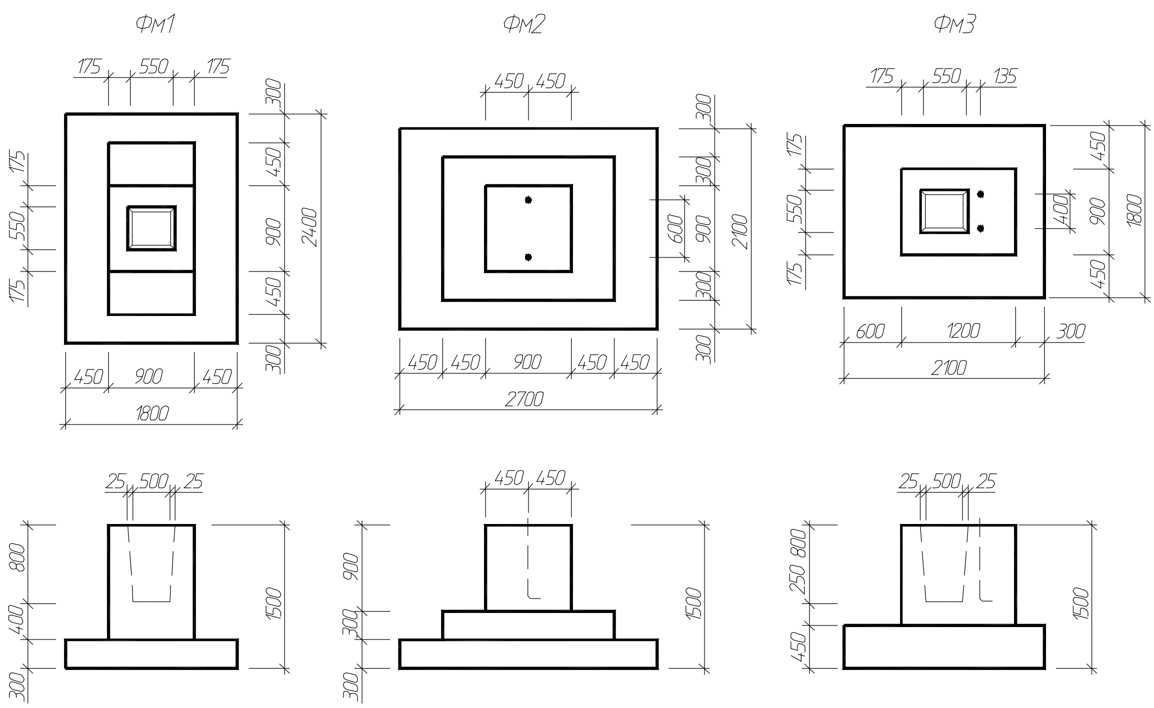


Fig. 1.5.3. Reinforced concrete monolithic foundations.

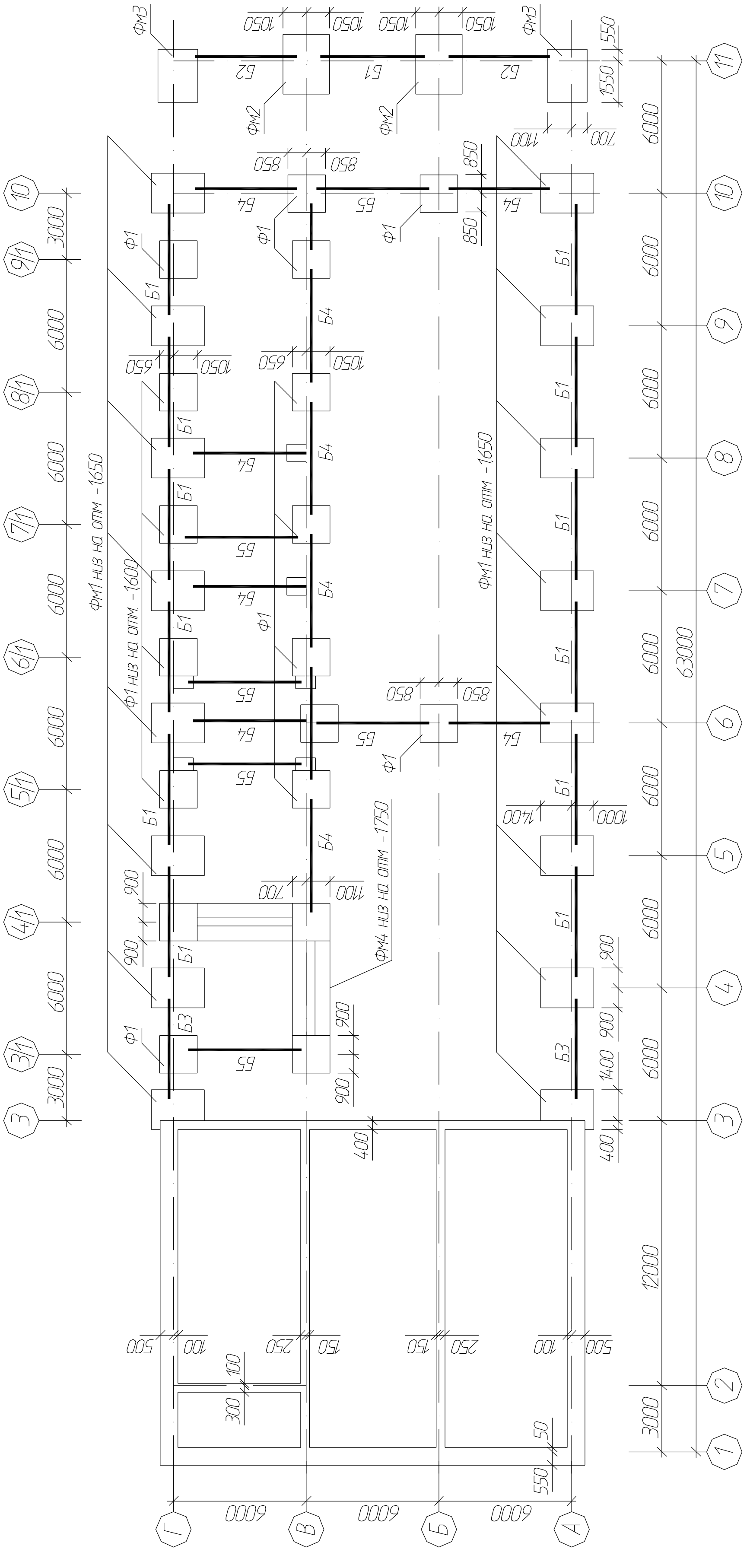


Fig. 1.5.4. The layout of the foundations location.

Specification of reinforced concrete foundations for columns and half-timbers.

Table 1.5.1

Brand, pos.	Marking	Name	Count	mass, T	Note.
1	2	3	4	5	6
Ф1	ИИ-04-1	Ф-17-4	15	4,04	
Фм1	1.412.1 вип.2	Фм-1	16	5,28	
Фм2	1.412.1 вип.2	Фм-2	2	7,776	
Фм3	1.412.1 вип.2	Фм-3	2	2,424	
Фм4	1.412.1 вип.2	Фм-4	1	-	

In the brick part of the building, precast reinforced concrete foundations are used. Reinforced concrete foundation blocks with a height of 0.6 m are installed in two rows in height with bandaging on foundation slabs with a thickness of 0.3 m. Mark the bottom of the base of the foundation slab -1.750 m.

Specification of reinforced concrete prefabricated strip foundations.

Table 1.5.2.

Brand, pos.	Marking	Name	count	Mass, T	Note.
1	2	3	4	5	6
ФБ1	ГОСТ 13579-78	ФБС 4.24	34	1,38	
ФБ2	ГОСТ 13579-78	ФБС 4.12	8	0,69	
ФБ3	ГОСТ 13579-78	ФБС 4.9	10	0,518	
ФБ4	Г+ОСТ 13579-78	ФБС 6.24	30	2,074	
ФБ5	ГОСТ 13579-78	ФБС 6.12	9	1,036	
ФБ6	ГОСТ 13579-78	ФБС 6.9	10	780	
ФП1	ГОСТ 13579-78	ФЛ 8.24	10	1,21	
ФП2	ГОСТ 13579-78	ФЛ 8.12	2	0,66	
ФП3	ГОСТ 13579-78	ФЛ 12.24	24	2,05	

1.5.2.2 Foundation beams

For transfer of weight of wall panels and internal partitions on the base foundation beams of T-section section 450 mm high are applied.

Foundation beams are installed on the inflows of the foundations on a layer of mortar grade 100 with a thickness of 20 mm.

Specification of reinforced concrete foundation beams.

Table 1.5.3.

Brand, pos.	Marking	Name	count	Mass, T	Note.
1	2	3	4	5	6
Б1	1.415-1 вип.1	ФББ – 17	13	1,5	
Б2	1.415-1 вип.1	ФББ – 13	2	1,4	
Б3	1.415-1 вип.1	ФББ – 14	2	1,3	
Б4	1.415-1 вип.1	ФББ – 2	11	1,3	
Б5	1.415-1 вип.1	ФББ – 1	5	1,6	

1.5.2.3 Columns

In the frame part of the building reinforced concrete columns of square section 400x400 mm with a length of 8.1 m with a step of 6 m are used. The mark of the column head is 7.2 m. fastening of a crossbar of a mezzanine is carried out to consoles of columns in height of 150 mm and departure of 150 mm.

Specification of reinforced concrete columns.

Table 1.5.4.

Brand, pos.	Marking	Name	Count	Mass, T	Note.
1	2	3	4	5	6
C1	1.020-1/83	1C60 4.48 -1	1	2,4	
C2	1.020-1/83	1C60 4.48 –2	1	2,4	
C3	1.020-1/83	1C60 4.48 –3	5	2,4	
C4	1.020-1/83	1C60 4.48 –4	6	2,4	
C5	1.020-1/83	1C60 4.48 –5	1	2,4	
C7	1.423-3	1C72 – 4M2-1	8	3,2	
C8	1.423-3	1C72 – 4M2-2	8	3,2	
C9	1.423-3	1C72 – 4M2-3	1	3,2	
C10	1.423-3	1C72 – 4M2-4	1	3,2	

C11	1.423-3	1C72 – 4M2-5	4	3,2	

For fastening of a steel crossbar of R-1 steel columns K6 with section 140x180 mm, made of two welded channels are designed.

Specification of steel columns.

Table 1.5.5.

Brand, pos.	Marking	Name	Count	Mass, T	Note.
1	2	3	4	5	6
C6		CC-1	2	0,15	

1.5.2.4 Half-timbered

Half-timbered columns are intended for fastening of face wall panels. Half-timbered columns are made of reinforced concrete, 8.5 m long. Half-timbered steel racks are used for fastening end wall panels from the edges on the corner.

Specification of half-timbered columns and racks.

Table 1.5.6.

Brand, pos.	Marking	Name	Count	mass, t	Note.
1	2	3	4	5	6
C12	1.030.1-1.4	БКФ85 – 1 – 1	2	3,15	
CC1	1.030.1-1.4	Half-timbered rack СФ7	2	0,42	

1.5.2.5 Roof structures and crossbars

The load-bearing elements of the enclosing part of the building in the frame part of the building are prefabricated reinforced concrete slabs of 6x3 m. Slabs with holes are designed in the places of installation of water intake funnels and under ventilation boxes.For covering and overlapping in the industrial and household brick case prefabricated round-hollow reinforced concrete slabs, 6 m long, 1.2 m wide and 1.5 m, 220 mm high, are used.

Prefabricated round-hollow reinforced concrete slabs 6 m and 3 m long, 1.2 m wide and 1.5 m wide are used to cover the mezzanine.

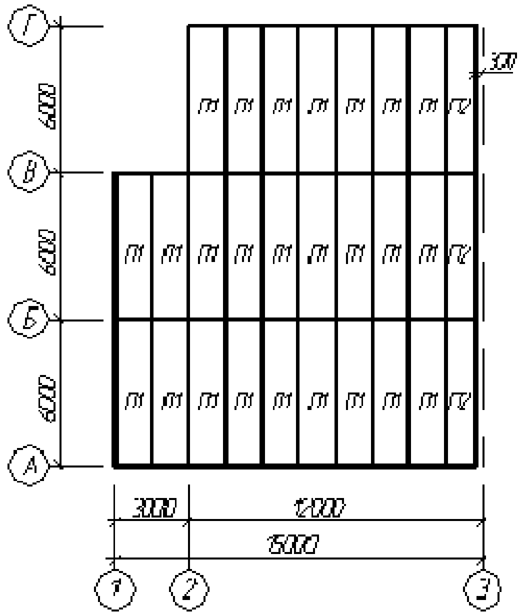


Fig. 1.5.6. The layout of the floor slabs on the resp. 4,200 in axes 1-3.

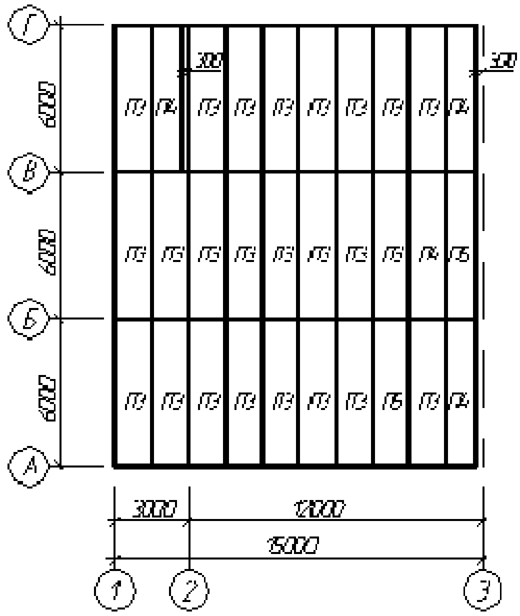


Fig. 1.5.7. The layout of the coating plates in the axes 1-3.

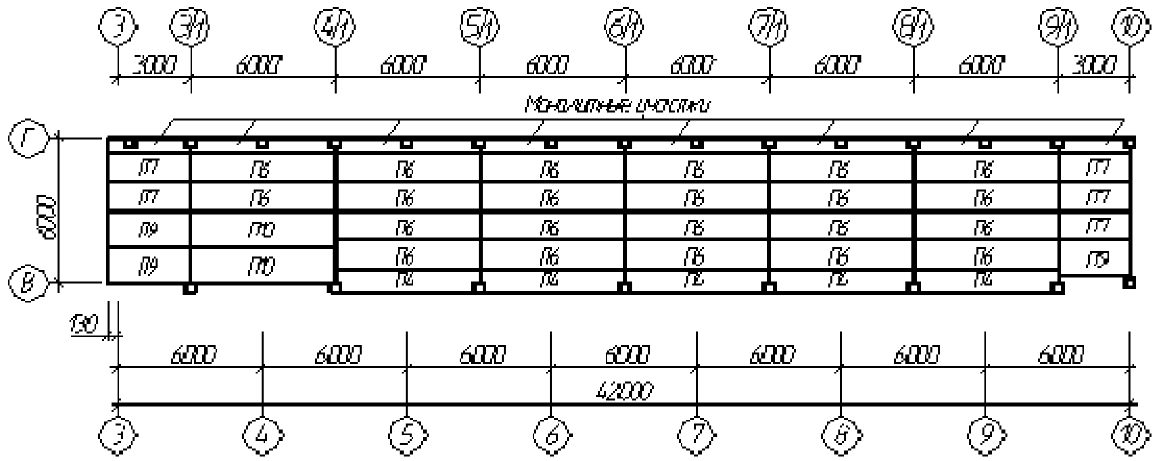


Fig. 1.5.8. The layout of the floor slabs on the resp. 4,800 th most common

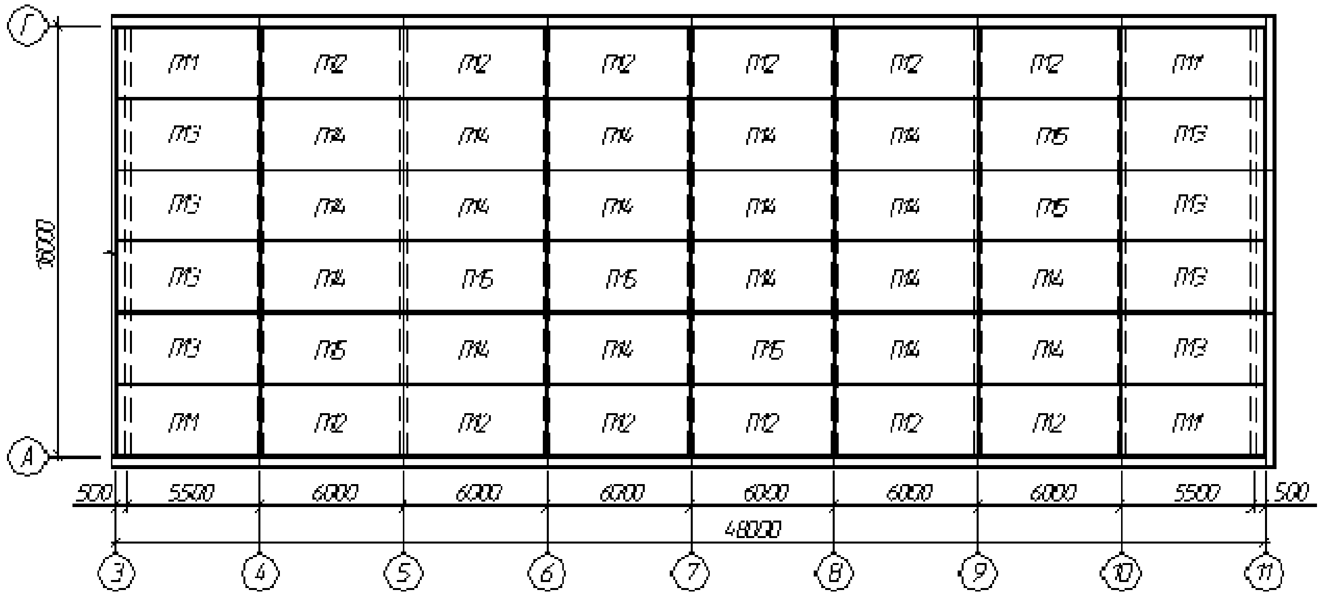


Fig. 1.5.9. The layout of the coating plates in the axes 3-11.

1.5.2.6 Plates of a covering and overlapping

Specification of reinforced concrete slabs and floors.

Table 1.5.8.

Brand, pos.	Marking	Name	Count	Mass, T	Note.
1	2	3	4	5	6
		Overlapping			
П1	1.141-1 вип.63	ПК 60.15-8АтV	25	2,8	
П2	1.141-1 вип.63	ПК 60.12-8АтV	3	2,8	
П5	1.465.1-7/84	2ПВБ – 4АтV- 4	2	2	
		Coating			
П3	1.141-1 вип.63	ПК 60.15-4АтV	24	2,1	
П4	1.141-1 вип.63	ПК 60.12-4АтV	4	2,1	
		Overlapping			
П6	1.041.1-2 вип.1	ПК 56.12 – 13АтV	22	2	
П7	1.041.1-1 вип.60	ПК 30.12 – 8т	5	1,08	
П8	1.041.1-2 вип.1	ПК 56.9 – 10АтV	5	1,7	
П9	1.041.1-1 вип.60	ПК 30.15 – 8т	3	1,08	
П10	1.041.1-2 вип.1	ПК 56.15 – 16АтV	2	2,6	
		Coating			
П11	ГОСТ 22701.1-77	ПГ-3 АтV-1	4	2,65	
П12	ГОСТ 22701.1-77	ПГ-3 АтV-2	12	2,65	
П13	ГОСТ 22701.1-77	ПГ-3 АтV-3	8	2,65	
П14	ГОСТ 22701.1-77	ПГ-3 АтV	18	2,65	
П15	ГОСТ 22701.2-77	ПВ7-3 АтV	6	3,2	

1.5.2.7 Outside walls

Self-supporting hinged wall panels with a thickness of 400 mm are used as external enclosing structures in the production building. In places of installation of gates, doors brick inserts on height of 3,6 m are projected. Filling of seams of panel walls is carried out by elastic synthetic linings 60-80 mm wide and tight mastics. Hinged panels within the tiers are attached to the embedded elements in reinforced concrete columns.

In the industrial and household building brick walls of three-layer construction. The external walls in the brick part of the building are made of silicate brick, 640 mm thick.

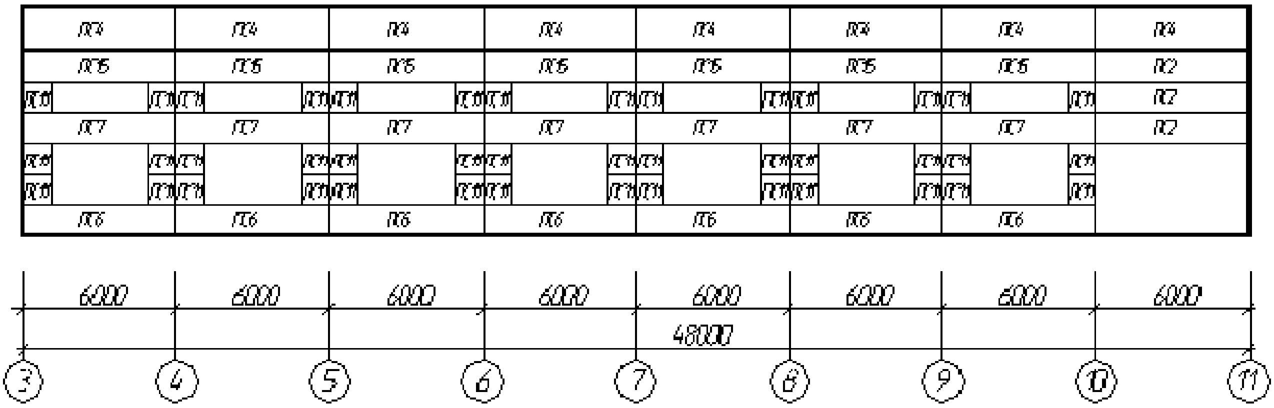


Fig. 1.5.10. The layout of the wall panels on the axis A.

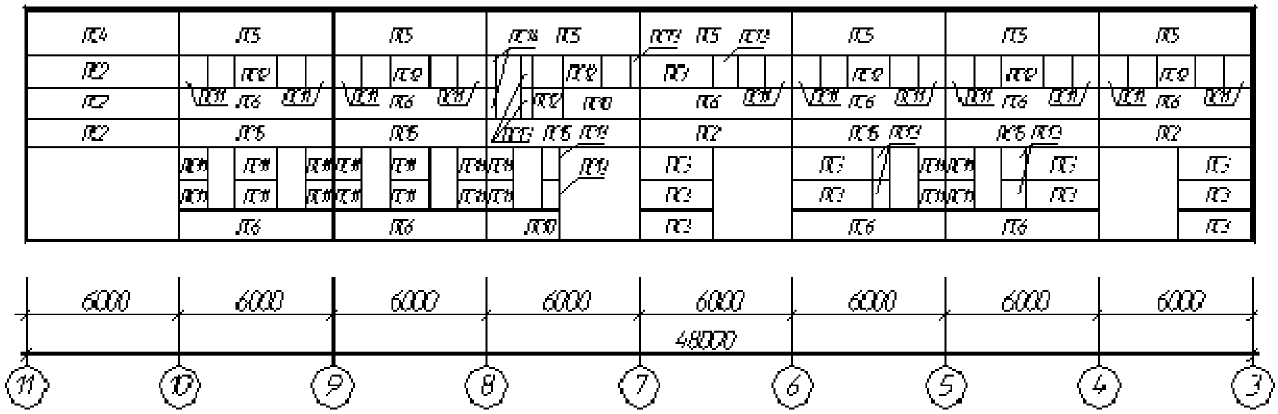


Fig. 1.5.11. The scheme of arrangement of wall panels on an axisB.

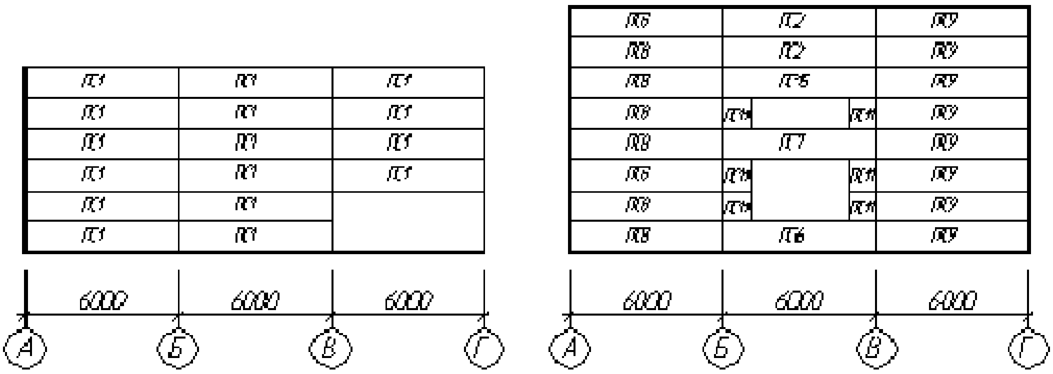


Fig. 1.5.12. The layout of the wall panels along the axis 10 and 11.

Specification of wall panels.

Table 1.5.9.

Brand, pos.	Marking	Name	Count	Mass, T	Note.
1	2	3	4	5	6
WP1	ТП503-2-40.90	WP 60.12.2,5-6Л-1	16	2,34	
WP2	ТП503-2-40.90	WP60.12.4,0-6Л-1	10	3,6	
WP3	ТП503-2-40.90	WP30.12.4,0-6Л-1	11	1,8	
WP4	ТП503-2-40.90	WP60.18.4,0-6Л-1	9	5,39	
WP5	ТП503-2-40.90	WP60.18.4,0-6Л-2	7	5,39	
WP6	ТП503-2-40.90	WP60.12.4,0-6Л-4	18	3,6	
WP7	ТП503-2-40.90	WP60.12.4,0-6Л-5	8	3,6	
WP8	ТП503-2-40.90	WP64.12.4,0-6Л-1	8	3,84	
WP9	ТП503-2-40.90	WP64.12.4,0-6Л-2	8	3,84	
WP10	ТП503-2-40.90	WP 30.12.4,0-Л-1	2	1,8	
WP11	ТП503-2-40.90	2WP 12.12.4,0-Л-2	77	0,71	
WP12	ТП503-2-40.90	2 WP 12.12.4,0-Л-1	6	0,71	
WP13	ТП503-2-40.90	2 WP 6.12.4,0-Л-1	10	0,36	
WP14	ТП503-2-40.90	2 WP 3.12.4,0-Л-1	2	0,16	
WP15	ТП503-2-40.90	WP 60.12.4,0-6Л-10	13	3,6	

1.5.2.8 Stairs

For the connection between the floors in the building, three stairs are designed, one located in the block of sanitary facilities and made of reinforced concrete platforms and marches, to climb to the second floor used three marches with two inter-floor platforms at 1,500 m and 3,150 m. condensed milk production plant and butter plant) there are two steel stairs with inter-floor platforms at the mark of 3,600 m, leading from the premises of the plantsto the second floor of the mezzanine. There are also two steel stairs from the outside of the building, which lead to the second floor, located in the block of sanitary facilities and in the frame part of the building. There is a steel ladder for lifting to the roof of the production building.

1.5.2.9 lintels

Reinforced concrete bridges, laid in an array of masonry, are installed above the gates and doorways. The lintelis a reinforced concrete structure of the "beam" type, which is used to cover the slots in the walls of small materials. The gate slot is framed by a prefabricated reinforced concrete frame, fits in the external size in the accepted section of the panel wall.

lintels specification.

Table 1.5.10.

Brand, Pos.	Marking	Name	Count	Mass, T	Note.
1	2	3	4	5	6
ПР1	ГОСТ 948-84	5ПБ 30-37	1	0,41	
ПР2	ГОСТ 948-84	5ПБ 25-37	7	0,34	
ПР3	ГОСТ 948-84	3Пб 18-37	3	0,12	
ПР4	ГОСТ 948-84	3Пб 16-37	14	0,102	
ПР5	ГОСТ 948-84	3Пб 13-37	5	0,085	
ПР6	ГОСТ 948-84	2ПБ 29-4	7	0,12	
ПР7	ГОСТ 948-84	2ПБ 22-3	14	0,092	
ПР8	ГОСТ 948-84	2ПБ 19-3	14	0,081	
ПР9	ГОСТ 948-84	2ПБ 16-2	31	0,065	
ПР10	ГОСТ 948-84	2ПБ 13-1	24	0,054	
ПР11	ГОСТ 948-84	1ПБ 13-1	53	0,025	
ПР12	ГОСТ 948-84	1ПБ 10-1	12	0,02	
ПР13	ГОСТ 948-84	3ПБ 34-4	1	0,221	

1.5.2.10 Gates, doors and windows

Two gates are located in a frame part of the building in axes 10-11 for through passage of motor transport. Gate in external walls in the size of 3500x3600 mm. Ramps are provided for entry and exit of transport.

According to the sizes of wall panels window panels with double glazing are accepted. Windows in the production building on the A axis in two tiers, the windows are placed at a mark of 1.2 m from the level of the clean floor and have a height of 2.4 m and at a mark of 4.8 m, a height of 1.2 m. fully open.

Window specification.

Table 1.5.11.

Brand, Pos.	Marking	Name	Count	Mass, T	Note.
1	2	3	4	5	6
OK1	ГОСТ 11214-86	OP 24-36	7		
OK2	ГОСТ 11214-86	OP 12-36	7		
OK3	ГОСТ 11214-86	OP 24-12	7		
OK4	ГОСТ 11214-86	OP 12-12	11		
OK5	ГОСТ 11214-86	OP 24-24	1		
OK6	ГОСТ 11214-86	OP 12-15	11		

Door specification.

Table 1.5.12.

Brand, Pos.	Marking	Name	Count	Mass, T	Note.
1	2	3	4	5	6
D1	ГОСТ 6629-88	ДГ – 19.24	3		
D2	ГОСТ 6629-88	ДГ – 12.24	1		
D3	ГОСТ 6629-88	ДГ – 10.24-1	5		
D4	ГОСТ 6629-88	ДГ – 10.21	30		
D5	ГОСТ 6629-88	ДГ – 15.24	5		
D6	ГОСТ 6629-88	ДГ – 9.21	8		
D7	ГОСТ 6629-88	ДГ – 7.21	15		

1.5.2.11 Partitions

Internal partitions are made of clay and silicate bricks with a thickness of 120 mm. Partitions in the refrigerator, engine room and laboratory in the vestibule are lined with additional insulating material. Partitions in the frame part of the building on the ground floor rest on the foundation beams.

1.5.2.12 Roofing

The roof is designed from 6 layers:

• protective layer of gravel on antiseptic bituminous mastic;

• linochrome 3 layers;

• cement-sand screed 15 mm thick;

• insulation - expanded polystyrene 90 mm;

• vapor barrier - one layer of polyethylene film;

• cement-sand screed 20 mm thick;

In places of adjoining to parapets the apron from roofing steel for improvement of waterproofing properties of a roof is located. Drainage funnels are provided for drainage of precipitation from the roof. The slope of the roof in the frame part of the building is 1:12.

1.5.2.13 Floors

According to the purpose of production sites accepted in butter plant and plant on production of condensed milk of the industrial case the floor from asphalt concrete is projected.

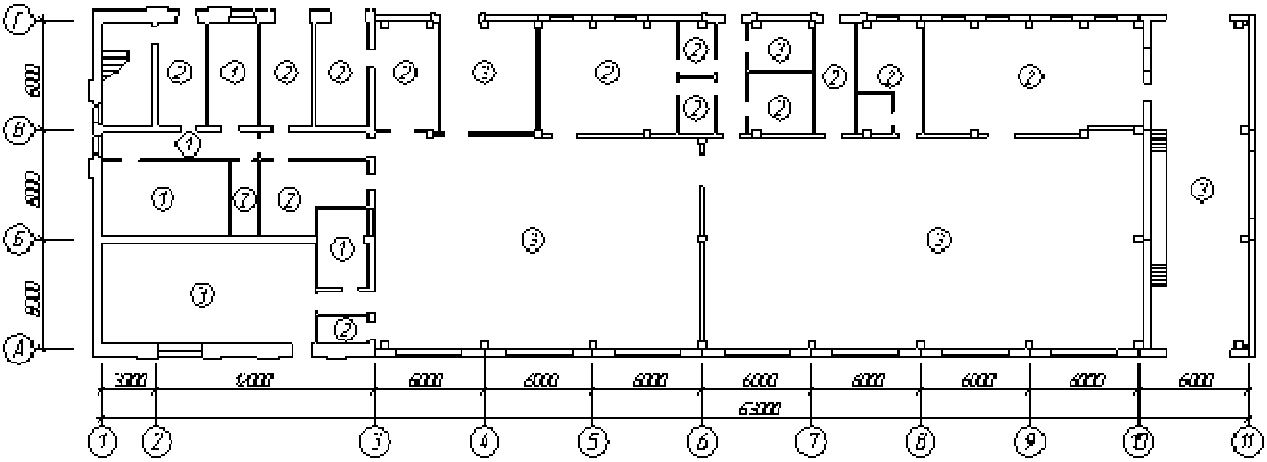


Fig. 1.5.13. The scheme of the floor on the assessment 0,000.

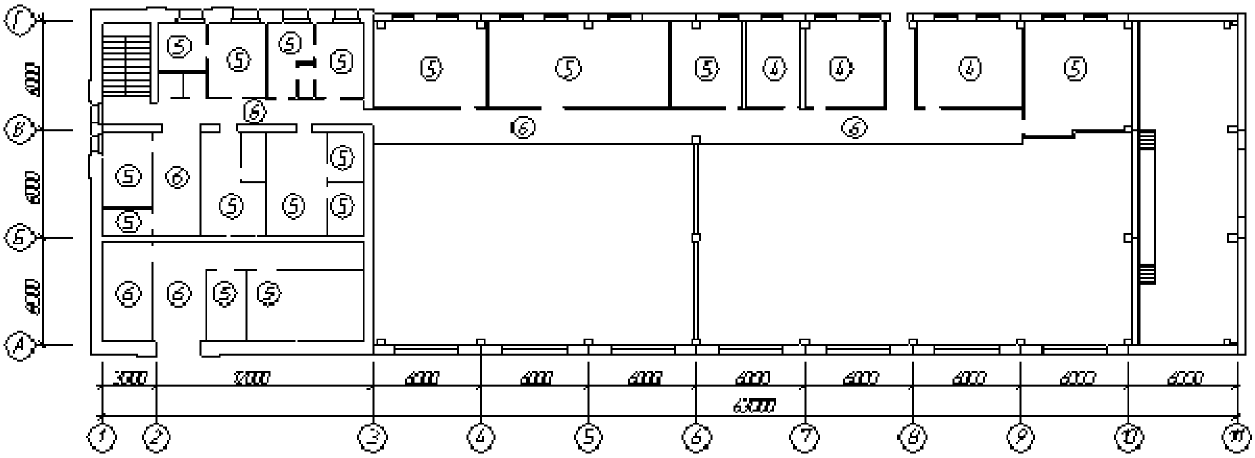
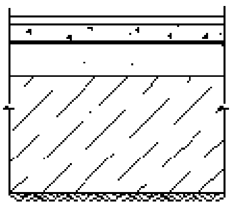
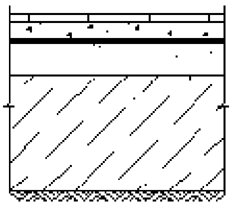
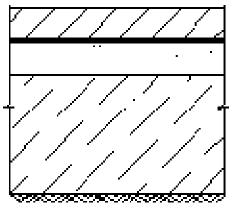
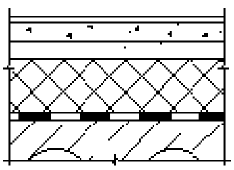
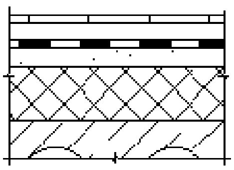
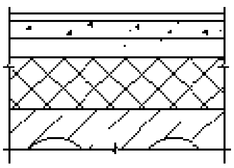


Fig. 1.5.13. The scheme of floors on an estimation 4,800.

Explication of the floor.

Table 1.5.13

N помещения	Тип пола	Схема пола	Элементы пола	Площадь м²
1 этаж				
21, 23, 25, 20	1		Линолеум,плитка ПВХ - 5мм Стяжка из цементного-песчаного раствора- 20мм Гидроизоляционный слой - 2 слоя гидроизола на битумной мастике Выравнивающа стяжка - 20мм Бетон - 80мм Щебень втопленный в грунт Уплотненный грунт	63,89
1, 2, 4-8, 9, 11-19, 24	2		Керамическая плитка - 5мм Стяжка из цементного-песчаного раствора- 20мм Гидроизоляционный слой - 2 слоя гидроизола на битумной мастике Выравнивающа стяжка - 20мм Бетон - 80мм Щебень втопленный в грунт Уплотненный грунт	416,9
3, 8, 10, 22	3		Асфальтобетон - 20мм Гидроизоляционный слой - 2 слоя гидроизола на битумной мастике Выравнивающа стяжка - 20мм Бетон - 100мм Щебень втопленный в грунт Уплотненный грунт	619,22
2 этаж				
27, 51, 52	4		Линолеум - 5мм Сухая штукатурка - 10мм Цементный раствор - 10мм Теплоизоляционная прокладка-30мм Звукоизоляция - 5мм	71,64
26, 29-41, 43-49	5		Керамическая плитка - 5мм Стяжка из цементного-песчаного раствора- 10мм Гидроизоляция - 5мм Стяжка из цементного-песчаного раствора- 10мм Теплоизоляционная прокладка-30мм	407,3
28, 42, 50	6		Линолеум, плитка ПВХ 5мм Сухая штукатурка - 10мм Цементно-песчаная стяжка - 20мм Теплоизоляционная прокладка 30мм	98,4

1.6 Finishing of facades and premises

Finishing of facades of the industrial and household brick case consists in plastering and painting by water-dispersed polymer-cement paint. The wall panels are painted, the brick inserts in the production building are plastered and also painted with water-dispersed polymer-cement paint.

Table 1.6 - List of finishing of premises

Name of the premises	Ceiling		Walls or partitions		The bottom of the walls or partitions		Processing of columns	
	area, м^2	Type of processing	area, м^2	Type of processing	area, м^2	Type of processing	area, м^2	Type of processing
Warehouses, chem. laboratory, vent chambers, pantries, switchboard,	740	Grout, painting with paints BA	940,4	Grout, painting with paints BA	210,2	Painting with oil paints	112,32	Grout, painting with polymer-cement paint
Production facilities	-	-	950,4	Grout, adhesive painting	-	-	94,7	Grout, painting with polymer-cement paint
Master's room, goal room. engineer, production manager's office	71,4	Grout, painting with water-emulsion paintЭ-8А-27А white	105,3	Plaster-rka, painting with water-emulsion paint	-	-	19,2	Grout, painting with water-emulsion paintЭ-8А-27А
Bathrooms, showers	68,3	Grout, silicate painting	103,1	Plaster-rka, silicate painting	31,5	Ceramic tile	-	-

1.7 Substantiation of the constructive decision of the building

1.7.1 Thermal calculation of enclosing structures

- Output data:
- construction site of cairo city EGYPT;

- operating conditions «Б»according to ДБН 23-03-2003;
- construction site of cairo city EGYPT;
- humidity is normal;
- humid zone is normal according to ДБН 23-03-2003;
- internal air temperature +20 pers.
-
- Thermal calculations of the roof in the frame part of the building
-
- Roof construction:
- protective layer of gravel on antiseptic bituminous mastic;
- waterproofing carpet from 3 layers of linochrome $\lambda 1$ = 0,17 W/(^{oc}·м^2), δ_1 = 12 мм, γ = 4 kg/м^2;
- Scaffolding their cement-sand mortar $\lambda 2$ = 0,93 W/(^{oc}·м^2), δ_2 = 15 мм, γ = 1800 kg/м^3;
- Insulation - expanded polystyrene $\lambda 3$= 0,05 W/(^{oc}·м^2), γ = 40 Kg/м^3;
- Vapor barrier - 1 layer of polyethylene film;
- Scaffolding their cement-sand mortar $\lambda 4$ = 0,93 W/(^{oc}·м^2), δ_4 = 20 мм, γ = 1800 kg/м^3;
- • Prefabricated reinforced concrete ribbed slab 6x3 m with a shelf thickness $\delta 5$ = 30 мм, $\lambda 5$ = 2,04 w /(^{oc}·м^2).

Degree of the heating period:

де *tint* = 18 ^{oc} – estimated average indoor air temperature;

tht і *Zht* – the average temperature and duration of the period with the average daily air temperature is less + 8 ^{oc}.

Determine the value of heat transfer resistance according to ГСОП:

D_d	- R
4000	- 1,8
6000	- 2,2

Then at $D_d = 4884{,}1$ calculated heat transfer resistance os • m2 / W.

Normative value of heat transfer resistance:

$$R_{red} = a \cdot D_d + b = 0{,}0002 \cdot 4884{,}1 + 1{,}0 = 1{,}98^{oc} \cdot м^2/w,$$

where a and b coefficients are taken from table. 4 ДБН 23-03-2003.

Heat transfer resistance of enclosing structures:

$$R_o = \frac{1}{\alpha_i} + \frac{\delta_1}{\lambda_1} + \frac{\delta_2}{\lambda_2} + \frac{\delta_3}{\lambda_3} + \frac{\delta_4}{\lambda_4} + \frac{\delta_5}{\lambda_5} + \frac{1}{\alpha_e}$$

де α_i - the heat transfer coefficient of the inner surface of the enclosing structures, according to table. 4 ДБН II-3-79*;

δ_i - layer thickness;

λ_i - the calculated thermal conductivity of the layer material;

α_e - heat transfer coefficient of the outer surface of the enclosing structures, according to table. 6 ДБН II-3-79*.

Equating $R_o = R_{red}$ determine the thickness of the insulation:

$$1{,}98 = \frac{1}{8{,}7} + \frac{0{,}012}{0{,}17} + \frac{0{,}015}{0{,}93} + \frac{\delta_3}{0{,}05} + \frac{0{,}02}{0{,}93} + \frac{0{,}03}{2{,}04} + \frac{1}{23},$$

$$\delta_3 = (1{,}98 - \frac{1}{8{,}7} - \frac{0{,}012}{0{,}17} - \frac{0{,}015}{0{,}93} - \frac{0{,}02}{0{,}93} - \frac{0{,}03}{2{,}04} - \frac{1}{23}) \cdot 0{,}05 = 0{,}0849 \text{ м.}$$

Accepts the thickness of the insulation - expanded polystyrene is 90 mm.

Thermal calculations of the roof in the brick part of the building

Roof construction:

- protective layer of gravel on antiseptic bituminous mastic;
- waterproofing carpet from 3 layers of linochrome $\lambda 1$ = 0,17 W/(^{oc}·м^2), δ_1 = 12 мм, γ = 4 кг/м^2;
- Scaffolding their cement-sand mortar $\lambda 2$ = 0,93 W/(^{oc}·м^2), δ_2 = 15 мм,
- γ = 1800 кг/м^3;
- Insulation - expanded polystyrene $\lambda 3$ = 0,05 W/(^{oc}·м^2), γ = 40 kg/м^3;
- Expanded clay gravel with a slope from 0 to 120 mm, γ = 600 kg/м^3;
- Vapor barrier - 1 layer of polyethylene film;
- Scaffolding their cement-sand mortar $\lambda 4$ = 0,93 W/(^{oc}·м^2), δ_4 = 20 мм,
- γ = 1800 kg/м^3;
- Prefabricated reinforced concrete round hollow slab thickness $\delta 5$ = 220 мм,
- $\lambda 5$ = 1,92 W/(^{oc}·м^2).

Equating $R_o = R_{red}$ determine the thickness of the insulation:

$$1{,}98 = \frac{1}{8{,}7} + \frac{0{,}012}{0{,}17} + \frac{0{,}015}{0{,}93} + \frac{\delta_3}{0{,}05} + \frac{0{,}02}{0{,}93} + \frac{0{,}22}{1{,}92} + \frac{1}{23},$$

$$\delta_3 = (1{,}98 - \frac{1}{8{,}7} - \frac{0{,}012}{0{,}17} - \frac{0{,}015}{0{,}93} - \frac{0{,}02}{0{,}93} - \frac{0{,}22}{1{,}92} - \frac{1}{23}) \cdot 0{,}05 = 0{,}079$$ м.

Accepts the thickness of the insulation - expanded polystyrene is 80 mm.

Thermal calculations of a wall protection in a frame part of the building

- Construction of a wall protection:
- expanded clay concrete on expanded clay sand$\lambda_{1,3}$= 0,92 W/(°C ·м²), γ= 1800 kg/м³;
- insulation - foam ПВ-1 λ_2= 0,064 W/(°C ·м²), γ= 125 kg/м³.

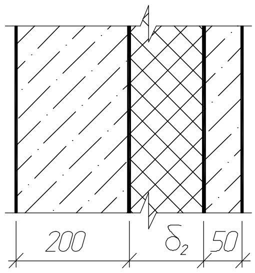


Fig. 1.7.1. Wall panel design.

Degree of the heating period: $D_d = (t_{\text{int}} - t_{ht}) \cdot Z_{ht} = (18 + 4{,}1) \cdot 221 = 4884{,}1$

де t_{int} = 18 °C – estimated average indoor air temperature;

t_{ht} и Z_{ht} – the average temperature and duration of the period with the average daily air temperature is less + 8 °C.

Determine the value of heat transfer resistance by ГСОП for walls:

D_d	- R
4000	- 1,8
6000	- 2,2

Then at $D_d = 4884{,}1$ calculated heat transfer resistance $R = 1{,}98$ °C ·м²/W.

Normative value of heat transfer resistance:

$R_{red} = a \cdot D_d + b = 0{,}0002 \cdot 4884{,}1 + 1{,}0 = 1{,}98$°C ·м²/W, where a and b coefficients are taken from table. 4 ДБН 23-03-2003.

Heat transfer resistance of enclosing structures:

$$R_o = \frac{1}{\alpha_i} + \frac{\delta_1}{\lambda_1} + \frac{\delta_2}{\lambda_2} + \frac{\delta_3}{\lambda_3} + \frac{1}{\alpha_e}$$

Equating $R_o = R_{red}$ determine the thickness of the insulation:

$$1{,}98 = \frac{1}{8{,}7} + \frac{0{,}2}{0{,}92} + \frac{0{,}05}{0{,}92} + \frac{\delta_2}{0{,}064} + \frac{1}{23}, \quad \delta_2 = (1{,}98 - \frac{1}{8{,}7} - \frac{0{,}2}{0{,}92} - \frac{0{,}05}{0{,}92} - \frac{1}{23}) \cdot 0{,}064 = 0{,}11 \text{ м.}$$

Accepts the thickness of the insulation – polyfoam ПВ-1 equal 150 мм and the thickness of the wall panel, respectively 400 мм.

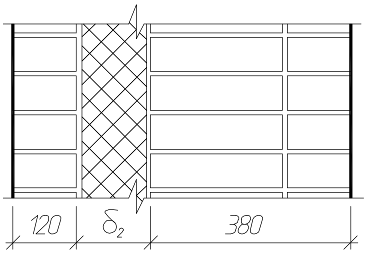
Thermal calculations of a wall protection in a brick part of the building

Construction of a wall protection:

silicate brick on cement-sand mortar $\lambda_{1,3}$= 0,7 W/($^oC \cdot м^2$),

γ= 1800 kg/м^3;

Fig. 1.7.2. Wall construction.



Equating $R_o = R_{red}$ determine the thickness of the insulation:

$$1{,}98 = \frac{1}{8{,}7} + \frac{0{,}12}{0{,}7} + \frac{0{,}38}{0{,}7} + \frac{\delta_2}{0{,}05} + \frac{1}{23}, \quad \delta_2 = (1{,}98 - \frac{1}{8{,}7} - \frac{0{,}12}{0{,}7} - \frac{0{,}38}{0{,}7} - \frac{1}{23}) \cdot 0{,}05 = 0{,}056 \text{ м.}$$

Approves thickness of a heater - expanded polystyrene is equal 60 mm and wall thickness accordingly 640 mm.

1.7.2 Calculation of sound insulation of a partition

The frequency response of airborne noise insulation by a frame-sheathing partition when filling the air gap with porous or porous-fibrous material is constructed in the following sequence.

The frequency response of sound insulation with an unfilled air gap is constructed. In this case, the total surface density of the structure

$m_{общ}$ when determining the correction, the surface density of the filling of the air gap is included.

The resonance frequency of the structure when filling the gap with a porous material with a solid skeleton (foam, polystyrene, fibrolite, etc.), the resonance frequency should be determined by the formula:

$$f_р = 0{,}16\sqrt{\frac{E_д\,(m_1 + m_2)}{d\, m_1 m_2}}, \text{ Hz}$$

where:

m_1 i m_2 – surface densities of linings, kg /м^2;

d – the thickness of the air gap, м;

$E_д$ – dynamic modulus of elasticity of the filling material, PA.

If the cladding does not stick to the filling material, the value $E_д$ are adopted with a coefficient 0,75.

Up to the resonant frequency inclusive ($f \le f_р$)the frequency response of the soundproofing of the structure completely coincides with the frequency response constructed for a partition with an unfilled air gap.

On frequencies $f \ge 1{,}6 f_р$ sound insulation is increased by an additional amount ΔR_4 (table. 15).

Table 15

Filling material	Filling the gap	ΔR_4
Porous-fibrous (mineral wool, fiberglass)	50-100%	5

When constructing the frequency response of the sound insulation of the structure at the frequency $f = 1{,}6 f_р$ (2 tertiary bands above the resonance frequency) a dot is marked Q with an ordinate of magnitude ΔR_4 above the point lying on the segment FK

, and connects to the point F. Next, the frequency response is built in parallel with the frequency response of the sound insulation of the structure with an unfilled air gap - line $A_1EFQK_1L_1M_1N_1P_1$ (Fig. 22).

When constructing the frequency character of the sound insulation of a structure on the frequency $f = 1{,}6f_p$ (2 third-octave bands above the resonance frequency) a point with an ordinate of magnitude is marked ΔR_4 above the point lying on the segment FK, and connects to a point F. Next, the frequency character of Maltika is built in parallel with the frequency character of the sound insulation of a structure with an unfilled air gap - line $A_1EFQK_1L_1M_1N_1P_1$ (Fig. 22).

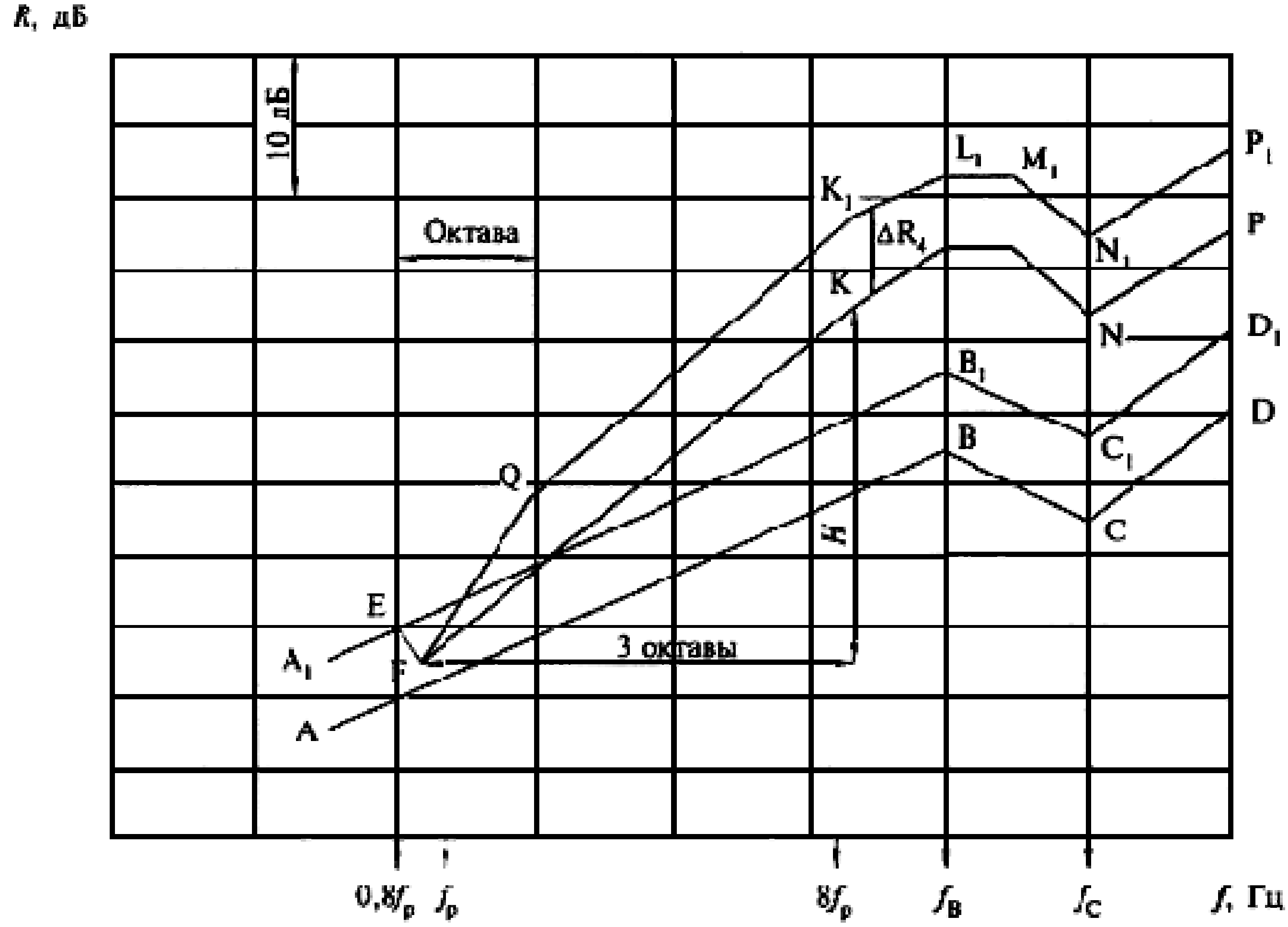


Fig. 22. Frequency characteristic of air noise isolation by a frame and sheathing partition with filling of an air gap

Calculations of airborne noise insulation characteristics by structures

The results of calculations of frequency characteristics of sound insulation Rb and sound insulation indices Ib and Rw for fences consisting of two sheets of GCL of different thickness 12.5 mm and 2 * 12.5 mm are presented in fig. 23 and in table. 18;

Description of the design: f_B = 500 hz R_B = 36 DB

h_1 =12,5 мм f_C = 1000 hz R_C = 30 DB

h_2 = 3*12,5 мм f_P = 63 hz R_K = 50 DB

γ = 1000 kg/м3 f_K = 500 hz

δ = 100 мм fF = 63 hz

δ_{3B} = 50 мм

Table 18

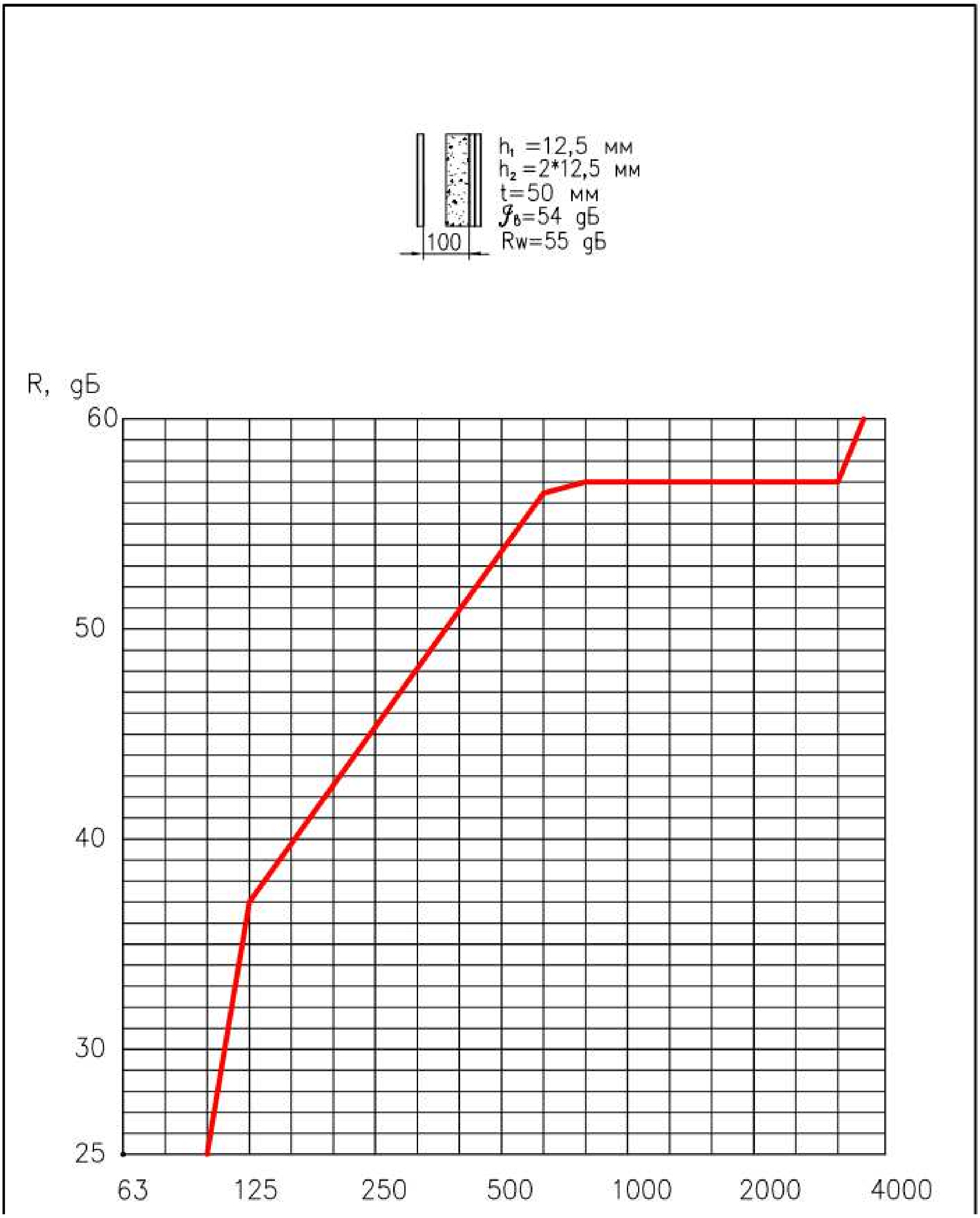
Geometric averages band frequency, Hz		R вн	Rв Σ	δ Δ=0	δ Δ=	Rwн	δ Δ=0	δ Δ=2
63	40							
	63							
	80							
125	100	27	36	-		33	-3	-1
	125	32	39	-		36	-3,5	-1,5
	160	37	42	-1,5	-	38	-2,5	-0,5
250	200	42	45	-3,5	-1,5	42	-3,5	-1,5
	250	45	47	-4	-2	45	-4	-2
	320	48	50	-4	-2	48	-4	-2
500	400	51	53	-4	-2	51	-4	-2
	500	53	51	-3	-1	52	-2	-
	630	55	51	-5	-3	53	-3	-1
1000	800	56	51	-6	-4	54	-4	-2
	1000	56	51	-6	-4	55	-5	-3
	1250	56	51	-6	-4	56	-6	-4
2000	1600	56	51	-6	-4	56	-6	-4
	2000	56	51	-6	-4	56	-6	-4
	2500	55	51	-5	-3	56	-6	-4

4000	3200	54	51	-4	-1	56	-6	-4
	4000	52	59	-				
	5000	50						
Σ				64	35,5		68,5	36,5
		$I_B = 50 + \Delta = 50+2=52$				$R^1_W = 52 + \Delta = 52+2=54$		

Conclusion about the soundproofing qualities of the enclosing structure:

$I_B = 52$ DB; $R^1_W = 54$ DB

$I_B^H = 45$ DB ‹ $I_B = 52$ DB – therefore, the fence meets the regulatory value (45 dB).


h₁ =12,5 мм
h₂ =2*12,5 мм
t=50 мм
Jв=54 дБ
Rw=55 дБ
100
R, дБ
60
50
40
30
25
63
125
250
500
1000
2000
4000

1.7.3 Lighting calculation of the premises

Construction site – мcairo city EGYPT.

Spatial planning characteristics of the premises:

the length of the premises l_n = 42 м;

depth of the premises B = 12 м;

area of sufficient natural light in one-sided lighting $S_n = L_n \cdot 1{,}5 \cdot B = 42 \cdot 1{,}5 \cdot 12 = 756$ м^2;

the height of the conditional work surface h_0= 0,8 м;

preliminary assessment of the top of the window h_{60}= 6 м;

height from the level of the work surface to the top of the window

$h_1 = h_{60} - h_0 = 6 - 0{,}8 = 5{,}2$ м;

the ratio of the length of the premises to its depth$ln/B = 42/12 = 3{,}5$;

the ratio of the depth of the room to the height from the level of the work surface to the top of the window$B / h_1 = 12/5{,}2 = 2{,}31$.

- Lighting characteristics:
- category of visual work IV;
- weighted average reflection coefficient of the ceiling, walls and floorp_{cp} = 0,35.

Normative value of KEO:

The construction area is in an area with unstable snow cover,

m = 0,9 – light climate coefficient.

For side lighting $e_н$ = 1,5 % - the value of KEO in the characterization of visual work - the average accuracy of ДБН В.2.5-28-2006 «Natural and artificial lighting».

The normative value of KEO is determined: $e_n = m \cdot e_H = 0{,}9 \cdot 1{,}5 = 1{,}35$ %

Approximate calculations of the area of glazing of windows

Calculations of the area of windows are carried out according to the formula:

$$S_0 = \frac{S_n \cdot k_3 \cdot e_n \cdot \eta_0}{100 \cdot T_0 \cdot r_1},$$

WHERE $\eta_0 = 7{,}5$ – lighting characteristics of windows;

r_1= 3,22 – coefficient that takes into account the increase in KEO in side lighting due to light, reflected from the surfaces of the room and the underlying layer adjacent to the building;

k_3= 1,3 – stock coefficient;

$To = T_1 \cdot T_2 \cdot T_3 \cdot T_4 \cdot T_5$= 0,8 · 0,6 · 0,8 · 0,8 · 1 = 0,31 – the total light transmittance of the windows

$$S_0 = \frac{756 \cdot 1{,}3 \cdot 1{,}35 \cdot 7{,}5}{100 \cdot 0{,}31 \cdot 3{,}22} = 99{,}7\,м^2$$

I accept the total height of the windows in the two tiers equal to 3.6 m.

Verification recalculation

Indicator, formula	Link to ДБН	Settlement point				
		1	2	3	4	5
Distance to the settlement point, m	-	1	3,5	6	8,5	11
n1	graph I	36	28	20	15	12
n2	graph II	66	53	51	50	49
e6 = 0,01 · n1 · n2	-	23,76	14,84	10,2	7,5	5,88
□	-	1,32	1,32	1,32	1,32	1,32
Q	Table. 35	1,23	1	0,78	0,74	0,69
τ_0	-	0,31	0,31	0,31	0,31	0,31
r1, при рср = 0,35	-	1,05	1,36	2,26	2,8	3,78
Кз	-	1,3	1,3	1,3	1,3	1,3
$e^б{}_р = e_б \cdot \beta \cdot q \cdot r_1 \cdot \frac{\tau_0}{k_3}$	-	9,66	6,35	5,66	4,89	4,83

The estimated value of k.e.o. satisfies the requirement ДБН В.2.5-28-2006 «Natural and artificial lighting "both on normal value, and on unevenness of natural lighting, proceeding from the received settlement values of k.e.o., which at lateral illumination of the room in all settlement points not less than normative value

1.8 НДРС. Thermal features of calculation of inversion roof

1.8.1 General information about inversion roofs

Inversion (from the Latin inversio - overturning, permutation) is a roof, the construction of which is "inverted" in comparison with the traditional one, ie the insulation layer is not under the waterproofing carpet, but above it. This design was developed and implemented in construction after the advent of a new generation of insulation - solid extruded polystyrene, which is a heat-insulating material with evenly distributed closed (closed) sockets, which does not absorb water, does not swell and does not shrink, has high mechanical strength stable and not subject to rot. These properties of a heater allow to place it over a waterproofing for which it is also protection against external influences (appendix 1).

Another important property of this insulation is that it is resistant to rot and does not contribute to the spread of mold and fungi, which is quite relevant for the construction of inverted roofs, as the insulation is in a closed, unventilated space.

This device of inversion roof gives a significant impetus to the use of flat roofs and reduce operating costs.

The advantages of inversion roofs include: protection of waterproofing from temperature changes and mechanical damage, the possibility of quick installation in any weather, no need for a vapor barrier layer. Consider the advantages of inverted roof compared to the classic design.

In a design of an inversion roof the waterproofing membrane is protected from temperature influences (temperature differences, limit values, cyclic freezing-thawing), from destructive influence of UV irradiation and mechanical damages;

Waterproofing membrane is less costly, because it is protected by a layer of thermal insulation material (extruded polystyrene foam);

Plates of extruded expanded polystyrene are not fixed on the membrane (free laying), thus do not create destructive stresses in the areas of fixation, which lead to damage to the membrane;

The waterproofing membrane, being under a layer of heat-insulating material (extruded expanded polystyrene), actually plays a role of vapor barrier, reducing risk of internal condensation of moisture and reducing design cost.;

The thermal insulation layer (extruded polystyrene foam), as well as the protective layer of gravel, reliably protect the waterproofing membrane from any mechanical influences during construction and subsequent operation;

The waterproofing membrane is fixed on the surface of the roof, which also reduces the likelihood of mechanical damage;

At dismantling of a roofing (for example, reconstruction of the building) plates of heat-insulating material on the basis of extruded expanded polystyrene can be reused (widespread practice in Europe and the USA);

When leaks occur, waterproofing faults are easily identified and repaired, because the gravel layer, the separation-filtration layer of geotextiles and plates of thermal insulation material (extruded polystyrene foam) are easily removed and, after removing the leak, mounted back;

During the implementation of the concept of inversion roof, it is possible to create "green" roofs, operated terrace structures up to the organization of parking lots through the use of thermal insulation boards;

It is possible to increase the thermal insulation parameters of the roofing by creating a "roof plus";

Extruded polystyrene boards can be laid in any weather, which makes the construction cycle virtually year-round.

As an example, fig. 1. shows the annual temperature difference in the waterproofing layer with a traditional roofing carpet and with the device of inversion roof. The figure shows that in the inversion roof, the waterproofing layer is almost all year round at a constant temperature close to the temperature inside the building. Characteristically, this actually eliminates the formation of condensate, and there is no need to arrange vapor barrier.

The following factors must be taken into account when choosing such a constructive solution:

- Difficulty of repair
- Requires a longer roof life
- Higher load on the structure
- Temperature-humidity regime, which is different from the usual regime
- More difficult drainage of water from the roof
- Cost
- Chemical and biological effects
- The need for root protection

Problems that arise when violating design requirements:

- Leakage
- Destruction of the roof structure
- Rotting of soil and plants
- Drying, freezing of the plant layer
- Typical projects usually do not take into account:
- Drainage between the waterproofing and thermal insulation layers for the inversion system.

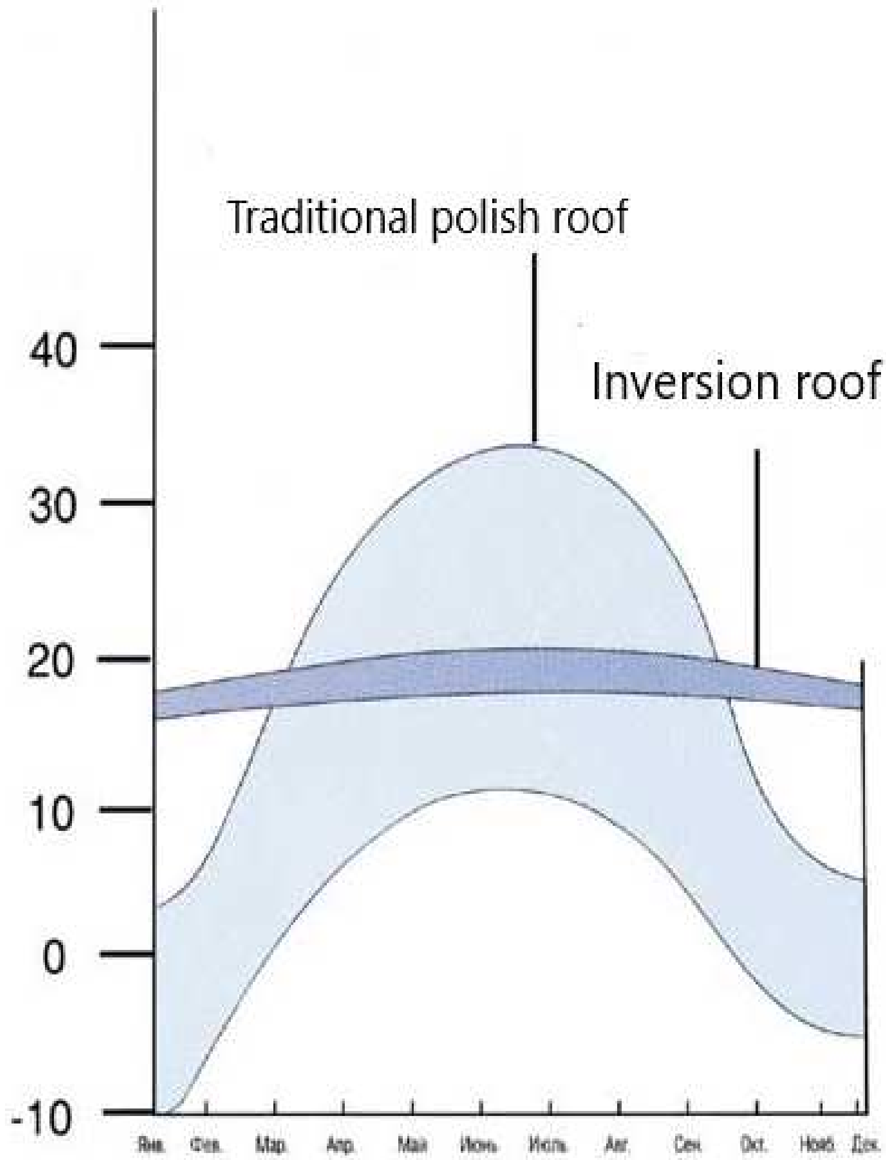


Fig.1.8.1. Graphs of temperature difference on the surface of the waterproofing layer in a traditional flat roof and in inversion roof.

The inverted roof design, developed in the early 50's in the US by Dow, has proven its effectiveness around the world.

Inversion roofs, known in Western Europe since the 60's, appeared in Russia in the late 80's. In 1994, the roof of the Stolychny Bank building was covered, and later such large facilities as the Church of Christ the Savior (overlap of the stylobate part), a shopping complex on Manezhnaya Square (upper floor), and the Bolshoi Theater (overlap of the engineering block) were built.), a complex of buildings of RAO "Gazpom" (ceiling of the underground garage) and many others.

Scheme of the device of an inversion roof:

1. A layer of gravel at least 50 mm thick
2. Filter material
3. Heater from extruded expanded polystyrene
4. Waterproofing carpet
5. Scaffolding
6. Slab contraction joints

The design of an inversion roof allows to use it as the operated flat roof which device opens additional opportunities for the organization of parking lots, pedestrian zones, summer cafes and gardens.

The main problem of inversion roofs is moisture, which is almost always present between thermal and waterproofing. In addition, even a very thin layer of water between the thermal and waterproofing leads to a decrease in thermal resistance of the structure, which can be quite significant. There is even an opinion that the inversion type of roofs is not optimal for areas with a humid climate (study by EUTON S.A. (Belgium) "Exploited and green roofs").

However, numerous studies by independent expert services have shown high functional reliability and durability of "inversion" roof structures. Based on the research data, the Institute of Construction Technology (Berlin) issued a permit for the use of this concept (number Z-23.4-101.1), which was later confirmed by such authoritative permitting bodies as the BBA (British Board of Agreement) and CEN..

1.8.2 Analysis of constructive decisions

During the operation of traditional roofs, the formation of condensate on the inner surfaces, in the nodes adjacent to the parapet, mounting antennas, funnels, etc..

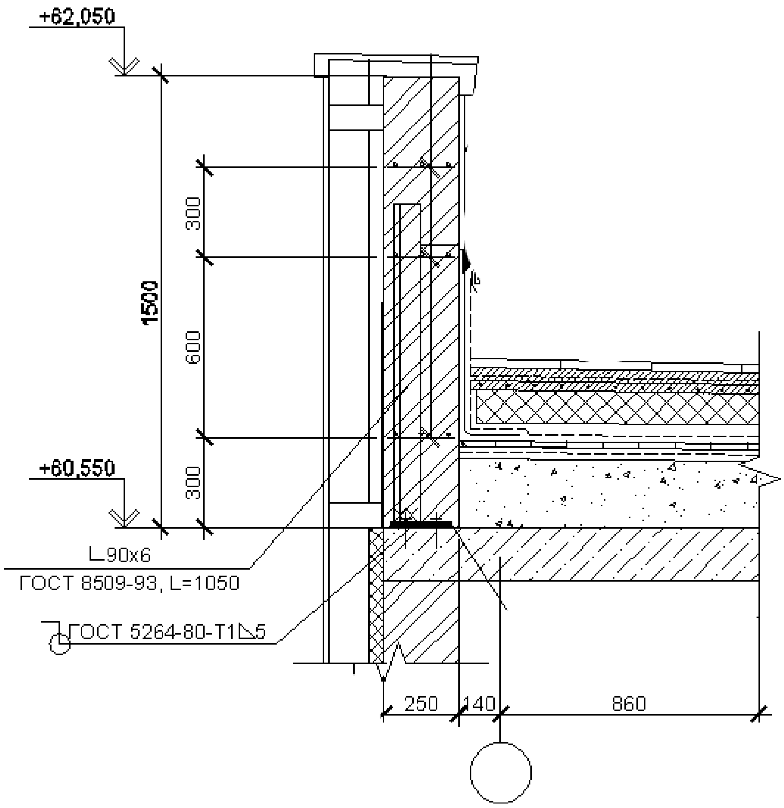


Fig.2.Analysis of constructive decisions.

Insulation brought to the level of the coating can lead to the formation of a "cold bridge", and on the inner surface of the coating may form condensation. It is necessary to make verification calculations.

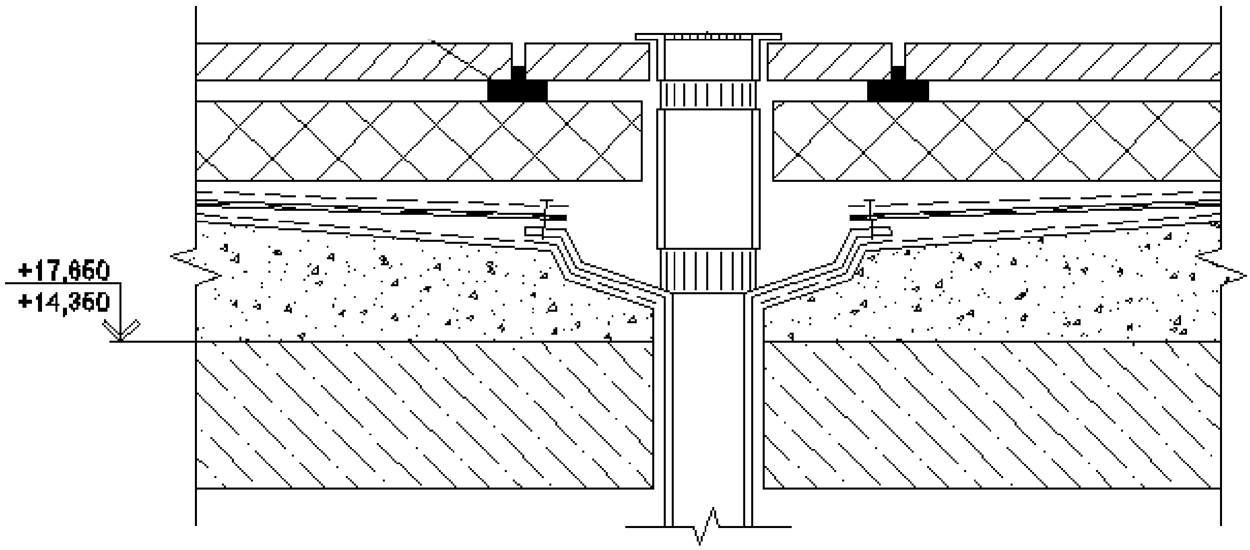


Fig.3. Knot in the place of the funnel.

As it was told above the traditional roof has a number of lacks therefore we replace it with inversion and we do for it calculations on possibility of formation of condensate.

1.8.3 Calculation of the possibility of condensation

According to table 1 [1], the minimum allowable value of the heat transfer resistance surrounding the structureRq_{min} = 3.3 м^2 ·К/Вт.

Estimated thermal characteristics of materials.

Estimated thermal characteristics of the materials are adopted in Annex L [1] and are given in table 1.

The following layers are not considered in heat engineering calculations: a waterproofing membrane, geotextiles.

Table 1 - Estimated thermal characteristics of materials

N layer	The name of the layer	Density ρ, kg / m3	Thickness δ, м	Thermal conductivity λ, W/($м^2$·K)
1	Reinforced concrete slab coating	2500	0,18	2,04
2	Expanded clay gravel	200	0,020	0,12
3	Cement-sand mortar	1600	0,035	0,81
4	Extruded polystyrene foam	39	0,100	0,037
5	Cement-sand mortar	1600	0,040	0,81
6	The tile is porcelain tile	2000	0,009	1,1

Thermally homogeneous design consists of all the elements indicated in Fig.1 and their characteristics are shown in table 1.

In this way, the heat transfer resistance is equalized:

$$R_\Sigma = \frac{1}{\alpha_в} + \sum_{i=1}^{n} R_i + \frac{1}{\alpha_з} = \frac{1}{\alpha_в} + \sum_{i=1}^{n} \frac{\delta_i}{\lambda_{i\,p}} + \frac{1}{\alpha_з}$$

=1/8,7+0,18/2,04+0,02/0,12+0,035/0,81+0,10/0,037+0,04/0,81+ 0,009/1,1+1/23=3.76 $м^2$·K/Вт.

Condition (1) [1] $R_\Sigma = 3{,}22$ $м^2$ К/Вт ≤ $R_{q\min} = 3{,}3 м^2$ К/Вт

not executed.

We increase the thickness of the insulation to 120 mm. In this way, the heat transfer resistance is equalized:

$$R_\Sigma = \frac{1}{\alpha_в} + \sum_{i=1}^{n} R_i + \frac{1}{\alpha_з} = \frac{1}{\alpha_в} + \sum_{i=1}^{n} \frac{\delta_i}{\lambda_{i\,p}} + \frac{1}{\alpha_з}$$

=1/8,7+0,18/2,04+0,02/0,12+0,035/0,81+0,12/0,037+0,04/0,81+ 0,009/1,1+1/23=3.76 $м^2$·K/Вт.

Condition [1] $R_\Sigma = 3{,}76$ $м^2$ К/Вт > $R_{q\min} = 3{,}3 м^2$ К/Вт

SECTION 2. REINFORCED CONCRETE STRUCTURES

2.1. Layout of elements`

The spatial rigidity of a one-storey industrial building is provided by a covering disk and firm clamping of columns in the bases.

The actual height of the production room in the frame part of the building is equal to Hп = 7.2 m.

The height of the column from the edge of the foundation to the bottom of the rafter structure:

H = Hп +0.15 = 7.2 + 0.15 = 7.35 m.

For buildings with a step of columns a = 6 m at Hп = 7,2 m binding of reinforced concrete columns "0" is accepted.

For the heating buildings with a step of columns of 6 m wall panels, thickness are acceptedδ_{cm} = 400 мм. The height of the buildingfrom the edge of the foundation to the top of the wall is equal to Hl = 9.15 m. The height of the wall panels is 1.2 m and 1.8 m.

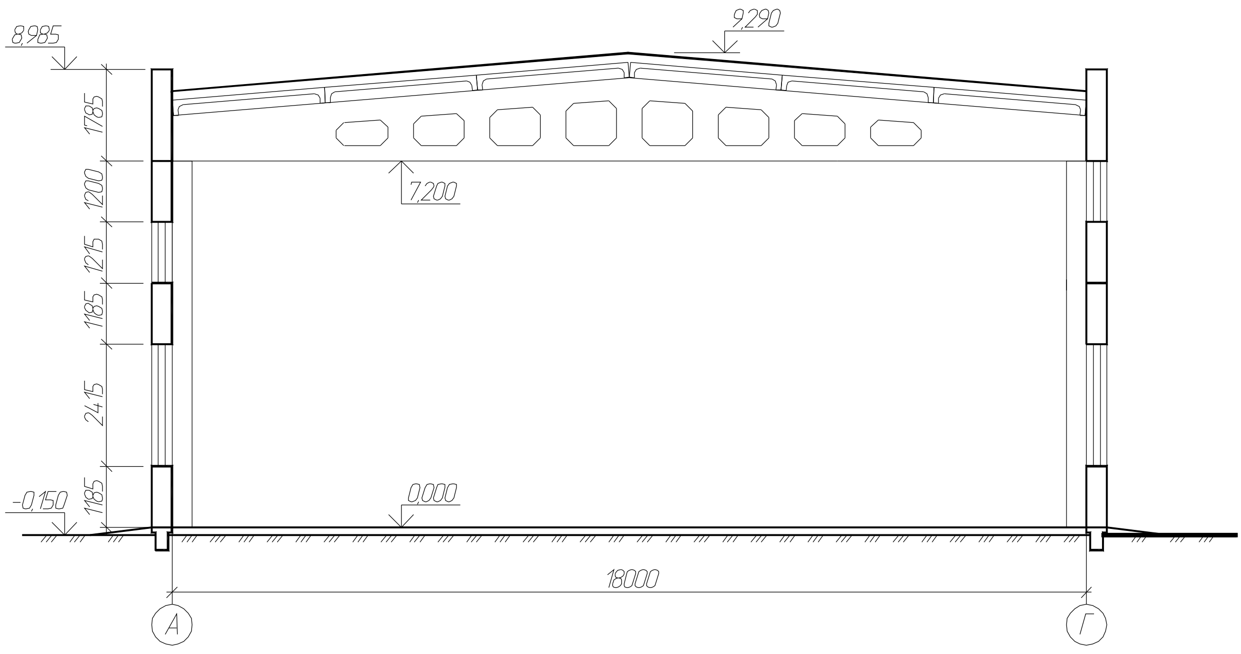


Fig. 2.2.1. Cross section of the production part of the building.

2.2. Determination of loads.

Table 2.1.

№ п/п	Name of loads		Regulatory load Nn, kn / m2	Odds. reliable. $\gamma\phi$	Estimated load N_p, кn/м^2
	Constant loads:				
1.	Layer of gravel on bituminous mastic $\delta 1$ = 10 мм, γ= 2000 kg/м^3		0,196	1,3	0,255
2.	Roll carpet of 3 layers of linochrome $\delta 1$ = 12 мм, γ= 4 kg/м^2		0,147	1,3	0,191
3.	Scaffolding their cement-sand mortar $\delta 2$ = 15 мм, γ= 1800 kg/м^3		0,265	1,3	0,344
4.	Insulation - expanded polystyrene γ = 40 kg/м^3, $\delta 2$ = 90 мм		0,051	1,2	0,061
5.	Scaffolding their cement-sand mortar $\delta 4$ = 20 мм, γ= 1800 kg/м^3		0,353	1,3	0,459
6.	Prefabricated reinforced concrete ribbed slab 3x12 m (option I)		2,01	1,1	2,21
7.	Prefabricated reinforced concrete ribbed slab 3x6 m (option II)		1,54	1,1	1,694
	Temporary loads:				
8.	Snow		1,68	0,7	2,4
9.	Total	Option I	4,7		5,92
		Option II	4,24		5,4

2.3.Strategic calculation of a single-span transverse frame.

The calculations of the transverse frame of a one-storey industrial building take into account the solid clamping of the columns in the foundation. Due to the high hardness in the plane of the frame, the rafter beam is considered to be absolutely rigid.

Initial data for calculations of a single-span transverse frame.

Table 2.3.1.

№	The initial value	Designation and dimension	Number value
1.	Surname and number of the variant	–	01166
2.	Extension to the left of the building	–	None
3.	Extension to the right of the building	–	None
4.	The height of the cross section of the crane part of the extreme column	h_B^K, *(м)*	0,4
5.	The height of the cross section of the crane part of the extreme column	h_H^K, *(м)*	0,4
	The height of the crane part of the extreme column	H_B^K, *(м)*	7,2
	The height of the crane part of the extreme column	H_H^K, *(м)*	0,000001
	The height of the section of the branch of the extreme two-branch column	h_K, *(м)*	0
	The number of slots of the extreme two-branch column	n_K, *(шт)*	0
	The width of the section of the extreme column	b_K, *(м)*	0,4
	The height of the cross section of the crane part of the middle column	h_b^C, *(м)*	0
	Modulus of elasticity of concrete columns	E_b, *(МПа)*	27000
	Binding size	*BINDING, (м)*	0
	Estimated load from the weight of the coating and the roof	*q, (кН/м²)*	3
	The weight of the crossbar	G_P, *(кг)*	12100
	Mass of snow cover per 1 m2 of land surface	S_0, *(кг/м²)*	240
	Wind pressure at a height of 10 meters	q_0, *(кг/м²)*	23
	Crane capacity	*Q, (т)*	32
	Maximum crane wheel pressure	$Fn_{, max}$, *(кН)*	235

	Minimum crane wheel pressure	*Fn*$_{, min}$, *(кН)*	108,5
	Step columns	*a, (м)*	6
	Flight of the building	*l, (м)*	18
	The height of the building to the top of the wall	*Hl, (м)*	9,0
	The total height of the glazing panels in the crane part of the building	Σh_{OC}*, (м)*	3,6
	The total height of the wall panels in the crane part of the building	Σh_{CT}*, (м)*	5,4

As a result of static calculations of a single-span frame the following efforts in settlement sections 1-1 and 2-2 of an extreme column and a combination of loadings are received:

Table 2.3.2.

	№	KC	Efforts in the calculated cross sections of the extreme column				
			1 – 1		2 – 2		
			M	N	M	N	Q
1	1	1	-8,6	215,9	4,3	245,4	1,8
2	2 3	1 0,9	-6,8 -6,1	169,1 152,2	3,4 3	169,1 152,2	1,4 1,3
3	14 15	1 0,9	0 0	0 0	47,7 42,5	0 0	11,7 10,6
4	16 17	1 0,9	0 0	0 0	43,8 39,4	0 0	9,3 -8,4

where

1 - constant;

2 - snow;

3 - wind to the left;

4 - wind to the right.

Table 2.3.3.

Odds. combinations	A combination of efforts	Crossing	
		1–1	2–2
0,9	Download	1	1+3+15
	M_{max} N_{coom} Q_{coom}	/	49,2 397,6 13,7
	download	1+3	1+17
	M_{min} N_{coom} Q_{coom}	/	-35,1 245,4 -6,6
	Download	1+3	1+3
	N_{max} M_{max} Q_{coom}	/	397,6 7,3 3,1
1	download	1	1+2+14
	M_{max} N_{coom} Q_{coom}	/	55 414,5 14,9
	download	1+2	1+16
	M_{min} N_{coom} Q_{coom}	-15,4 385 3,1	-39,5 245,4 11,1
	Download	1+2	1+2
	N_{max} M_{max} Q_{coom}	385 -15,4 3,1	414,5 7,9 3,1

2.4. Calculation and design of pre-stressed coating panel.

Prefabricated reinforced concrete ribbed slabs of 3x6 m are used to cover the building with a span of 18 m and a pitch of columns.

The panel plate is a multi-span single-row plate bordered by ribs. The middle sections are clamped on four sides, and the extreme ones are clamped on three sides and freely supported on the end ribs. The plate of the panel is reinforced by one welded grid which keeps within the middle of its thickness.

The covering panel is made of heavy concrete of a class*B30,* γ_{b2} = 0,9;

R_b= 17 МПа, R_{bt}= 1,2 МПа, $R_{b,ser}$= 22 МПа, $R_{bt,ser}$= 1,8 МПа, E_b= 29·10^3 МПа.

Concrete undergoes heat treatment. Tensioning fittings, class A-V,
R_s= 680 MPA, $R_{s,ser}$ = 785 MPA, E_s = 1,9·10^{5}MPA. Longitudinal armature, subjected to stress, transverse ribs - A-III, diameter d >10 мм. *Rs*= 365 MPA. Grid of a plate, cross and assembly fittings of edges of a class Bp-I at *d* =3 мм *Rs*= 375 MPA; at *d* = 4 мм *Rs*= 370 MPA; at*d* = 5 мм *Rs*= 360 MPA; *Es*= 1,7·105 MPA.

The formation of cracks is allowed in the panel. The method of prestressing the electrothermal armature is automated on the stops of the form. Pre-tension without lossesσ_{sp} = 550 MPA. Concrete undergoes heat treatment.

PANEL SHELF CALCULATIONS

Collecting loads.

Table 2.4.1.

№ п/п	Name of loads	Regulatory load $N_н$, кп/м^2	Coeff. reliable. $\gamma\phi$	Calculation load N_p, KN/м^2
	Constant loads:			
1.	Layer of gravel on bituminous mastic $\delta 1$ = 10 мм, γ= 2000 kg/м^3	0,196	1,3	0,255
2.	Roll carpet of 3 layers of linochrome $\delta 1$ = 12 мм, γ= 4 kg/м^2	0,147	1,3	0,191
3.	Scaffolding their cement-sand mortar $\delta 2$ = 15 мм, γ= 1800 kg/м^3	0,265	1,3	0,344
4.	Insulation - expanded polystyreneγ = 40 kg/м^3, $\delta 2$ = 90 мм	0,036	1,2	0,043
5.	Scaffolding their cement-sand mortar $\delta 4$ = 20 мм, γ= 1800 kg/м^3	0,353	1,3	0,459
6.	Prefabricated reinforced concrete ribbed slab 3x6 m	1,54	1,1	1,694
	Temporary loads:			
7.	snow	1,71	0,714	2,4
8.	Total	4,27		5,4

Estimated spans:

for medium areas: $l_{01} = 150 - 9 = 141$ см;

$l_{02} = 298 - 2 \cdot (1{,}5 + 10{,}5) = 274$ см;

$$\frac{l_{02}}{l_{01}} = \frac{274}{141} = 1{,}94 < 3.$$

for extreme areas: $l_{01} = 148{,}5 - 1 - 17{,}5 - 9/2 = 125{,}5$ см;

$l_{02} = 298 - 2 \cdot (1{,}5 + 10{,}5) = 274$ см;

$$\frac{l_{02}}{l_{01}} = \frac{274}{125{,}5} = 2{,}18 < 3$$

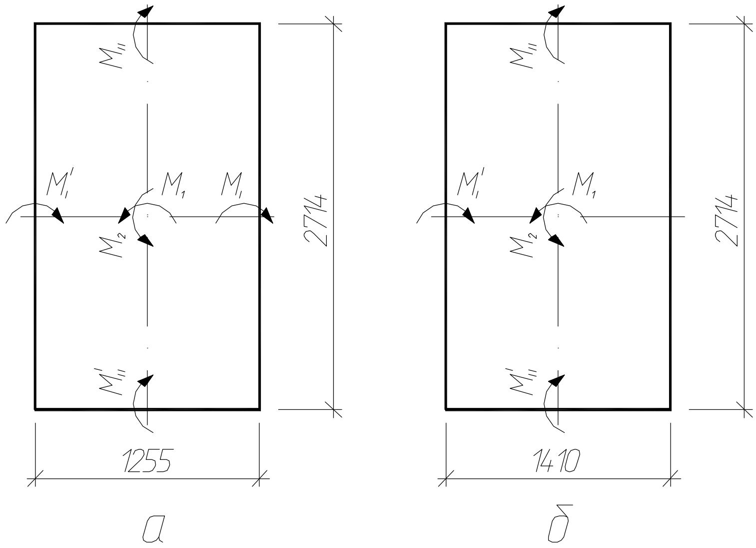


Fig. 2.4.1. The settlement scheme and designation of the moments operating in the panel: and - for average sites; б – for extreme areas.

Estimated constant load per 1m2, including the weight of the slab with a thickness of 30 mm: $g = g_1 + h_f^{'} \cdot 1 \cdot 1 \cdot 2{,}5 \cdot \gamma_f \cdot 9{,}81 \cdot \gamma_n = 1{,}54 + 0{,}03 \cdot 2{,}5 \cdot 1{,}1 \cdot 9{,}81 \cdot 0{,}95 = 2{,}31$ KN/м^2.

The calculated bending moments are determined by two combinations of loads:

1. Under the action of permanent and temporary (snow) load.

Equilibrium condition: $\frac{(g+v)l_{01}^2}{12} \cdot (3l_{02} - l_{01}) = (2M_1 + M_I + M_I^{'}) \cdot l_{02} + (2M_2 + M_{II} + M_{II}^{'}) \cdot l_{01}$

,we accept the following relations between the moments: M_2/M_I= 0,4; M_I= M_I= $M_I^{'}$; M_2= M_{II}= $M_{II}^{'}$= 0,4$M_1$and consider the middle areas.

Then the equilibrium condition can be written:

$$\frac{(g+v) \cdot l_{01}^2}{12} \cdot (3 \cdot l_{02} - l_{01}) = (4 \cdot l_{02} + 1{,}6 \cdot l_{01}) \cdot M_1 \Rightarrow$$

$$M_1 = \frac{(2{,}31 + 2{,}4) \cdot 1{,}41^2 \cdot (3 \cdot 2{,}74 - 1{,}41)}{12 \cdot (4 \cdot 2{,}74 + 1{,}6 \cdot 1{,}41)} = 0{,}401 \text{ кН·м};$$

For extreme sections we accept the same ratios between the moments and we consider that on an end edge M_I= 0.

The equilibrium condition can be written: $\frac{(g+v)\cdot l_{01}^2}{12}\cdot(3\cdot l_{02}-l_{01})=(3\cdot l_{02}+1{,}6\cdot l_{01})M_1 \Rightarrow$

$$M_1=\frac{(2{,}31+2{,}4)\cdot 1{,}255^2\cdot(3\cdot 2{,}74-1{,}255)}{12\cdot(3\cdot 2{,}74+1{,}6\cdot 1{,}255)}=0{,}421\text{KN·м}.$$

2. Under the action of constant and temporary concentrated load from the weight of the worker with the tool

Equilibrium condition $\frac{g\cdot l_{01}^2}{12}\cdot(3l_{02}-l_{01})+F\frac{l_{01}}{2}=(2M_1+M_I+M_I^{'})\cdot l_{02}+(2M_2+M_{II}+M_{II}^{'})\cdot l_{01}$

The relationship between the moments is the same.

For medium spans:

$$M_1=\frac{\frac{g\cdot l_{01}^2}{12}\cdot(3l_{02}-l_{01})+F\frac{l_{01}}{2}}{4l_{02}+1{,}6l_{01}}=\frac{\frac{2{,}31\cdot 1{,}41^2}{12}\cdot(3\cdot 2{,}74-1{,}41)+1{,}14\frac{1{,}41}{2}}{4\cdot 2{,}74+1{,}6\cdot 1{,}41}=0{,}257\text{ KN·м};$$

For extreme flights:

$$M_1=\frac{\frac{g\cdot l_{01}^2}{12}\cdot(3l_{02}-l_{01})+F\frac{l_{01}}{2}}{3l_{02}+1{,}6l_{01}}=\frac{\frac{2{,}31\cdot 1{,}255^2}{12}\cdot(3\cdot 2{,}74-1{,}41)+1{,}14\frac{1{,}255}{2}}{3\cdot 2{,}74+1{,}6\cdot 1{,}255}=0{,}272\text{ KN·м}.$$

Thus, the calculation is the first combination with the definition of the valves by the moments for the extreme spans.

Based on the ratios, we obtain:

$M_I = M_I^{'}= 0{,}421$ кН·м; $M_2 = M_{II} = MII^{'}= 0{,}421\cdot 0{,}4 = 0{,}168$ KN·м.

Fittings directed along the coating panel.

The minimum working height of a plate at an arrangement of a reinforcing grid in plate thickness and at diameter of armature of 4 mm is defined by the formula:

$$h_0=\frac{h}{2}-\frac{d}{2}=\frac{30}{2}-\frac{4}{2}=13\text{mm}.$$

Characteristics of the compressed zone of concrete:

$\omega = \alpha - 0{,}008 \cdot R_b = 0{,}85 - 0{,}008 \cdot 17 \cdot 0{,}9 = 0{,}7276$, де $\alpha = 0{,}85$ - for heavy concrete.

$\gamma_{b2} = 0{,}9 < 1 \Rightarrow \sigma_{sc,u} = 500$,

then the limit value of the relative height of the compressed zone:

$$\xi_R = \frac{\omega}{1 + \frac{\sigma_{sR}}{\sigma_{sc,u}}\left(1 - \frac{\omega}{1{,}1}\right)} = \frac{0{,}7276}{1 + \frac{360}{500}\left(1 - \frac{0{,}7276}{1{,}1}\right)} = 0{,}585;$$

$$\alpha_m = \frac{0{,}9 \cdot M_1}{R_b \cdot b \cdot h_0^2} = \frac{0{,}9 \cdot 0{,}421 \cdot 10^6}{15{,}3 \cdot 1000 \cdot 13^2} = 0{,}146.$$

The relative height of the compressed zone:

$$\xi = 1 - \sqrt{1 - 2 \cdot \alpha_m} = 1 - \sqrt{1 - 2 \cdot 0{,}146} = 0{,}158$$

$$\xi = 0{,}158 < \xi_R = 0{,}585 \Rightarrow \varsigma = 1 - 0{,}5 \cdot \xi = 1 - 0{,}5 \cdot 0{,}158 = 0{,}921.$$

Reinforcement area:

$$A_{s1} = \frac{M_1}{R_s \cdot \varsigma \cdot h_0} = \frac{0{,}9 \cdot 0{,}421 \cdot 10^6}{360 \cdot 0{,}921 \cdot 13} = 87{,}91 \text{ мм}^2.$$

Reinforcement factor:

$$\mu = \frac{A_{s1}}{b \cdot h_0} = \frac{87{,}91}{1000 \cdot 13} = 0{,}0068 > \mu_{\min} = 0{,}0005$$

We accept fittings ∅5 Bp-I with a step of 200 mm, A_{s1}= 99 mm^2 > 87,91см^2. Armature directed across the coating panel.

The minimum working height of a plate taking into account diameter of armature is 3 mm

$$h_0 = \frac{h}{2} - \frac{d}{2} = \frac{30}{2} - \frac{3}{2} = 13{,}5 \text{мм}.$$

Characteristics of the compressed zone of concrete:

$\omega = \alpha - 0{,}008 \cdot R_b = 0{,}85 - 0{,}008 \cdot 17 \cdot 0{,}9 = 0{,}7276$, де $\alpha = 0{,}85$ -

for heavy concrete.

$\gamma_{b2} = 0{,}9 < 1 \Rightarrow \sigma_{sc,u} = 500$,

then the limit value of the relative height of the compressed zone:

$$\xi_R = \frac{\omega}{1 + \frac{\sigma_{sR}}{\sigma_{sc,u}}\left(1 - \frac{\omega}{1{,}1}\right)} = \frac{0{,}7276}{1 + \frac{370}{500}\left(1 - \frac{0{,}7276}{1{,}1}\right)} = 0{,}582;$$

$$\alpha_m = \frac{0{,}9 \cdot M_2}{R_b \cdot b \cdot h_0^2} = \frac{0{,}9 \cdot 0{,}168 \cdot 10^6}{15{,}3 \cdot 1000 \cdot 13{,}5^2} = 0{,}054 .$$

The relative height of the compressed zone:

$\xi = 1 - \sqrt{1 - 2 \cdot \alpha_m} = 1 - \sqrt{1 - 2 \cdot 0{,}054} = 0{,}056$,

$\xi = 0{,}056 < \xi_R = 0{,}582 \Rightarrow \varsigma = 1 - 0{,}5 \cdot \xi = 1 - 0{,}5 \cdot 0{,}056 = 0{,}972$.

Reinforcement area:

$$A_{s1} = \frac{M_2}{R_s \cdot \varsigma \cdot h_0} = \frac{0{,}9 \cdot 0{,}168 \cdot 10^6}{370 \cdot 0{,}972 \cdot 13{,}5} = 30{,}97 \text{ мм}^2.$$

Reinforcement factor:

$$\mu = \frac{A_{s1}}{b \cdot h_0} = \frac{30{,}97}{1000 \cdot 13{,}5} = 0{,}0023 > \mu_{\min} = 0{,}0005$$

We accept fittings∅3 Bp-I with a step 200 мм, $A_{s1} = 35{,}3$ mm$^2 > 31$ mm^2.

Finally, to reinforce the plate, we adopt a grid

$C1 \dfrac{5Bp - I - 200}{3Bp - I - 200} 2970x5950$, grid 3 2 is adopted constructively.

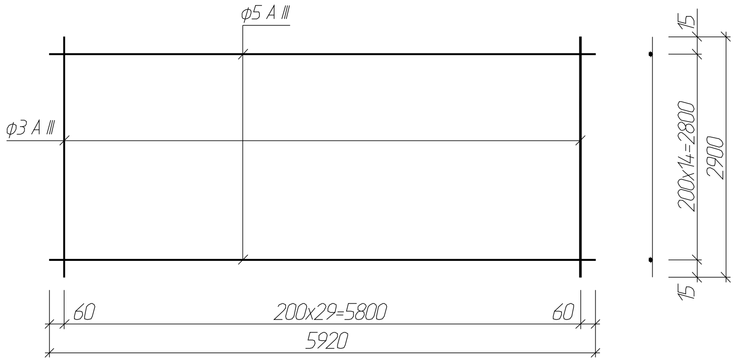


Fig. 2.4.2. Welded mesh З 1 for panel shelf reinforcement.

CALCULATED FLANGE, LOADS AND FORCES IN THE CROSS РЕБРЕ

Calculate the average transverse rib as the most loaded. The trapezoidal shape of the diagrams is due to the support on the edge of the plates supported by the contour. The estimated span is accepted: $l_0 = l_{02} = 274$ cm.

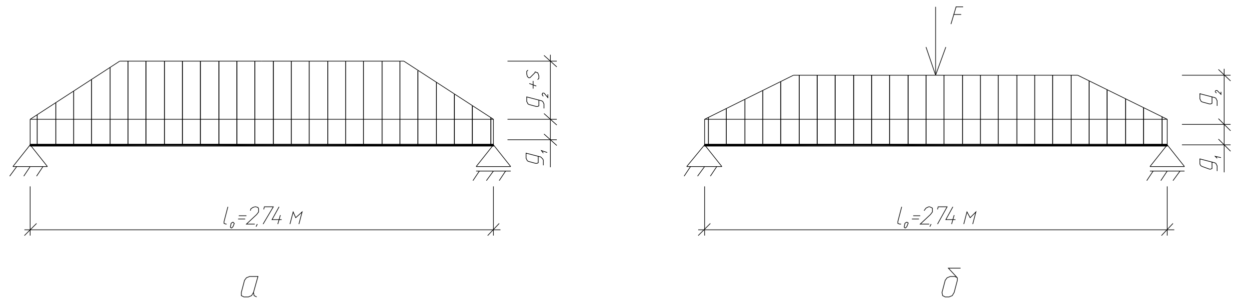


Fig. 2.4.3. Estimated schemes of a cross edge: and - from constant and snow loading; б – from constant and concentrated loading.

Weight of 1 m of a cross rib taking into account $\gamma_n = 0{,}95$:

$$g_1 = \frac{0{,}05 + 0{,}09}{2}(0{,}15 - 0{,}03) \cdot 2{,}5 \cdot 1{,}1 \cdot 9{,}81 \cdot 0{,}95 = 0{,}216 \text{ KN/м}$$

Load from weight of a plate and an insulating carpet: $g_2 = 2{,}31 \cdot 1{,}5 = 3{,}465$ KN/м

Estimated snow load: $s = 2{,}4 \cdot 1{,}5 = 3{,}6$ KN/м

Efforts from calculation of constant and snow loading:

$$M = \frac{(g_1 + g_2 + s) \cdot l_0^2}{8} - \frac{(g_2 + s) \cdot l_1^2}{24} = \frac{(0{,}216 + 3{,}465 + 3{,}6) \cdot 2{,}74^2}{8} - \frac{(3{,}465 + 3{,}6) \cdot 1{,}5^2}{24} = 6{,}17$$

KN·M

$$Q = \frac{(g_1 + g_2 + s) \cdot l_0}{2} - \frac{(g_2 + s) \cdot l_1}{4} = \frac{(0{,}216 + 3{,}465 + 3{,}6) \cdot 2{,}74}{2} - \frac{(3{,}465 + 3{,}6) \cdot 1{,}5}{4} = 7{,}32$$

KN

Effort from constant and concentrated loading:

$$M = \frac{(g_1 + g_2) \cdot l_0^2}{8} + \frac{g_2 \cdot l_1^2}{24} + \frac{F \cdot l_0}{5} = \frac{(0{,}216 + 3{,}465) \cdot 2{,}74^2}{8} + \frac{3{,}465 \cdot 1{,}5^2}{24} + \frac{1{,}14 \cdot 2{,}74}{5} = 4{,}56$$

KN·M

$$Q = \frac{(g_1 + g_2) \cdot l_0}{2} + \frac{g_2 \cdot l_1}{4} + F = \frac{(0{,}216 + 3{,}465) \cdot 2{,}74}{2} + \frac{3{,}465 \cdot 1{,}5}{4} + 1{,}14 = 7{,}28 \text{ кН}$$

Next, we calculate the first combination of efforts.

CALCULATIONS ON THE STRENGTH OF NORMAL CROSS SECTIONS OF THE CROSSРЕБРА

Transverse ребро h = 150 mm, shelf thickness $h_f = 30$ mm, relation $h_f / h = 3/15 = 0{,}2 > 0{,}1$, the estimated width of the shelf section of the T-section:

$$b_f = \frac{1}{3} l_0 + b = \frac{1}{3} \cdot 2740 + 90 = 1002 \text{mm.}$$

Working height ребра: $h_0 = h - a = 150 - (15 + \frac{14}{2}) = 128$mm;

$$\xi_R = \frac{\omega}{1 + \frac{\sigma_{sR}}{\sigma_{sc,u}}\left(1 - \frac{\omega}{1{,}1}\right)} = \frac{0{,}7276}{1 + \frac{365}{500}\left(1 - \frac{0{,}7276}{1{,}1}\right)} = 0{,}583;$$

$M = 6{,}17 \cdot 10^6$ Н·мм $< R_b \cdot b_f^` \cdot h_f^` (h_0 - 0{,}5 \cdot h_f^`) = 15{,}3 \cdot 1002 \cdot 30 \cdot (128 - 0{,}5 \cdot 30) = 52{,}4 \cdot 10^6$ Н·мм

$$\alpha_m = \frac{M}{R_b \cdot b_f^` \cdot h_0^2} = \frac{6{,}17 \cdot 10^6}{15{,}3 \cdot 1002 \cdot 128^2} = 0{,}0242$$

The relative height of the compressed zone:

$$\xi = 1 - \sqrt{1 - 2 \cdot \alpha_m} = 1 - \sqrt{1 - 2 \cdot 0{,}0242} = 0{,}0245,$$

$$\xi = 0{,}0245 < \xi_R = 0{,}583 \Rightarrow \varsigma = 1 - 0{,}5 \cdot \xi = 1 - 0{,}5 \cdot 0{,}0245 = 0{,}988.$$

Reinforcement area:

$$A_{s1} = \frac{M}{R_s \cdot \varsigma \cdot h_0} = \frac{6{,}17 \cdot 10^6}{365 \cdot 0{,}988 \cdot 128} = 132{,}6 \text{ mm}^2.$$

Reinforcement factor:

$\mu = \frac{A_{s1}}{b \cdot h_0} = \frac{132{,}6}{70 \cdot 128} = 0{,}0015 > \mu_{\min} = 0{,}0005$, where $b = (9 + 5)/2 = 7$ cm.

We accept fittings 1∅14 A-III, $A_s = 153{,}9$ mm^2 > 132,6 mm^2.

CALCULATIONS OF ANGLED CROSS SECTIONS OF THE CROSS РЕБРА WITH STRENGTH.

Working height ребра: $h_0 = h - a = 150 - (15 + \frac{14}{2}) = 128$ mm;

Distributed load: $q_1 = g_1 + g_2 + s/2 = 0{,}216 + 3{,}465 + 3{,}6/2 = 5{,}48$ KN/m;

as $q_1 = 5{,}48$ KN/m< $q_a = 0{,}16 \cdot \varphi_{b4} \cdot (1 + \varphi_n) \cdot R_{bt} \cdot b = 0{,}16 \cdot 1{,}5 \cdot 1{,}2 \cdot 70 = 20{,}16$ KN/m, the length of the projection of the most dangerous inclined section is accepted: $c = 2{,}5 \cdot h_0 = 2{,}5 \cdot 128 = 320$ mm, where coffie $\varphi_{b4} = 1{,}5$ for heavy concrete.

Check the need for installation of transverse reinforcement at the rate:

$Q = Q_{\max} - q_1 \cdot c = 7320 - 5{,}48 \cdot 320 = 5566{,}4$ Н

$Q_b = \varphi_{b4} \cdot (1 + \varphi_n) \cdot R_{bt} \cdot b \cdot h_0^2 / c = 1{,}5 \cdot 1 \cdot 1{,}2 \cdot 70 \cdot 128^2 / 320 = 6501{,}6$ Н,

that is, the transverse reinforcement is installed only for design requirements.

We accept cross rods from a wire of a class Вр-I ∅4 with a step of 75 mm.

CALCULATED FLIGHT, LOAD AND EFFORT IN LONGITUDINAL РЕБРАХ

Estimated span of the rib along the axes of the supports: $l_0 = l_{nn} - l_{on} = 5970 - 2 \cdot 50 = 5870$ mm;

Counting loads on 1 m panel:

$q = g + s = 3 \cdot 3 + 2{,}4 \cdot 3 = 16{,}2$ кН/м; $g_n = 2{,}53 \cdot 3 = 7{,}59$ кН/м; $q_H = 4{,}27 \cdot 3 = 12{,}81$ kN/m.

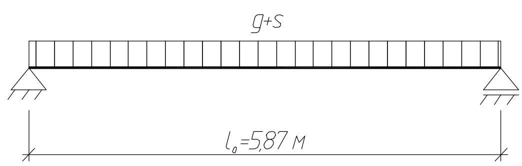


Fig. 2.4.4. Estimated longitudinal scheme ребра.

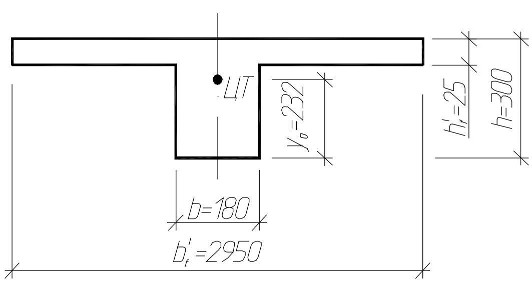


Fig. 2.4.5. Equivalent cross section of the panel.

Effort in longitudinal ребрах:

from full load at $\gamma_f > 1$: $M = \frac{q \cdot l_0^2}{8} = \frac{16{,}2 \cdot 5{,}87^2}{8} = 69{,}78$ KN·m;

$Q = \frac{q \cdot l_0}{2} = \frac{16{,}2 \cdot 5{,}87}{2} = 47{,}55$ KN;

from full load at $\gamma_f = 1$: $M = \frac{q_n \cdot l_0^2}{8} = \frac{12{,}81 \cdot 5{,}87^2}{8} = 55{,}17$ KN·m;

$Q = \frac{q_n \cdot l_0}{2} = \frac{12{,}81 \cdot 5{,}87}{2} = 37{,}6$ KN;

from a constant load at $\gamma_f = 1$: $M = \frac{g_n \cdot l_0^2}{8} = \frac{7{,}59 \cdot 5{,}87^2}{8} = 32{,}7$ KN·m;

$Q = \frac{g_n \cdot l_0}{2} = \frac{7{,}59 \cdot 5{,}87}{2} = 22{,}28$ KN.

CALCULATION OF NORMAL SECTIONS OF LONGITUDINAL RIBS WITH STRENGTH

The cross section of the panel is reduced to a T-shape, and in the calculations we enter the width of the floor slab, reduced by a factor that takes into account the uneven distribution of compressive forces across the width of the thin shelf:

$b`_f = (2980 - 2 \cdot 15) \cdot 0{,}65 = 1918$ mm.

Working height ребра: $h_0 = h - a = 300 - (20 + \frac{16}{2}) = 274$ мм

Characteristics of the compressed zone of concrete:

$\omega = \alpha - 0{,}008 \cdot R_b = 0{,}85 - 0{,}008 \cdot 17 \cdot 0{,}9 = 0{,}7276$, at $\alpha = 0{,}85$ -

for heavy concrete.

Припустиме відхилення попередньої напруги арматури:

$P = 30 + \frac{90}{l} = 30 + \frac{360}{6} = 90$ МПа.

Pre-tension without losses:

$\sigma_{sp} = R_{s,ser} - P = 785 - 90 = 695$ MPA, we approve $\sigma_{sp} = 550$ MPA;

$\Delta\gamma_{sp} = 0{,}5 \cdot \frac{P}{\sigma_{sp}} \cdot (1 - \frac{1}{\sqrt{n_p}}) = 0{,}5 \cdot \frac{90}{550} \cdot (1 - \frac{1}{\sqrt{2}}) = 0{,}024$, at $n_p = 2$ - pre-accepted number of strains of tensioned valves in two longitudinal ребрах.

Since $\Delta\gamma_{sp} = 0{,}024 < 0{,}1$ the minimum allowable value, then accept $\Delta\gamma_{sp} = 0{,}1$.

Pre-stress losses from deformation of anchors located in tensioning devices:

$\sigma_3 = \frac{\Delta l}{l} E_s = \frac{3{,}65}{6000} 19 \cdot 10^4 = 115{,}6$, де $\Delta l = 1{,}25 + 0{,}15 \cdot d = 1{,}25 + 0{,}15 \cdot 16 = 3{,}65$ mm.

Prestress loss due to deformation of the steel mold:

$\sigma_5 = 30$ MPA

(in the absence of data on the form).

Prestress in the straining fittings before compression of concrete and taking into account losses σ_3 і σ_5:

$\sigma_{sp1} = \sigma_{sp}(1 - \Delta\gamma_{sp}) - \sigma_3 - \sigma_5 = 550 \cdot (1 - 0{,}1) - 115{,}6 - 30 = 349{,}4$ MPA.

$\Delta\sigma_{sp} = 1500 \frac{\sigma_{sp1}}{R_s} - 1200 = 1500 \cdot \frac{349{,}2}{680} - 1200 < 0$, we approve $\Delta\sigma_{sp} = 0$.

Pre-voltage in the valves at an unknown value of total losses:

$\sigma_{sp} = 0{,}6 \cdot R_s = 0{,}6 \cdot 680 = 408$ MPA.

$\sigma_{sR} = R_s + 400 - \sigma_{sp} - \Delta\sigma_{sp} = 680 + 400 - 408 - 0 = 672$ MPA.

Maximum relative height of the compressed zone:

$$\xi_R = \frac{\omega}{1 + \frac{\sigma_{sR}}{\sigma_{sc,u}}\left(1 - \frac{\omega}{1{,}1}\right)} = \frac{0{,}7276}{1 + \frac{672}{500}\left(1 - \frac{0{,}7276}{1{,}1}\right)} = 0{,}5;$$

$M = 69{,}78 \cdot 10^6$ Н·мм $< R_b \cdot b_f^{`} \cdot h_f^{`}(h_0 - 0{,}5 \cdot h_f^{`}) = 15{,}3 \cdot 1918 \cdot 30 \cdot (274 - 0{,}5 \cdot 30) = 227{,}1 \cdot 10^6$ Н·мм

$$\alpha_m = \frac{M}{R_b \cdot b_f^{`} \cdot h_0^2} = \frac{69{,}78 \cdot 10^6}{15{,}3 \cdot 1918 \cdot 274^2} = 0{,}032$$

The relative height of the compressed zone:

$\xi = 1 - \sqrt{1 - 2 \cdot \alpha_m} = 1 - \sqrt{1 - 2 \cdot 0{,}032} = 0{,}0325$,

$\xi = 0{,}0325 < \xi_R = 0{,}5 \Rightarrow \varsigma = 1 - 0{,}5 \cdot \xi = 1 - 0{,}5 \cdot 0{,}0325 = 0{,}984$.

Determine the coefficient of working conditions:

$\gamma_{s6} = \eta - (\eta - 1) \cdot (2\frac{\xi}{\xi_r} - 1) = 1{,}15 - (1{,}15 - 1) \cdot (2\frac{0{,}0325}{0{,}5} - 1) = 1{,}28 > \eta = 1{,}15$, we accept $\gamma_{s6} = 1{,}15$.

The required cross-sectional area of the longitudinal, pre-stressed reinforcement: $A_{sp1} = \frac{M}{R_s \cdot \varsigma \cdot h_0 \cdot \gamma_{s6}} = \frac{69{,}78 \cdot 10^6}{680 \cdot 0{,}984 \cdot 1{,}15 \cdot 274} = 332{,}2$ mm^2.

Reinforcement factor:

$\mu = \frac{A_{sp1}}{b \cdot h_0} = \frac{332{,}2}{180 \cdot 274} = 0{,}007 > \mu_{\min} = 0{,}0005$, at $b = 2 \cdot (75 + 105) / 2 = 180$cm.

Adopt pre-stressed valves 2∅16 A-V,

A_{sp} = 402 мм^2 > 332,2 мм^2 (one rod in each ребрі).

CALCULATION OF STRENGTH OF SLOPE OF LONGITUDINAL РЕБЕР

Working height ребра: $h_0 = h - a = 300 - (20 + \frac{16}{2}) = 272$ mm.

Distributed load: $q_1 = g + s/2 = 3 \cdot 3 + 2{,}4 \cdot 3/2 = 12{,}6$ кН/м, since $q_1 = 12{,}6$KN/M< $q_a = 0{,}16 \cdot \varphi_{b4} \cdot (1 + \varphi_n) \cdot R_{bt} \cdot b = 0{,}16 \cdot 1{,}5 \cdot (1 + 0{,}308) \cdot 1{,}2 \cdot 0{,}9 \cdot 180 = 61{,}02$KN/M, then accept the length $c = 2{,}5 \cdot h_0 = 2{,}5 \cdot 272 = 680$mm, at coffie $\varphi_{b4} = 1{,}5$ for heavy concrete.

$\gamma_n = 0{,}1\frac{P}{R_{bt} \cdot b \cdot h_0} = 0{,}1\frac{162810}{1{,}2 \cdot 0{,}9 \cdot 180 \cdot 272} = 0{,}308 < 0{,}5$, where the compression force *P*accepted at approximate values $\sigma_1 = 100$MPA, and coefficients $\gamma_{sp} < 1$:

$P = \gamma_{sp} \cdot (\sigma_{sp} - \sigma_1) \cdot A_{sp} = (1 - 0{,}1) \cdot (550 - 100) \cdot 402 = 162810$H.

Check the need for installation of transverse reinforcement at the rate:

$Q = Q_{\max} - q_1 \cdot c = 47550 - 12{,}6 \cdot 680 = 38982$ H <<

$Q_b = \varphi_{b4} \cdot (1 + \varphi_n) \cdot R_{bt} \cdot b \cdot h_0^2 / c = 1{,}5 \cdot (1 + 0{,}308) \cdot 1{,}2 \cdot 0{,}9 \cdot 180 \cdot 272^2 / 680 = 41497{,}7$ H,

that is, the transverse reinforcement is installed only for design requirements. We accept cross rods from a wire of a class Bp-I ∅4 with a step of 150 mm.

CALCULATIONS OF LONGITUDINAL РЕБЕРFROM THE BOUNDARY STATES OF THE SECOND GROUP: FROM THE FORMATION OF CRACKS; ON DISCLOSURE OF CRACKS; BY DEFORMATIONS

The initial voltage in the stressed valves is accepted: σ sp = 550 MPA;

Maximum allowable deflection of the plate: fu = ℓ / 250 = 6/250 = 0,024 m.

Initial data for calculations

Table 2.4.1.

N п/п	The initial value	Designation and dimension	Numerical value
1.	Weight of 1 m2 of a plate	$g_п$, kg	154
2.	Estimated running load	P, KN/m	16,2
3.	Regulatory running load	P_n, KN/m	12,81
4.	Regulatory long-term load	$P_{n,\ell}$, KN/m	7,59
5.	Plate rib width	b, м	0,18
6.	The width of the compressed plate shelf	b'_f, м	2,95
7.	The height of the compressed shelf of the plate	h'_f, м	0,025
8.	The width of the stretched shelf of the plate	b_f, м	2,95
9.	The height of the stretched shelf of the plate	h_f, м	0
10.	Plate height	h , м	0,3
11.	Estimated span of the plate	ℓ_p, м	5,87
12.	The length of the slab support platform	$\ell_{оп}$, м	0,12
13.	The distance from the end to the place of slinging loops	$\ell_{пет}$, м	0,065
14.	Concrete class	B	30
15.	Transmission strength of concrete	R_{bp}, МПа	21
16.	Estimated resistance of tensioned valves	R_{sp}, МПа	680
17.	Initial stresses in tensioned valves	σ_{sp}, МПа	550
18.	The modulus of elasticity of the compressed zone	E_s, МПа	200000
19.	Modulus of elasticity of tensioned fittings	E_{sp}, МПа	190000
20.	The area of compressed fittings	A'_s, $м^2$	0,0003
21.	The area of tensioning fittings	A_{sp}, $м^2$	0,000402
22.	Diameter of tensioning fittings	D, мм	16
23.	Distance from t.t. concise arm. to the top face	A', м	0,015
24.	The distance from the center of gravity of the tensioning fittings to the lower face of the plate	a, м	0,05
25.	The distance from the center of gravity of the lower row of tensioned fittings to the lower face of the plate	A_1, м	0,05
26.	Maximum allowable deflection of the plate	f_u, м	0,024

2.5. Calculation and design of faceted beam.

Design data:

Construction area –CAIRO CITY,EGYPT;

Span l = 18 m;

Step a = 6 m;

Plates of a covering – 3 × 6 m;

- Operating environment - non-aggressive;
- Light aeration lantern - absent;
- Overhead cranes - no.

As a tensioning armature, I accept a rod armature of a class
A-V за ДСТ 5781-82.

As a non-stressing working armature, I accept steel *A–III*by ДСТ 5181–82. As constructive – reinforcing wire of periodic profile *Bр–I*by ДСТ 6727–80 and fittings A –*I*by ДСТ 5781–82.

For tensioned fittings, I approve:

$RSP_{,SER}$ = 785 MPA; *RSP* = 680 MPA; *ESP* = 190000 MPA.

For non-tensioning fittings, class A-III:

RS = 365 МПа [∅ 10…40 (mm)];*RSC* = 365 MPA [∅ 10…40 (mm)];

RSW = 285 MPA [∅ 6…8 (mm)]; *ES* = $2 \cdot 10^5$MPA.

Estimated load from the coating: $q = 3$ KN/m^2.

The total design load from a covering and snow is equal:

$q = 3 + 2,4 = 5,4$ KN/m^2.

I approve the brand beam *3БРД18–4AV–H.*

As a source material I accept heavy concrete of a class B30, subjected to heat treatment at atmospheric pressure:

$Rb_{,SER}$ = 22 MPA;Rb = 17 MPA; $Rbt_{,SER}$ = 1,8 MPA;

Rbt = 1,2 MPA;γ_{b2} = 0,9;*Eb* = 29000 MPA.

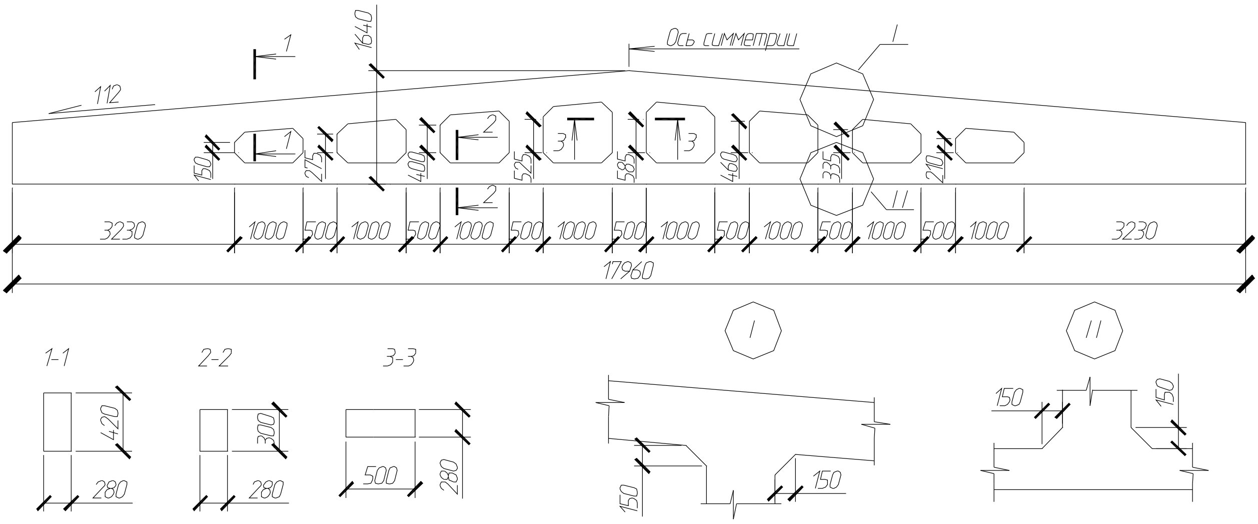


Fig. 2.5.1. Lattice beam brands 3*БРД18–4AV–H*.

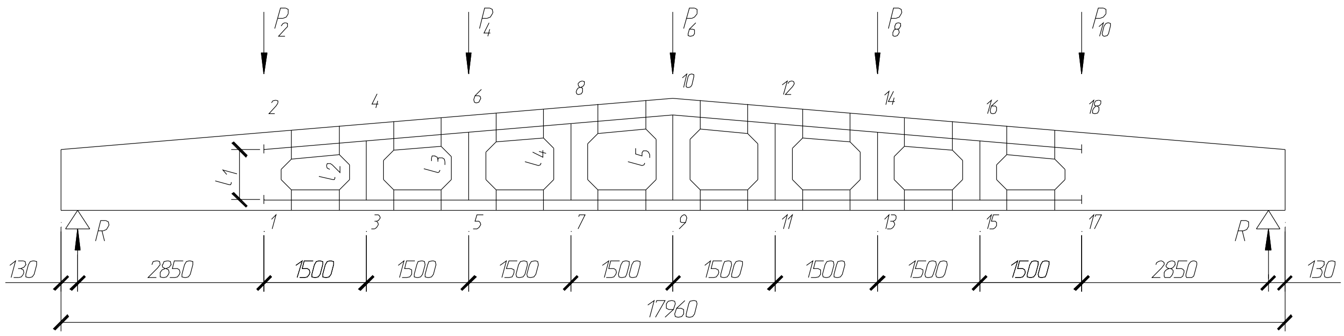


Fig. 2.5.2. Calculation scheme of a lattice beam.

STATIC CALCULATION OF THE GRATED BEAM

The standard load from the own weight of the coating per 1 m2 of horizontal surface is equal: $q_{n,\, ser}$ = 2,56 KN/m^2.

The load from the own weight of the beam is equal:

$q_{б,\, ser} = G_б \cdot 10^{-3} \cdot 9{,}81 / (l \cdot a)$, $q_{б,\, ser}$ = 12100 · 10^{-3}· 9,81 / (18 · 6) = 1,1 KN/m^2.

Normative short-term snow load per 1 m2 of surface:

$S_{l,\, SER}$ = 1,71 KN/m^2.

The normative long-term snow load is:

$Sl_{, SER} = k \cdot SSER = 0,3 \cdot 1,71 = 0,513$ KN/m$^{2.}$

Constant load from its own weight per 1 m2 of horizontal surface is equal:

$qn = 3 \cdot 0,95 = 2,85$ KN/m^2

- from the own weight of the beam:

$q_б = 1,1 \cdot 1,1 \cdot 0,95 = 1,15$ KN/m^2

- from snow cover:

$S = 1,71 \cdot 1,4 \cdot 0,95 = 2,27$ KN/m^2

$Sl = 0,3 \cdot 2,27 = 0,682$ KN/m^2

Nodal (concentrated) loads are equal:

- normative:$Pn_{, SER} = (qn_{, SER} + q_{б, SER}) \cdot 6 \cdot 3 = (2,56 + 1,1) \cdot 6 \cdot 3 = 65,88$ KN

$PS_{, SER} = SSER \cdot 6 \cdot 3 = 1,71 \cdot 6 \cdot 3 = 30,78$ KN

$Psl_{, SER} = Sl_{, SER} \cdot 6 \cdot 3 = 0,513 \cdot 6 \cdot 3 = 9,23$ KN

- estimated:$Pn = (qn + q_б) \cdot 6 \cdot 3 = (2,85 + 1,15) \cdot 6 \cdot 3 = 72$ KN

$PS = S \cdot 6 \cdot 3 = 2,27 \cdot 6 \cdot 3 = 40,86$ KN

$Psl = Sl \cdot 6 \cdot 3 = 0,682 \cdot 6 \cdot 3 = 12,28$ KN

The effort in the elements of the lattice beam is calculated by two combinations of loads to obtain the following combinations: *NMAX, MCOOTB, MMAX, NCOOTB*.

Lower belt:

N_{ser}=10,569 · (65,88+30,78)=1021,6 KN (element 5-7)

$N_{l,ser}$=10,569 · (65,88+9,23)= 793,84 KN

N=10,569 · (72+40,86)= 1192,82 KN

M_{ser}=0,167 · (65,88+30,78)= 16,14 KN·m

$M_{l,ser}$=0,167 · (65,88+9,23)= 12,54 KN·m

M=0,167 · (72+40,86)= 18,85 KN·m

N_{ser}=9,061 · (65,88+30,78)= 875,84 KN (element 3-1)

$N_{l,ser}$=9,061 · (65,88+9,23)= 680,57 KN

N=9,061 · (72+40,86)= 1022,62 KN

M_{ser}=0,26 · (65,88+30,78)= 25,13 KN·m

$M_{l,ser}$=0,26 · (65,88+9,23)= 19,53 KN·m

M=0,26 · (72+40,86)= 29,34 KN·m

Upper belt:

N=10,58 · (72+40,86)= 1194,1 KN (element 6-8)

N_l=10,58 · (72+12,28)= 891,68 KN

M=0,43 · (72+40,86)= 48,53 KN·M

M_l=0,43 · (72+12,28)= 36,24 KN·M

N=9,114 · (72+40,86)= 1028,61 KN (element 4-2)

N_l=9,114 · (72+12,28)= 768,13 KN

M=0,571 · (72+40,86)= 64,44 KN·M

M_l=0,571 · (72+12,28)= 48,12 KN·M

Racks:

N=0,401 · (72+40,86)= 45,26 KN (element 5-6)

N_l=0,401 · (72+12,28)= 33,8 KN

M=0,058 · (72+40,86)= 6,55 KN·M

M_l=0,058 · (72+12,28)= 4,9 KN·M

N=0,065 · (72+40,86)= 7,34 KN (element 4-3)

N_l=0,065 · (72+12,28)= 5,48 KN

M=0,217 · (72+40,86)= 24,5 KN.

M_l=0,217 · (72+12,28)= 18,29 KN·M

The transverse force on the support of the beam is equal:

$Q = (P_2 + P_4 + P_6) / 2 = 3 \cdot (P_n + P_S) / 2$ =5· (72+40,86)/2 = 282,15 KN

CALCULATION OF THE LOWER BELT.

Calculations for the first group of limit states.

Cross section of the lower belt 280 × 300 mm.

The calculated forces in the lower belt are equal:

$NMAX$ = 1192,82 кН;$MMAX$ = 18,85 KN·m – (the first combination of efforts)

$NMAX$= 1022,62 кН;$MMAX$ = 29,34 KN·m – (the second combination of efforts)

- The calculated eccentricity of the longitudinal force for the first intersection of forces is equal:

$e_0 = M / N$ = 18,85/ 1192,82 = 0,0158 m;

$e = 0{,}5 \cdot h - e_0 - a$ = 0,5 · 0,3 – 0,0158 – 0,06 = 0,0742 m;

$e' = 0{,}5 \cdot h + e_0 - a'$ = 0,5 · 0,3 + 0,0158 – 0,06 = 0,1058 m;

$h_0 = h - a$ = 0,3 – 0,06 = 0,24 m.

Subject to the condition $e' < h_0 - a'$, that is: 0,1058 < 0,24 – 0,06 = 0,18 m

$$A_{sp} = \frac{N \cdot e'}{\gamma_{sp} \cdot R_{sp} \cdot (h_0 - a)} = \frac{1192{,}82 \cdot 0{,}1058}{1{,}15 \cdot 680 \cdot 10^3 \cdot (0{,}24 - 0{,}06)} = 8{,}96 \cdot 10^{-4}\,\text{m}^2$$

$$A'_{sp} = \frac{N \cdot e}{\gamma_{sp} \cdot R_{sp} \cdot (h_0 - a)} = \frac{1192{,}82 \cdot 0{,}0742}{1{,}15 \cdot 680 \cdot 10^3 \cdot (0{,}24 - 0{,}06)} = 6{,}27 \cdot 10^{-4}\,\text{m}^2$$

- The calculated eccentricity of the longitudinal force for the second intersection of forces is equal:

$e_0 = M / N$ = 29,34/ 1022,62 = 0,0287 m;

$e = 0{,}5 \cdot h - e_0 - a$ = 0,5 · 0,3 – 0,0287 – 0,06 = 0,0613 m;

$e' = 0{,}5 \cdot h + e_0 - a'$ = 0,5 · 0,3 + 0,0287 – 0,06 = 0,1187 m;

Subject to the condition $e' < h_0 - a'$, тобто: 0,1187 < 0,24 – 0,06 = 0,18 m

$$A_{sp} = \frac{N \cdot e'}{\gamma_{sp} \cdot R_{sp} \cdot (h_0 - a)} = \frac{1022{,}62 \cdot 0{,}1187}{1{,}15 \cdot 680 \cdot 10^3 \cdot (0{,}24 - 0{,}06)} = 8{,}6 \cdot 10^{-4}\,\text{m}^2$$

$$A'_{sp} = \frac{N \cdot e}{\gamma_{sp} \cdot R_{sp} \cdot (h_0 - a)} = \frac{1022{,}62 \cdot 0{,}0613}{1{,}15 \cdot 680 \cdot 10^3 \cdot (0{,}24 - 0{,}06)} = 4{,}45 \cdot 10^{-4} \text{m}^2$$

Received the value of the cross-sectional areas of the working reinforcement:

ASP = 8,96 · 10 $^{-4}$ м^2;A'_{SP}= 6,27 · 10 $^{-4}$m^2.

I approve the assortment: 6 ∅ 14 A – V c A_{SP} = 9,23 · 10 $^{-4}$m^2

2 ∅ 20 A – V c A'_{SP} = 6,28 · 10 $^{-4}$m^2

The reinforcement factor is equal:

$$\mu = \frac{A_{sp} + A'_{sp}}{b \cdot h_0} = \frac{9{,}23 \cdot 10^{-4} + 6{,}28 \cdot 10^{-4}}{0{,}28 \cdot 0{,}24} = 0{,}023$$

The condition of reinforcement is fulfilled:

$\mu_{min} \le \mu \le \mu_{max}$, 0,0005 < 0,023 < 0,035

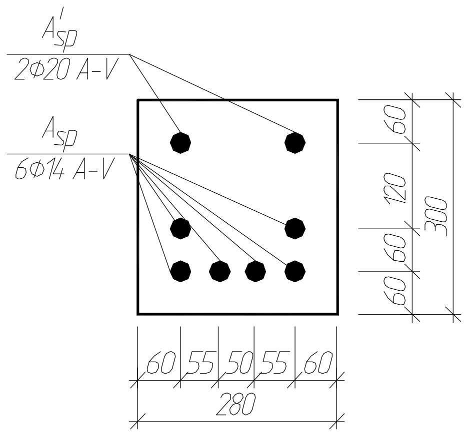


Fig. 2.5.3. Reinforcement of the lower belt of the lattice beam.

Calculations for the second group of limit states

Determination of preload losses.

Prestressing in prestressed valves with mechanical stress method: $\sigma_{sp} \le R_{s,ser}$ /1,05=785/1,05 =748 MPA, I approve σ_{sp}= 740 MPA.

Preliminary strength of concrete at the time of reinforcement is assigned by condition:

$R_{bp} \geq 0,7 \cdot B = 0,7 \cdot 30 = 21$ MPA; $R_{bp} > 11$ MPA. approve $R_{bp} = 21$ MPA

- The first preload losses in the fittings:
- from relaxation of armature tension: □1 = 0,1 □ □SP – 20 = 0,1 □ 740 – 20 = 54 MPA
- from the temperature difference of 65□ during heat treatment of concrete:
- gamma 2 = 1,25 □ 65 = 81,25 MPA
- - from the deformation of the anchors located in the tensioning devices:
- MPA
- MPA
- from deformation of a steel form at production of a beam: □5 = 30 MPA
- from the fast-flowing creep of concrete: the compressive force of concrete taking into account the voltage losses of the reinforcement □1, □2, □3 and □5 is equal:
- P01= ASP□ (□SP – □1 – □2 – □3 – □5) = 9,23□10 –4□(740 – 54 – 81,25 – 35,36 – 30)□103 = 498 KN
- P’01=A’SP□(□SP – □’1 – □’2 – □’3 – □’5) =6,28□10 –4□(740 –54–81,25– 44,86–30)□103 = 333 KN
- P0 = P01 + P’01¬ = 498 + 333 = 831 KN.
-
- static moment of the reduced section relative to the lower face of the section:
- m3
- shows the cross-sectional area of the lower belt:
- the reduced cross-sectional area of the lower belt:

$A_{RED} = b \cdot h + \alpha_{SP} \cdot (A_{SP} + A'_{SP}); \alpha_{SP} = E_{SP} / E_b$

$A_{RED} = 0,28 \cdot 0,3 + 190000 \cdot (9,23 \cdot 10^{-4} + 6,28 \cdot 10^{-4}) / 29000 = 0,0942\ m^2$

- the distance from the lower face to the center of gravity of the given section is exactly:

$$y_н = \frac{S_{red}}{A_{red}} = \frac{0{,}01395}{0{,}0942} = 0{,}148\ \text{м};$$ y_B= 0,3 – 0,148 = 0,152 m.

- the given moment of inertia of section:

$$I_{red} = \frac{b \cdot h^3}{12} + b \cdot h \cdot \left(\frac{h}{2} - y_н\right)^2 + \alpha_{sp} \cdot A_{sp} \cdot (y_н - a)^2 + \alpha_{sp} \cdot A'_{sp} \cdot (y_в - a)^2$$

$$I_{red} = \frac{0{,}24 \cdot 0{,}3^3}{12} + 0{,}24 \cdot 0{,}3 \cdot \left(\frac{0{,}3}{2} - 0{,}148\right)^2 + \frac{190000}{29000} \cdot 9{,}23 \cdot 10^{-4} \cdot (0{,}148 - 0{,}06)^2 +$$
$$+ \frac{190000}{29000} \cdot 6{,}28 \cdot 10^{-4} \cdot (0{,}152 - 0{,}06)^2 = 18{,}823 \cdot 10^{-4}\ \text{м}^4$$

- -eccentricity of equal force:

$$e_{01} = \frac{P_{01} \cdot (y_н - a) - P'_{01} \cdot (y_в - a')}{P_{01} + P'_{01}} = \frac{498 \cdot (0{,}148 - 0{,}06) - 333 \cdot (0{,}152 - 0{,}06)}{498 + 333} = 0{,}0159\ \text{m}$$

- - stress in concrete at the level of the reinforcement axis *S* i *S'*:

$$\sigma_{bp} = \frac{P_0}{A_{red}} + \frac{P_0 \cdot e_{01} \cdot (y_н - a)}{I_{red}} = \frac{831 \cdot 10^{-3}}{0{,}0942} + \frac{831 \cdot 10^{-3} \cdot 0{,}0159 \cdot (0{,}148 - 0{,}06)}{18{,}823 \cdot 10^{-4}} = 9{,}44\text{MPA}$$

$$\sigma'_{bp} = \frac{P_0}{A_{red}} - \frac{P_0 \cdot e_{01} \cdot (y_в - a)}{I_{red}} = \frac{831 \cdot 10^{-3}}{0{,}0942} - \frac{831 \cdot 10^{-3} \cdot 0{,}0159 \cdot (0{,}152 - 0{,}06)}{18{,}823 \cdot 10^{-4}} = 9{,}47\text{MPA}$$

$$\frac{\sigma_{bp}}{R_{bp}} = \frac{9{,}44}{21} = 0{,}45 < \alpha = 0{,}8 \quad \frac{\sigma'_{bp}}{R_{bp}} = \frac{9{,}47}{21} = 0{,}451 < \alpha = 0{,}8$$

α = 0,25 + 0,025 · *RBP* = 0,25 + 0,025 · 21 = 0,78 < 0,8

$$\sigma'_6 = \frac{36 \cdot \sigma'_{вр}}{R_{bp}} = \frac{36 \cdot 9{,}47}{21} = 16{,}23\ \text{МПа} \quad \sigma_6 = \frac{36 \cdot \sigma_{вр}}{R_{bp}} = \frac{36 \cdot 9{,}44}{21} = 16{,}18\ \text{MPA}$$

The first losses:

$\sigma_{LOS1} = \sigma_1 + \sigma_2 + \sigma_3 + \sigma_5 + \sigma_6$= 54 + 81,25 + 35,36 + 30 + 16,18 = 216,8MPA

$\sigma'_{LOS1} = \sigma'_1 + \sigma'_2 + \sigma'_3 + \sigma'_5 + \sigma'_6$= 54 + 81,25 + 44,86 + 30 + 16,23 = 226,34MPA

Second losses:

from shrinkage of concrete σ_8 = 40 MPA from the creep of concrete:

$$\sigma_9 \approx 150 \cdot 0{,}85 \cdot \frac{\sigma_{bp}}{R_{bp}} = 150 \cdot 0{,}85 \cdot \frac{9{,}44}{21} = 57{,}31 \text{MPA}$$

$$\sigma'_9 \approx 150 \cdot 0{,}85 \cdot \frac{\sigma'_{bp}}{R_{bp}} = 150 \cdot 0{,}85 \cdot \frac{9{,}47}{21} = 57{,}5 \text{MPA}$$

The second losses are equal:

$\sigma_{LOS2} = \sigma_9 + \sigma_8 = 40 + 57{,}31 = 97{,}31\text{MPA}$

$\sigma'_{LOS2} = \sigma'_9 + \sigma'_8 = 40 + 57{,}5 = 97{,}5$ MPA

Total losses:

$\sigma_{LOS} = \sigma_{LOS1} + \sigma_{LOS2} = 216{,}8 + 97{,}31 = 314{,}11$ MPA

$\sigma'_{LOS2} = \sigma'_{LOS1} + \sigma'_{LOS2} = 226{,}34 + 97{,}5 = 323{,}84\text{MPA}$

Voltages in fittings taking into account all losses:

$\sigma_{SP2} = \sigma_{SP} - \sigma_{LOS} = 740 - 314{,}11 = 425{,}89\text{MPA}$

$\sigma'_{SP2} = \sigma'_{SP} - \sigma'_{LOS} = 740 - 323{,}84 = 416{,}16\text{MPA}$

Effort of compression of concrete taking into account all losses:

$P = \sigma_{SP2} \cdot ASP = 425{,}89 \cdot 10^3 \cdot 9{,}23 \cdot 10^{-4} = 393{,}1$ KN

$P' = \sigma'_{SP2} \cdot A'_{SP} = 416{,}16 \cdot 10^3 \cdot 6{,}28 \cdot 10^{-4} = 260{,}1\text{KN}$

Taking into account $\gamma_{SP} = 0{,}9$:

$P_{02} = P \cdot \gamma_{SP} = 393{,}1 \cdot 0{,}9 = 353{,}8\text{KN}$

$P'_{02} = P' \cdot \gamma_{SP} = 260{,}1 \cdot 0{,}9 = 234{,}1\text{KN}$

$P_2 = P_{02} + P'_{02} = 353{,}8 + 234{,}1 = 587{,}9\text{Kn}$

Eccentricity of equal forceP_2equal:

$$e_{02} = \frac{P_{02} \cdot (y_н - a) - P'_{02} \cdot (y_в - a')}{P_2} = \frac{353{,}8 \cdot (0{,}148 - 0{,}06) - 234{,}1 \cdot (0{,}152 - 0{,}06)}{587{,}9} = 0{,}016\text{m}$$

Calculations from the formation of cracks for the first combination of efforts

Estimated effort in the lower belt:

N_{MAX} = 1192,82 кН;M_{MAX} = 18,85 KN·m – (the first combination of efforts)

Calculations of eccentrically stretched elements from the formation of cracks are carried out under the condition:

$M_R \le M_{CRC} = R_{BT,\ SER} \cdot W_{PL} + M_{RP}$

The eccentricity of the NSER force relative to the center of gravity of the section:

$$e_0 = \frac{M_{ser}}{N_{ser}} = \frac{18{,}85}{1192{,}82} = 0{,}0158\,\text{m}$$

checking the condition: $N_{SER} > P_2$: 1192,82 кН > 587,9KN ⇒ the given moment of resistance of section:

$$W_{red} = \frac{I_{red}}{y_н} = \frac{18{,}823 \cdot 10^{-4}}{0{,}148} = 12{,}72 \cdot 10^{-3}\,\text{m}^3$$

The moment of resistance of the resulted section for the extreme stretched fiber taking into account inelastic deformations of the stretched concrete is equal:

$W_{PL} = \gamma \cdot W_{RED}$ = 1,75 · 12,72 · 10 $^{-3}$ = 22,26 · 10 $^{-3}$m^3

The distance from the center of gravity of the reduced section to the core point furthest from the stretched zone:

$$r = \frac{W_{pl}}{A_{red}} = \frac{22{,}26 \cdot 10^{-3}}{0{,}0942} = 0{,}236\,\text{m}$$

$M_R = N_{SER} \cdot (e_0 + r)$ = 1192,82 · (0,0158 + 0,236) = 300,35 KN·m

$M_{RP} = P_2 \cdot (e_{02} + r)$ = 587,9 · (0,016 + 0,236) = 148,15 KN·m

$M_{CRC} = R_{BT,\ SER} \cdot W_{PL} + M_{RP}$ = 1,8 · 10 ^{3}· 22,26 · 10 $^{-3}$ + 148,15 = 188,22 KN·m

$M_R > M_{CRC}$ 300,35 > 188,22 ⇒ normal cracks are formed in the lower belt.

Calculations for opening cracks for the first combination of efforts

The width of the cracks in the lower belt of the beam is determined:

$a_{CRC} = a_{CRC1} - a_{CRC2} + a_{CRC3}$

as $N_{SER} > P_2$, то $N_{TOT} = N_{SER} - P_2 = 1192{,}82 - 587{,}9 = 604{,}92$ KN

$$e_{0,tot} = \frac{N_{ser} \cdot e_0 - P_2 \cdot e_{02}}{N_{tot}} = \frac{1192{,}82 \cdot 0{,}0158 - 587{,}9 \cdot 0{,}016}{604{,}92} = 0{,}0156\,\text{m}$$

$e_{0,\,TOT} < 0{,}8 \cdot h_0$; $0{,}0154$ м $< 0{,}8 \cdot 0{,}24 = 0{,}192$ м $\Rightarrow$ The condition is fulfilled.

The voltage in the valve from the short-term action of the full regulatory load is equal:

$$\sigma_s = \frac{N_{ser} \cdot (z_s - e_s) - P_2 \cdot (z_s - e_{sp})}{(A_{sp} + A'_{sp}) \cdot z_s}$$

Where $z_S = h_0 - a' = 0{,}24 - 0{,}06 = 0{,}18$ m

$e_S = h / 2 - e_0 - a = 0{,}3 / 2 - 0{,}0158 - 0{,}06 = 0{,}0742$ m

$e_{SP} = h / 2 - e_{02} - a' = 0{,}3 / 2 - 0{,}016 - 0{,}06 = 0{,}074$ m

$$\sigma_s = \frac{[1192{,}82 \cdot (0{,}18 - 0{,}0742) - 587{,}9 \cdot (0{,}18 - 0{,}074)] \cdot 10^3}{(9{,}23 + 6{,}28) \cdot 10^{-4} \cdot 0{,}18} = 228{,}14\,\text{MPA}$$

Voltage in fittings from action of constant and long loading:

$$\sigma_{sl} = \frac{N_{l,ser} \cdot (z_s - e_s) - P_2 \cdot (z_s - e_{sp})}{(A_{sp} + A'_{sp}) \cdot z_s}$$

$$\sigma_{sl} = \frac{[793{,}84 \cdot (0{,}18 - 0{,}0742) - 587{,}9 \cdot (0{,}18 - 0{,}074)] \cdot 10^3}{(9{,}23 + 6{,}28) \cdot 10^{-4} \cdot 0{,}18} = 77{,}4\,\text{MPA}$$

Width of opening of cracks from short action of full loading:

$$a_{crc1} = \delta \cdot \varphi_l \cdot \eta \cdot \frac{\sigma_s}{E_{sp}} \cdot 20 \cdot (3.5 - 100 \cdot \mu) \cdot \sqrt[3]{d}$$

$$a_{crc1} = 1{,}2 \cdot 1 \cdot 1 \cdot \frac{228{,}14}{190000} \cdot 20 \cdot (3{,}5 - 100 \cdot 0{,}02) \cdot \sqrt[3]{15{,}94} = 0{,}109\,\text{mm}$$

where $\mu = \frac{(A_{sp} + A'_{sp})}{(b \cdot h_0)} = \frac{9{,}23 \cdot 10^{-4} + 6{,}28 \cdot 10^{-4}}{0{,}28 \cdot 0{,}24} = 0{,}027 > 0{,}02 \Rightarrow \mu = 0{,}02$;

$$d = \frac{d_1^2 \cdot n_1 + d_2^2 \cdot n_2}{d_1 \cdot n_1 + d_2 \cdot n_2} = \frac{6 \cdot 14^2 + 2 \cdot 20^2}{6 \cdot 14 + 2 \cdot 20} = 15{,}94 \text{ mm.}$$

Width of opening of cracks from short-term action of constant and long loading:

$$a_{crc2} = \delta \cdot \varphi_l \cdot \eta \cdot \frac{\sigma_{sl}}{E_{sp}} \cdot 20 \cdot (3.5 - 100 \cdot \mu) \cdot \sqrt[3]{d}$$

$$a_{crc2} = 1{,}2 \cdot 1 \cdot 1 \cdot \frac{77{,}4}{190000} \cdot 20 \cdot (3{,}5 - 100 \cdot 0{,}02) \cdot \sqrt[3]{15{,}94} = 0{,}037 \text{ mm}$$

Width of opening of cracks from long action of constant and long loading:

$$a_{crc3} = \delta \cdot \varphi_l \cdot \eta \cdot \frac{\sigma_{sl}}{E_{sp}} \cdot 20 \cdot (3.5 - 100 \cdot \mu) \cdot \sqrt[3]{d}$$

$\varphi_L = 1{,}6 - 15 \cdot \mu = 1{,}6 - 15 \cdot 0{,}02 = 1{,}3$

$$a_{crc3} = 1{,}2 \cdot 1{,}3 \cdot 1 \cdot \frac{77{,}4}{190000} \cdot 20 \cdot (3{,}5 - 100 \cdot 0{,}02) \cdot \sqrt[3]{15{,}94} = 0{,}048 \text{ mm}$$

Short width of crack opening:

$a_{crc} = a_{crc1} - a_{crc2} + a_{crc3} = 0{,}109 - 0{,}037 + 0{,}048 = 0{,}12 \text{ mm} < 0{,}3 \text{ mm}$

Prolonged crack opening width:

$a_{crc3} = 0{,}048$ мм $< 0{,}2$ мм$\Rightarrow$Conditions for crack resistance are met.

Calculations from the formation of cracks for the second combination of forces

The calculated forces in the lower belt are equal:

N_{MAX}= 1022,62 кН;M_{MAX}= 29,34 KN·m – (second combination of efforts)

Calculations of eccentrically stretched elements from the formation of cracks are carried out under conditions:

$M_R \le M_{CRC} = R_{BT,\,SER} \cdot W_{PL} + M_{RP}$

Eccentricity of forces N_{SER}relative to the center of gravity of the section:

$$e_0 = \frac{M_{ser}}{N_{ser}} = \frac{29{,}34}{1022{,}62} = 0{,}0287\ \text{m}$$

The given moment of resistance of section is equal:

$$W_{red} = \frac{I_{red}}{y_н} = \frac{18{,}823 \cdot 10^{-4}}{0{,}148} = 12{,}72 \cdot 10^{-3}\ \text{m}^3$$

The moment of resistance of the resulted section for the extreme stretched fiber taking into account inelastic deformations of the stretched concrete is equal:

$W_{PL} = \gamma \cdot W_{RED} = 1{,}75 \cdot 12{,}72 \cdot 10^{-3} = 22{,}26 \cdot 10^{-3}\text{m}^3$

The distance from the center of gravity of the reduced section to the core point furthest from the stretched zone:

$$r = \frac{W_{pl}}{A_{red}} = \frac{22{,}26 \cdot 10^{-3}}{0{,}0942} = 0{,}236\ \text{m}$$

$M_R = N_{SER} \cdot (e_0 + r) = 1022{,}62 \cdot (0{,}0287 + 0{,}236) = 270{,}7$ KN·m

$M_{RP} = P_2 \cdot (e_{02} + r) = 587{,}9 \cdot (0{,}016 + 0{,}236) = 148{,}15$ KN·m

$M_{CRC} = R_{BT,\,SER} \cdot W_{PL} + M_{RP} = 1{,}8 \cdot 10^3 \cdot 22{,}26 \cdot 10^{-3} + 148{,}15 = 188{,}22$ KN·m

$M_R > M_{CRC}$ $270{,}7 > 188{,}22 \Rightarrow$ normal cracks are formed in the lower belt.

Calculations for opening cracks for the second combination of efforts

The width of the cracks in the lower belt of the beam is determined:

$a_{CRC} = a_{CRC1} - a_{CRC2} + a_{CRC3}$

Since $N_{SER} > P_2$, то $N_{TOT} = N_{SER} - P_2 = 1022{,}62 - 587{,}9 = 434{,}72$ KN

$$e_{0,tot} = \frac{N_{ser} \cdot e_0 - P_2 \cdot e_{02}}{N_{tot}} = \frac{1022{,}62 \cdot 0{,}0287 - 587{,}9 \cdot 0{,}016}{434{,}72} = 0{,}046\ \text{m}$$

$e_{0,\,TOT} < 0{,}8 \cdot h_0$; 0,046 м < 0,8 · 0,24 = 0,192 м⇒The condition is fulfilled.

The voltage in the valve from the short-term action of the full regulatory load is equal:

$$\sigma_s = \frac{N_{ser} \cdot (z_s - e_s) - P_2 \cdot (z_s - e_{sp})}{(A_{sp} + A'_{sp}) \cdot z_s}$$

where$z_S = h_0 - a' = 0{,}24 - 0{,}06 = 0{,}18$ m

$e_S = h / 2 - e_0 - a = 0{,}3 / 2 - 0{,}0287 - 0{,}06 = 0{,}0613$ m

$e_{SP} = h / 2 - e_{02} - a' = 0{,}3 / 2 - 0{,}016 - 0{,}06 = 0{,}074$ m

$$\sigma_s = \frac{[1022{,}62 \cdot (0{,}18 - 0{,}0613) - 587{,}9 \cdot (0{,}18 - 0{,}074)] \cdot 10^3}{(9{,}23 + 6{,}28) \cdot 10^{-4} \cdot 0{,}18} = 210{,}95 \text{ MPA}$$

Voltage in the valve from the action of constant and prolonged load:

$$\sigma_{sl} = \frac{N_{l,ser} \cdot (z_s - e_s) - P_2 \cdot (z_s - e_{sp})}{(A_{sp} + A'_{sp}) \cdot z_s}$$

$$\sigma_{sl} = \frac{[680{,}57 \cdot (0{,}18 - 0{,}0613) - 587{,}9 \cdot (0{,}18 - 0{,}074)] \cdot 10^3}{(9{,}23 + 6{,}28) \cdot 10^{-4} \cdot 0{,}18} = 65{,}94 \text{ MPA}$$

Width of crack opening from short action of full loading:

$$a_{crc1} = \delta \cdot \varphi_l \cdot \eta \cdot \frac{\sigma_s}{E_{sp}} \cdot 20 \cdot (3.5 - 100 \cdot \mu) \cdot \sqrt[3]{d}$$

$$a_{crc1} = 1{,}2 \cdot 1 \cdot 1 \cdot \frac{210{,}95}{190000} \cdot 20 \cdot (3{,}5 - 100 \cdot 0{,}02) \cdot \sqrt[3]{15{,}94} = 0{,}1 \text{ mm}$$

where $\mu = \frac{(A_{sp} + A'_{sp})}{(b \cdot h_0)} = \frac{9{,}23 \cdot 10^{-4} + 6{,}28 \cdot 10^{-4}}{0{,}28 \cdot 0{,}24} = 0{,}027 > 0{,}02 \Rightarrow \mu = 0{,}02$;

$$d = \frac{d_1^2 \cdot n_1 + d_2^2 \cdot n_2}{d_1 \cdot n_1 + d_2 \cdot n_2} = \frac{6 \cdot 14^2 + 2 \cdot 20^2}{6 \cdot 14 + 2 \cdot 20} = 15{,}94 \text{ mm.}$$

The voltage in the valve from the short-term action of the full regulatory load is equal:

$$\sigma_s = \frac{N_{ser} \cdot (z_s - e_s) - P_2 \cdot (z_s - e_{sp})}{(A_{sp} + A'_{sp}) \cdot z_s}$$

where$z_S = h_0 - a' = 0{,}24 - 0{,}06 = 0{,}18$ m

$es = h / 2 - e_0 - a = 0{,}3/2 - 0{,}0287 - 0{,}06 = 0{,}0613$ m

$esp = h / 2 - e_{02} - a' = 0{,}3/2 - 0{,}016 - 0{,}06 = 0{,}074$ m

$$\sigma_s = \frac{[1022{,}62 \cdot (0{,}18 - 0{,}0613) - 587{,}9 \cdot (0{,}18 - 0{,}074)] \cdot 10^3}{(9{,}23 + 6{,}28) \cdot 10^{-4} \cdot 0{,}18} = 210{,}95 \text{ MPA}$$

Voltage in fittings from action of constant and long loading:

$$\sigma_{sl} = \frac{N_{l,ser} \cdot (z_s - e_s) - P_2 \cdot (z_s - e_{sp})}{(A_{sp} + A'_{sp}) \cdot z_s}$$

$$\sigma_{sl} = \frac{[680{,}57 \cdot (0{,}18 - 0{,}0613) - 587{,}9 \cdot (0{,}18 - 0{,}074)] \cdot 10^3}{(9{,}23 + 6{,}28) \cdot 10^{-4} \cdot 0{,}18} = 65{,}94 \text{ MPA}$$

Width of opening of cracks from short action of full loading:

$$a_{crc1} = \delta \cdot \varphi_l \cdot \eta \cdot \frac{\sigma_s}{E_{sp}} \cdot 20 \cdot (3.5 - 100 \cdot \mu) \cdot \sqrt[3]{d}$$

$$a_{crc1} = 1{,}2 \cdot 1 \cdot 1 \cdot \frac{210{,}95}{190000} \cdot 20 \cdot (3{,}5 - 100 \cdot 0{,}02) \cdot \sqrt[3]{15{,}94} = 0{,}1 \text{ mm}$$

where $\mu = \frac{(A_{sp} + A'_{sp})}{(b \cdot h_0)} = \frac{9{,}23 \cdot 10^{-4} + 6{,}28 \cdot 10^{-4}}{0{,}28 \cdot 0{,}24} = 0{,}027 > 0{,}02 \Rightarrow \mu = 0{,}02$;

$$d = \frac{d_1^2 \cdot n_1 + d_2^2 \cdot n_2}{d_1 \cdot n_1 + d_2 \cdot n_2} = \frac{6 \cdot 14^2 + 2 \cdot 20^2}{6 \cdot 14 + 2 \cdot 20} = 15{,}94 \text{ mm.}$$

Width of opening of cracks from short-term action of constant and long loading:

$$a_{crc2} = \delta \cdot \varphi_l \cdot \eta \cdot \frac{\sigma_{sl}}{E_{sp}} \cdot 20 \cdot (3.5 - 100 \cdot \mu) \cdot \sqrt[3]{d}$$

$$a_{crc2} = 1{,}2 \cdot 1 \cdot 1 \cdot \frac{65{,}94}{190000} \cdot 20 \cdot (3{,}5 - 100 \cdot 0{,}02) \cdot \sqrt[3]{15{,}94} = 0{,}0314 \text{ mm}$$

Width of opening of cracks from long action of constant and long loadings:

$$a_{crc3} = \delta \cdot \varphi_l \cdot \eta \cdot \frac{\sigma_{sl}}{E_{sp}} \cdot 20 \cdot (3.5 - 100 \cdot \mu) \cdot \sqrt[3]{d}$$

$\varphi_L = 1{,}6 - 15 \cdot \mu = 1{,}6 - 15 \cdot 0{,}02 = 1{,}3$

$$a_{crc3} = 1{,}2 \cdot 1{,}3 \cdot 1 \cdot \frac{65{,}94}{190000} \cdot 20 \cdot (3{,}5 - 100 \cdot 0{,}02) \cdot \sqrt[3]{15{,}94} = 0{,}041 \text{ mm}$$

Short width of crack opening:

$a_{crc} = a_{crc1} - a_{crc2} + a_{crc3} = 0{,}1 - 0{,}0314 + 0{,}041 = 0{,}11$ мм $<0{,}3$ mm

Prolonged crack opening width:

$a_{crc3} = 0{,}041$ мм $< 0{,}2$ мм$\Rightarrow$Conditions for crack resistance are met.

2.5.4. Upper belt calculations.

Element 6 – 8:$N = 1194{,}1$ KN;$m = 48{,}53$ KN·m.

Estimated element length 6-8 the upper belt in the plane of the beam: $l_0 = 1{,}5 - 0{,}4 = 1{,}1$ m

We check the condition: $\lambda = \frac{l_0}{i} = \frac{l_0 \cdot \sqrt{12}}{0{,}42} = \frac{1{,}1 \cdot \sqrt{12}}{0{,}42} = 9{,}07$ m< 14

therefore, the effect of deflection on the eccentricity of the force N is not taken into account.

The height of the compressed zone: $x = \frac{N / \cos\alpha}{\gamma_{b2} \cdot R_b \cdot b} = \frac{1194{,}1 / 0{,}996}{0{,}9 \cdot 17 \cdot 10^3 \cdot 0{,}28} = 0{,}28$ m;

$h_0 = h - a' = 0{,}42 - 0{,}04 = 0{,}38$ m;

$$\xi = \frac{x}{h_0} = \frac{0{,}28}{0{,}38} = 0{,}736;$$

$\omega = 0{,}85 - 0{,}008 \cdot RB = 0{,}85 - 0{,}008 \cdot 17 \cdot 0{,}9 = 0{,}728$;

Maximum relative height of the compressed zone:

$$\xi_R = \frac{\omega}{1+\frac{R_s}{\sigma_{sc,u}}\cdot\left(1-\omega/_{1,1}\right)} = \frac{0,728}{1+\frac{365}{500}\cdot\left(1-0,728/_{1,1}\right)} = 0,584$$ condition □□ =0,736 □>□$_r$ =0,584

$$A_r = \xi_r\cdot(1-0,5\cdot\xi_r) = 0,584\cdot(1-0,584) = 0,243$$

$e_0 = M/N$ = 48,53/ 1194,1 = 0,041 m

e = $e_0 + h/2 - as$=0,041 + 0,42/2 – 0,04 = 0,211 m

$$\alpha_m = \frac{N\cdot e}{\gamma_{b2}\cdot R_b\cdot b\cdot h^2 0} = \frac{1194,1\cdot 0,211}{0,9\cdot 17\cdot 0,28\cdot 0,38^2\cdot 10^3} = 0,407$$

$$\alpha = \frac{\alpha_m - \xi(1-0,5\cdot\xi\ )}{1-a/h} = \frac{0,407-0,736\cdot(1-0,5\cdot 0,736)}{1-0,04/0,42} = -0,065 < 0$$

longitudinal reinforcement is installed according to design requirements:

$A_S = A'_S = \mu_{MIN}\cdot b\cdot h_0$ = 0,0005 · 0,24 · 0,42 = 0,504 · 10 $^{-4}$ м^2

By assortment, taking into account the requirements $ds \geq 10$ (mm) we accept:

$A_S = A_{SC}$ = 1,57 · 10 $^{-4}$м^2 по 2∅ 10 A–III.

The diameter of the transverse rods is equal:

$d_{SW} \geq (1 / 4)\cdot d_S$= (1 / 4) · 10 = 2,5 mmwe accept∅ 6 A–III

Step rods: S ≤ 20 · d_S = 20 · 10 = 200 mm⇒we accept S = 200 мм.

Element 4 – 2:N = 1028,61 KN;M = 64,44 KN·м.

The height of the compressed zone: $x = \frac{N/\cos\alpha}{\gamma_{b2}\cdot R_b\cdot b} = \frac{1028,61/0,996}{0,9\cdot 17\cdot 10^3\cdot 0,28} = 0,241$ м

$h_0 = h - a'$ = 0,42 – 0,04 = 0,38 м

$\xi = \frac{x}{h_0} = \frac{0,241}{0,38} = 0,634$; ω = 0,85 – 0,008 · R_B= 0,85 – 0,008 · 17 · 0,9 = 0,728

Maximum relative height of the compressed zone:

$$\xi_R = \frac{\omega}{1+\frac{R_s}{\sigma_{sc,u}}\cdot\left(1-\omega/_{1,1}\right)} = \frac{0,728}{1+\frac{365}{500}\cdot\left(1-0,728/_{1,1}\right)} = 0,584$$ requirement □□ =0,634

□>□$_r$=0,584

$A_r = \xi_r \cdot (1 - 0{,}5 \cdot \xi_r) = 0{,}584 \cdot (1 - 0{,}584) = 0{,}243$

$e_0 = M/N$ = 64,44 / 1028,61 = 0,0626 м

e = $e_0 + h/2 - a_s$ =0,0626 + 0,42/2 – 0,04 = 0,233 м

$$\alpha_m = \frac{N \cdot e}{\gamma_{b2} \cdot R_b \cdot b \cdot h^2 0} = \frac{1028{,}61 \cdot 0{,}233}{0{,}9 \cdot 17 \cdot 0{,}28 \cdot 0{,}38^2 \cdot 10^3} = 0{,}387$$

$$\alpha = \frac{\alpha_m - \xi(1 - 0{,}5 \cdot \xi\ )}{1 - a/h} = \frac{0{,}387 - 0{,}634 \cdot (1 - 0{,}5 \cdot 0{,}634)}{1 - 0{,}04/0{,}42} = -0{,}051 < 0$$

longitudinal reinforcement is installed according to design requirements:

$A_S = A'_S = \mu_{MIN} \cdot b \cdot h_0$ = 0,0005 · 0,28 · 0,42 = 0,588 · 10 $^{-4}$ м^2

By assortment, taking into account the requirements $ds \geq 10$ (мм) we accept:

$A_S = A_{SC}$ = 1,57 · 10 $^{-4}$м^2 по 2∅ 10 A–III.

The diameter of the transverse rods is equal:

$d_{SW} \geq (1 / 4) \cdot d_S$= (1 / 4) · 10 = 2,5 mmwe accept∅ 6 A–III

Step rods: S ≤ 20 · d_S = 20 · 10 = 200 mm⇒we accept S = 200 mm

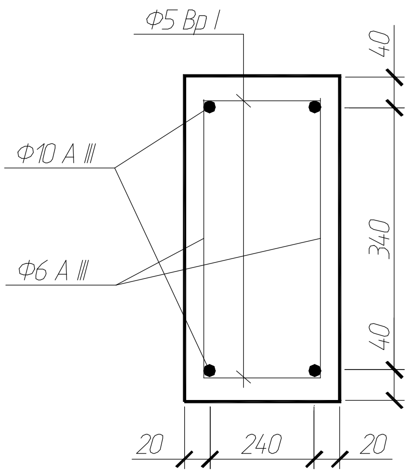


Fig. 2.5.4. Reinforcement of the upper belt of the lattice beam.

CALCULATIONS STAND

As efforts in racks 5-6 and 4-3 are less, than in elements of the top belt, and height of section of racks is more than height of section of the top belt:

hct = 500 > 420 мм, then the racks are reinforced without calculations of design requirements:

A_S = A_{SC} = 0,0005 · 0,28 · (0,5 – 0,04) = 0,644 · 10 $^{-4}$ м^2

acceptA_S= A_{SC} = 1,57 · 10 $^{-4}$ м^2 по 2∅ 10 A–III.

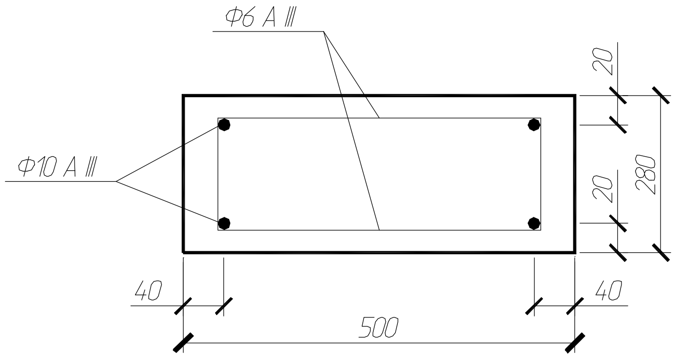


Fig. 2.5.5. Reinforcement of lattice beam racks.

CALCULATIONS OF THE BEAM SUPPORT KNOT

Maximum calculated transverse forceQ_{MAX} = 282,15 KN

The length of the projection of the inclined section: c = 2850 – 130 = 2720 мм

The height of the cross section of the beam at the end of the inclined section:

h = 890 + (2720 + 260) · (1/12) = 1138 mm

Working height of section: $h_0 = h – a$ = 1138 – 133 = 1005 mm

$$a = \frac{A_{sp} \cdot a + A'_{sp} \cdot h_0^{н.п.}}{A_{sp} + A'_{sp}} = \frac{\cdot 9{,}23 \cdot 10^{-4} \cdot 0{,}06 + 6{,}28 \cdot 10^{-4} \cdot 0{,}24}{9{,}23 \cdot 10^{-4} + 6{,}28 \cdot 10^{-4}} = 0{,}133\,\text{m}$$

where$h_0^{Н.П.}$ = 0,24 м – working height of the lower belt section

$c > 2 \cdot h_0$ = 2 · 1005 = 2021mm. We acceptз = 1850 mm

Then h = 890 + (1850 + 260) · (1/12) = 1066 mm

h_0 = 1066 – 133 = 933 mm

c = 1850 < 2 ·h_0 = 2 · 933 = 1866 mm

The minimum transverse force perceived by concrete is determined by the formula:

$$\varphi_n = \frac{0{,}1 \cdot P_2}{\gamma_{b2} \cdot R_{bt} \cdot b \cdot h_0} = \frac{0{,}1 \cdot 587{,}9}{0{,}9 \cdot 1{,}2 \cdot 10^3 \cdot 0{,}28 \cdot 0{,}933} = 0{,}21 < 0{,}5\,;$$

$Q = \varphi_{B3} \cdot (1 + \varphi_N) \cdot RBT \cdot \gamma_{B2} \cdot b \cdot h_0$ = 0,6 · (1 + 0,243) · 1,2 · 103· 0,9 · 0,28 · 0,933 = 210,4 KN

Q= 210,4 кН <$QMAX$ = 282,15 KNtherefore, the cross section of the valves is determined by calculation.

Determine the transverse force perceived by the concrete:

$QB^* = QMAX / 2$ = 282,15/2 = 141,075 KN

$B = \varphi_{B2} \cdot (1 + \varphi_F + \varphi_N) \cdot RBT \cdot \gamma_{B2} \cdot b \cdot h_{02}$= 2·(1+0+ 0,243) · 1,2 · 103 · 0,9 · 0,28 · 0,9332 =

=654,4 KN

$c = B / QB^*$ = 654,4/ 141,075 = 4,64 м > 2 ·h_0 = 2 · 0,933 = 1,866 м

we accept$з$ = 2 · h_0 = 1,866 м.

$QB = B / c$ = 654,4/1,866 = 350,7 KN> $QMAX$ = 282,15 KN⇒transverse reinforcement is installed according to design requirements:

approve: fittings – ∅ 6 *A – III*

step rods – $S = h / 3$ = 890 / 3 = 297 mm

we accept$S$ = 200 mm

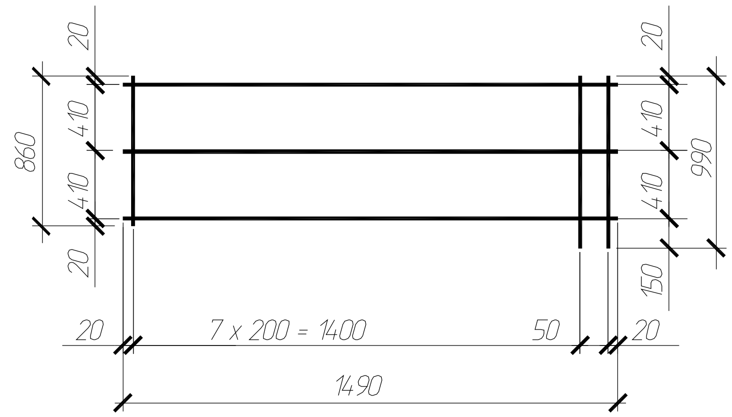


Fig. 2.5.6. Frame of a basic knot of a beam.

Checking the strength of concrete under the influence of the main compressive stresses:

$Q \leq 0,3 \cdot \varphi_{W1} \cdot \varphi_{B1} \cdot RB \cdot \gamma_{B2} \cdot b \cdot h_0$

$$\varphi_{w1} = 1 + \frac{5 \cdot E \cdot A_{sw}}{E_b \cdot b \cdot S} = 1 + \frac{5 \cdot 2 \cdot 10^5 \cdot 0{,}57 \cdot 10^{-4}}{29000 \cdot 0{,}28 \cdot 0{,}2} = 1{,}035 < 1{,}3,$$

whereA_{SW} – the cross-sectional area of the longitudinal reinforcement

φ_{B1} = 1 – 0,01· RB ·γ_{B2} = 1 – 0,01 · 17 · 0,9 = 0,847

Q ≤0,3 · 1,035 · 0,847 · 17 · 103 · 0,9 · 0,28 · 0,933 = 1051,2 кН >Q_{MAX}=282,15 KN

$h_O^{ОП} = h_{ОП} - a$ = 0,82 – 0,133 = 0,687 м

The strength of the concrete support zone of the beam to the action of compressive forces is checked by the formula:

$Q \le 0{,}8 \cdot RB \cdot \gamma_{B2} \cdot b \cdot l_{ОП} \cdot sin^2\theta$

Whereθ– the angle of inclination of the compressed strip of concrete

$$\sin\theta = \frac{h_o^{on}}{\sqrt{l_{on}^2 + (h_o^{on})^2}} = \frac{0{,}687}{\sqrt{0{,}27^2 + 0{,}687^2}} = 0{,}93$$

Q = 282,15 кН <0,8 · 17 · 103 · 0,9 · 0,28 · 0,27 · 0,93 ^{2} = 800,3 KN

The condition of durability of concrete is carried out and statement of horizontal collars on a support at calculation is not required.

Grid C1 is installed according to design requirements. The required cross-sectional area of the anchor rods of the supporting mortgage part MN - 2 is equal:

$$A_{S,AH}^{TP} = \frac{0{,}2 \cdot R_{sp} \cdot A_{sp}}{R_{S,AH}} = \frac{0{,}2 \cdot 680 \cdot 10^3 \cdot (9{,}23 \cdot 10^{-4} + 6{,}28 \cdot 10^{-4})}{365 \cdot 10^3} = 5{,}78 \cdot 10^{-4}$$

approve the anchor rods 6∅12 A–III c $AS_{,AH} = 6{,}79 \cdot 10^{-4} m^2$

Condition: $ds \ge 10$ mm – is performed.

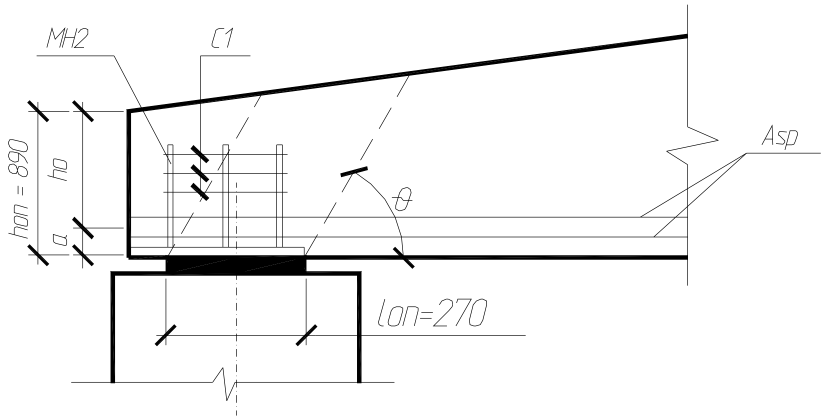


Fig. 2.5.7. To the calculations of the support node of the beam.

2.6. Calculation and design of a column of continuous square section.

Design data:

Extreme column code – К8

- Geometric dimensions of column sections:
- the height of the cross section of the column – *h* = 0,4 м;
- column section width – *b* = 0,4 м;
- column height *H* = 8,1 м.

Class of concrete columns – B25. Fittings class AIII.

Calculations of the eccentric compressed column with symmetrical reinforcement

The working armature is selected in combination with the greatest bending moment.

Estimated effort in the extreme column:

M = 55 KN·м; N = 414,5 KN;Q = 14,9 KN.

Cross section of the column *b* x *h* = 400 x 400 mm.

The length of the column without taking into account the depth of anchoring in the foundation:

$H_p = 7{,}2 + 0{,}15 = 7{,}35$ м;

Estimated column length: $l_0 = \mu \cdot H_p = 1{,}5 \cdot 7{,}35 = 11{,}025$ м;

The minimum working height of the cross section of the column:

$h_0 = h - a = 400 - 50 = 350$ mm.

Radius of inertia of rectangular section: $i_{red} = \sqrt{\frac{h^2}{12}} = \sqrt{\frac{400^2}{12}} = 115{,}5$ mm

Since $\frac{l_0}{i_{red}} = \frac{11025}{115{,}5} = 95{,}5 > 14$, it is necessary to take into account the effect of column deflection on the increase in eccentricity.

Estimated eccentricity: $e_0 = \frac{M}{N}$; $e_0 = \frac{55}{414{,}5} = 0{,}133$ m

$M_1 = M + 0{,}5 \cdot M_s + k \cdot M_{кр,верт}$; $M_1 = 4{,}3 + 0{,}5 \cdot 3{,}4 = 6$ KN·m

$N_1 = N + 0{,}5 \cdot N_s + k \cdot N_{кр,верт}$; $N_1 = 245{,}4 + 0{,}5 \cdot 169{,}1 = 329{,}95$ KN

Moments relative to the axis passing through the center of the stretched or less compressed reinforcement:

$M_1 = M + 0{,}5 \cdot N \cdot (h_0 - a')$; $M_1 = 55 + 0{,}5 \cdot 414{,}5 \cdot (0{,}35 - 0{,}05) = 117{,}18$ KN·m

$M_{11} = M_1 + 0{,}5 \cdot N_1 \cdot (h_0 - a')$; $M_{11} = 6 + 0{,}5 \cdot 329{,}95 \cdot (0{,}35 - 0{,}05) = 55{,}49\,KN \cdot m$

$$\frac{l_0}{h} = \frac{11025}{400} = 27{,}6 > 4$$

Coefficient that takes into account the effect of prolonged action of the load on the deflection of the column:

$\varphi_1 = 1 + \beta \frac{M_{11}}{M_1} = 1 + \frac{1 \cdot 55{,}49}{117{,}18} = 1{,}474$; for heavy concrete $\beta = 1$

Coefficient that takes into account the action of the bending moment in the cross section of the column:

$\delta_e = \frac{e_0}{h}$; $\delta_e = \frac{0{,}133}{0{,}4} = 0{,}33$;

$\delta_{e,min} = 0{,}5 - 0{,}01 \cdot \frac{l_0}{h} - 0{,}01 \cdot \gamma_{b2} \cdot R_{b,ser}$; $\delta_{e,min} = 0{,}5 - 0{,}01 \cdot \frac{11{,}025}{0{,}4} - 0{,}01 \cdot 1{,}1 \cdot 18{,}5 = 0{,}02$

$\delta_e = 0{,}33 > \delta_{e,min} = 0{,}02 \Rightarrow$ we approve $\delta_e = 0{,}33$;

The limiting force perceived by the column at the time of loss of stability:

$$N_{cr} = \frac{6{,}4 \cdot E_b \cdot 1000}{l_0^2} \cdot \left[\frac{J}{\varphi_1} \cdot \left(\frac{0{,}11}{0{,}1 + \delta_e} + 0{,}1 \right) + \alpha \cdot J_s \right],$$

where $\alpha = \frac{E_s}{E_b}$; $\alpha = \frac{200000}{27000} = 7{,}41$; $J = \frac{b \cdot h^3}{12}$; $J = \frac{0{,}4 \cdot 0{,}4^3}{12} = 0{,}0053$ м^4

$J_s = 0{,}005 \cdot b \cdot h \cdot (\frac{h}{2} - a)^2$; $J_s = 0{,}005 \cdot 0{,}4 \cdot 0{,}4 \cdot (\frac{0{,}4}{2} - 0{,}05)^2 = 18 \cdot 10^{-6}$ м^4

$$N_{cr} = \frac{6{,}4 \cdot 27000 \cdot 1000}{11{,}025^2} \cdot \left[\frac{0{,}0053}{1{,}474} \cdot \left(\frac{0{,}11}{0{,}1 + 0{,}33} + 0{,}1 \right) + 7{,}41 \cdot 18 \cdot 10^{-6} \right] = 2009{,}3\,KN$$

N = 414,5 KN< Ncr= 2009,3 KN.

Coefficient that takes into account the effect of deflection of the column:

$\eta = \frac{1}{1 - \frac{N}{N_{cr}}}$; $\eta = \frac{1}{1 - \frac{414{,}5}{2009{,}3}} = 1{,}25$

- Determine the area of the fittings of the off-center compressed column:
- distance from the point of application of the longitudinal force to the equivalent force in the stretched reinforcement: $e = \eta \cdot e_0 + 0,5 \cdot (h - a_s)$;

  $e = 1,25 \cdot 0,133 + 0,5 \cdot (0,4 - 0,05) = 0,34$ м

$\omega = 0,85 - 0,008 \cdot R_b$; $\omega = 0,85 - 0,008 \cdot 14,5 \cdot 0,9 = 0,746$; $\gamma_{b2} = 0,9 < 1 \Rightarrow$

- - maximum relative height of the compressed zone:

$\xi_R = \dfrac{\omega}{1 + \dfrac{\sigma_{sr}}{500} \cdot (1 - \dfrac{\omega}{1,1})}$; $\xi_R = \dfrac{0,746}{1 + \dfrac{365}{500} \cdot (1 - \dfrac{0,746}{1,1})} = 0,604$, where $\sigma_{sr} = 365$

MPAforreinforcement class A-A- III.

$\delta = \dfrac{a'}{h_0}$; $\delta = \dfrac{0,05}{0,35} = 0,143$ м

- determine the position of the compressed zone:

$\alpha_n = \dfrac{N}{R_b \cdot b \cdot h_0 \cdot 1000}$; $\alpha_n = \dfrac{414,5}{14,5 \cdot 0,9 \cdot 0,4 \cdot 0,35 \cdot 1000} = 0,227$

$\alpha_m = \dfrac{N \cdot e}{R_b \cdot b \cdot h_0^2 \cdot 1000}$; $\alpha_m = \dfrac{414,5 \cdot 0,34}{14,5 \cdot 0,9 \cdot 0,4 \cdot 0,35^2 \cdot 1000} = 0,22$

$\alpha_n = 0,227 < \xi_R = 0,604 \Rightarrow A_s = A_s^{'} = \dfrac{R_b \cdot b \cdot h_0}{R_s} \cdot \dfrac{\alpha_m - \alpha_n \cdot (1 - 0,5 \cdot \alpha_n)}{1 - \delta}$

$A_s = A_s^{'} = \dfrac{14,5 \cdot 0,9 \cdot 0,4 \cdot 0,35}{365} \cdot \dfrac{0,22 - 0,227 \cdot (1 - 0,5 \cdot 0,227)}{1 - 0,143} = 1,1 \cdot 10^{-4}$ м^2

μ = As · 2 / (b ·ho) = 0,00011 · 2 / (0,4 · 0,35) = 0,0016 м^2

i = 0,289 · h = 0,289 · 0,4 = 0,116; l_0 / i = 11,025/0,116 = 95; we approve μ = 0,004;

$2 \cdot A_s = \mu \cdot b \cdot h_0 = 0,004 \cdot 400 \cdot 350 = 560$ mm^2

As= 560/2 = 280 mm^2; μ = 0,0038 > μmin= 0,004

We accept reinforcment 2 ∅ 16 A–III c AS = AS$^{'}$= 4,02 · 10 $^{-4}$ м^2

μ = As · 2 / (b ·ho) = 0,000402 · 2 / (0,4 · 0,35) = 0,0057 m^2

There is no need to check the strength of the section, because the reinforcement was selected by a combination of forces with the highest values M i N.

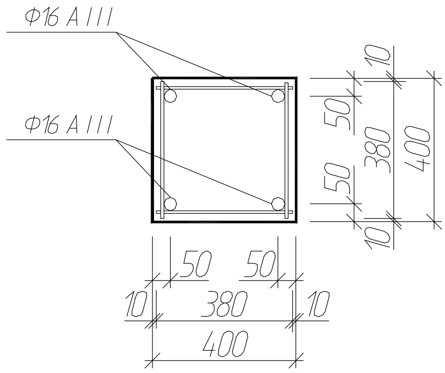


Fig. 2.6.1. Reinforcement of the column.

CONSTRUCTION OF A COLUMN OF A CONTINUOUS SECTION

Along the entire length of the column is reinforced with a frame KP1.

The diameter of the transverse reinforcement is determined from the condition of weldability and is assumed to be equal:

$$\begin{cases} d_w = 0{,}25 \cdot d_s = 0{,}25 \cdot 16 = 4\text{мм} \\ d_w \geq 5\text{мм} \end{cases} \Rightarrow \text{we approve dw = 5 mm;}$$

The pitch of the transverse rods is assigned by condition:

$S_1 \leq 20 \cdot ds = 20 \cdot 16 = 320$ мм, we approve S = 300 mm

Length of a flat framework KP1 equal:

$l = L_к - 30 = 8100 - 30 = 8070$ mm

The distance from the top of the frame to the transverse rods is not more:

$b \leq 230 + S_1$; $b \leq 230 + 300 = 530$ mm, we approve b = 480 mm.

The column head is reinforced 4-я grids З1.

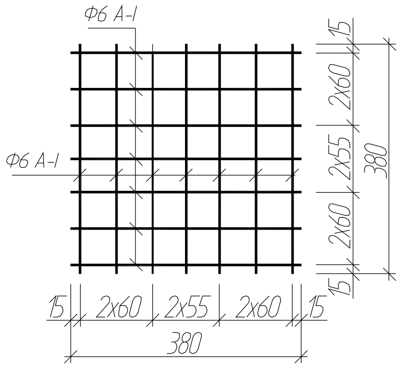


Fig. 2.6.2. Net C1.

SECTION 3. FUNDAMENTALS AND FOUNDATIONS

3.1. Data for design

For the designed building in its production part separate reinforced concrete foundations of step type under columns are applied. Concrete class B15.

- Physical properties of soil:
- the basis is loam with a porosity coefficient*e* = 0,75;
- fluidity indicator *Il* = 0,56;
- the calculated value of the specific clutchc_{II} = 20 KPA;
- the angle of internal friction φ = 18 про;
- groundwater level – 2,5 m.

3.2. Determining the depth of laying

Depth of laying of the bases is appointed as a result of joint consideration of engineering-geological and hydrogeological conditions of a building site, seasonal freezing and heaving of soils, constructive and operational features of buildings, size and character of loading on the basis.

The depth of the foundations was determined in the architectural and construction section (п. 1.6) : *df*= 0,8 м.

From design requirements:

$H_f \geq l_{an} + 0{,}05 + 0{,}2 = 0{,}75 + 0{,}05 + 0{,}2 = 1$ m,

where $\begin{cases} l_{an} \geq 1{,}5 b_{col} = 1{,}5 \cdot 0{,}4 = 0{,}6 \text{ м} \\ l_{an} \geq h_{col} = 0{,}4 \text{ м} \end{cases}$, we accpet $l_{an} = 0{,}75$ m.

Since the typical series is the minimum height of the foundation $H_f = 1{,}5$ м, we adopt the minimum depth of laying the foundations: *d*= 1,5 + 0,15 = 1,65 м.

3.3. Calculation of the basis

Based on combinations of efforts(п.2.4) we accept the calculated loads in the column at the level of its laying in the foundation (crossing 2-2):

M= 55 KN·m; N = 414,5 KN; Q = 14,9 KN.

Check of durability of the ground basis is carried out on standard loadings:

$N_n = 9{,}81 \cdot 1{,}5 + 9{,}81 \cdot 18{,}32 = 194{,}4$ KN – the load from wall panels which is transferred directly to the base beam and through the base to the basis.

$M_f = M + Q \cdot H = 55 + 14{,}9 \cdot 1{,}5 = 77{,}35$; $N_f = N + N_n = 414{,}5 + 194{,}4 = 609$

$M_{ser} = M_f / \overline{\gamma_f} = 77{,}35 / 1{,}17 = 66{,}1$ кН·м; $N_{ser} = N_f / \overline{\gamma_f} = 609 / 1{,}17 = 553{,}5$ KN;

where $\overline{\gamma_f}$ = 1,17 - average reliability factor for single-storey industrial buildings.

In the first approximation we accept b = 2100 mm; l = 2400 mm.

The average soil pressure under the base of the foundation:

$$p = \frac{N_{ser}}{bl} + \frac{M_{ser}}{bl^2/6} + \bar{\gamma} H_{çàë} = \frac{553{,}5}{2{,}4 \cdot 2{,}1} + \frac{66{,}1}{2{,}1 \cdot 2{,}4^2/6} + 20 \cdot 1{,}65 = 175{,}6 \text{ KPA}.$$

Determine the calculated soil resistance of the base by the formula:

$$R = \frac{\gamma_{c1}\gamma_{c2}}{k}\left[M_\gamma k_z b \gamma_{II} + M_q d_1 \gamma_{II}^{/} + (M_q - 1) d_b \gamma_{II}^{/} + M_c c_{II}\right];$$

$$R = \frac{1{,}0 \cdot 1{,}0}{1{,}1}\left[0{,}43 \cdot 1 \cdot 2{,}1 \cdot 15{,}7 + 2{,}73 \cdot 1{,}65 \cdot 15{,}7 + 0 + 5{,}31 \cdot 20\right] = 173{,}7 \text{ KPA},$$

- $\gamma_{c1} = 1{,}0$ - coefficient of working conditions for loams at $0{,}25 < Il = 0{,}56 \leq 0{,}5$;
- $\gamma_{c2} = 1{,}0$ - coefficient of working conditions at L/H = 48/7,2 = 6,67 > 4;
- $M_\gamma = 0{,}43$; $M_q = 2{,}73$; $M_c = 5{,}31$; $k = 1{,}1$ at $\varphi = 16^{\circ}$;
- $k_z = 1$ at b = 2,4 м < 10 м;
- b = 2,4 м - the width of the base of the foundation;
- $\gamma_{II} = \rho \cdot g = 1600 \cdot 9{,}81 \cdot 10^{-3} = 15{,}7$ KN/m^3 – the average calculated value of the specific weight of soils below the base of the foundation;

- $\gamma_{II}^{/} = \rho^{/} \cdot g = 1600 \cdot 9{,}81 \cdot 10^{-3} = 15{,}7$ KN/m^3 – the average calculated value of the specific weight of soils above the base of the foundation;

- $d_1 = 1{,}65$м - depth of laying the foundations from the level of planning;

- $d_b = 0$ - basement depth.

checking the condition: $P = 175{,}6 \text{ кПа} \quad < \quad 1{,}2R = 208{,}5 \text{ кПа}.$

We specify the sizes of a sole:

$$b_1 = \sqrt{\frac{N_{ser}}{\frac{l}{b}(R - \bar{\gamma} d)}} = \sqrt{\frac{553{,}5}{1{,}43 \cdot (173{,}7 - 20 \cdot 1{,}65)}} = 1{,}66 \text{ м;}$$

$$l_1 = \sqrt{\frac{N_{ser}}{\frac{b}{l}(R - \bar{\gamma} d)}} = \sqrt{\frac{553{,}5}{0{,}875 \cdot (173{,}7 - 20 \cdot 1{,}65)}} = 2{,}12 \text{ м.}$$

checking the condition: $\left| \frac{b - b_1}{b} \right| = \frac{2{,}1 - 1{,}66}{2{,}1} = 0{,}21 > 0{,}03$.

In the second approximation we acceptb_2 = 1800 mm; l_2 = 2400 mm.

The average soil pressure under the base of the foundation:

$$p = \frac{N_{ser}}{bl} + \frac{M_{ser}}{bl^2/6} + \bar{\gamma} H_{çàë} = \frac{553{,}5}{1{,}8 \cdot 2{,}4} + \frac{66{,}1}{1{,}8 \cdot 2{,}4^2/6} + 20 \cdot 1{,}65 = 199{,}35 \text{ KPA.}$$

Estimated resistance of the base soil:

$$R = \frac{1{,}0 \cdot 1{,}0}{1{,}1}\left[0{,}43 \cdot 1 \cdot 1{,}8 \cdot 15{,}7 + 2{,}73 \cdot 1{,}65 \cdot 15{,}7 + 0 + 5{,}31 \cdot 20\right] = 211{,}5 \text{ KPA.}$$

checking the condition: $p = 199{,}35 \text{ кПа} \quad < \quad 1{,}2R = 206{,}1 \text{ кПа}.$

We specify the sizes of a sole:

$$b_3 = \sqrt{\frac{N_{ser}}{\frac{l}{b}(R - \bar{\gamma} d)}} = \sqrt{\frac{553{,}5}{\frac{2{,}4}{1{,}8} \cdot (171{,}7 - 20 \cdot 1{,}65)}} = 1{,}73 \text{ м;}$$

$$l_3 = \sqrt{\frac{N_{ser}}{\frac{b}{l}(R - \bar{\gamma} d)}} = \sqrt{\frac{553{,}5}{\frac{1{,}8}{2{,}4} \cdot (171{,}7 - 20 \cdot 1{,}65)}} = 2{,}21 \text{ м.}$$

checking the condition:

$$\left|\frac{b_2 - b_3}{b_2}\right| = \frac{1,8 - 1,73}{1,8} = 0,039 > 0,03.$$

We approveb_3 = 1800 mm; l_3 = 2100 mm.

The average soil pressure under the base of the foundation:

$$p = \frac{N_{ser}}{bl} + \frac{M_{ser}}{bl^2/6} + \bar{\gamma} H_{çàë} = \frac{553,4}{1,8 \cdot 2,1} + \frac{66,1}{1,8 \cdot 2,1^2/6} + 20 \cdot 1,65 = 229,4 \text{ KPA}.$$

Estimated resistance of the base soil:

$$R = \frac{1,0 \cdot 1,0}{1,1}\left[0,43 \cdot 1 \cdot 1,8 \cdot 15,7 + 2,73 \cdot 1,65 \cdot 15,7 + 0 + 5,31 \cdot 20\right] = 171,7 \text{ KPA}.$$

checking the condition:

$P = 229,4\,кПа$ > $1,2R = 206,1\,кПа$ → the strength condition is not met, it is necessary to increase the area of the base of the foundation.

We accept for further design and calculations:

b = 1800 mm; l = 2100 mm.

3.4. Construction of the foundation

Determine the size of the subcolumn:

$l_n \geq h_{col} + 2 \cdot 75 + 2 \cdot l_{cm}$= 400 + 2·75 + 2·175 = 900 mm.

We approvel_n = 900 mm, l_{cm} = 175 mm.

$b_n \geq b_{col} + 2 \cdot 75 + 2 \cdot b_{cm}$= 400 + 2·75 + 2·175 = 900 mm.

We acceptb_n = 900 mm.

We approveb_n = 900 mm.

We design a plate part:

$l_{выл} = (l - l_n)/2$= (2400 – 900) / 2 = 750 mm;

$b_{выл} = (b - b_n)/2$= (1800 – 900) / 2 = 450 mm.

scince$l_{выл}$= 750 мм і $b_{выл}$= 450 mm, therefore the plate part is one-stage on width and two-stage in length, in the plane of a frame.

The minimum value of the working height of the slab is determined by the approximate formula:

$$H_0 = -0{,}25(h_{col} + b_{col}) + 0{,}5\sqrt{\frac{N}{0{,}85\gamma_{b2}\gamma_{b9}R_{bt} + p}} =$$

$$= -0{,}25(0{,}4 + 0{,}4) + 0{,}5\sqrt{\frac{609}{0{,}85 \cdot 1{,}1 \cdot 0{,}9 \cdot 750 + 161{,}1}} = 0{,}238 \text{ м},$$

where $\gamma_{b9} = 0{,}9$ - coefficient of working conditions;

$P = N / b \cdot l = 609 / 2{,}1 \cdot 1{,}8 = 161{,}1$ KPA.

The minimum height of the slab: $h = H_0 + a = 0{,}238 + 0{,}05 = 0{,}288$ м.

We accept height of the first step of a plate part: h_1 = 0,3 м;

The depth of the glass $h_c = l_{an} + 0{,}05 = 0{,}75 + 0{,}05 = 0{,}8$ м. We accept $h_c = 0{,}8$ м, atdepth of anchoring $l_{an} = 0{,}75$ м.

The thickness of the bottom of the glass $h_{bot} = H_f - h_c = 1{,}5 - 0{,}8 = 0{,}6$ м;

Working height of the bottom of the glass $h_{bot,0} = h_{bot} - a = 0{,}6 - 0{,}05 = 0{,}55$ м.

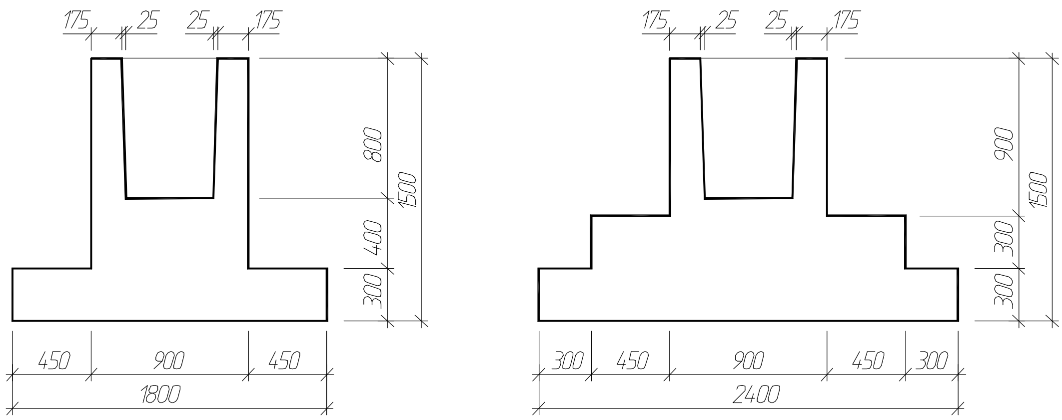


Fig. 3.1. Dimensions of the foundation

3.5. Calculation of punching and splitting

Let's define to what type the designed base (high or low) belongs. To do this, calculate:

$a = [\, l_n - (h_{col} + 2\cdot 50)] / 2 = [900 - (400 + 2\cdot 50)] / 2 = 200$ mm;

$b = h_{подк} - (\, l_{an} + 50) = 1200 - (750 + 50) = 400$ mm.

a = 300 мм > b = 100 mm - the foundations are "high", so we do not make calculations for pushing the foundation along the column face.

To check the accepted height of the first step, calculate the strength along the face of the penetration plane, which is parallel to the smaller side of the base of the foundation.

The size of the underside of the face of the penetration plane:

$b_{01} = b_1 + 2h_1 = 900 + 2\cdot 450 = 1800$ mm;

The average size of this face:

$u_m = \frac{b_{01} + b_1}{2} = \frac{1800 + 900}{2} = 1350$ mm;

Обчислимо площу прямокутника продавлювання:

$A = 150 \cdot 1800 = 270 \cdot 10^3$ mm^2;

Estimated pushing force:

$A = l \cdot b = 2{,}4 \cdot 1{,}8 = 4{,}32$ м^2; $W = \frac{b \cdot l^2}{6} = \frac{1{,}8 \cdot 2{,}4^2}{6} = 1{,}728$ м^3;

$P = \frac{N}{A} + \frac{M}{W} = \frac{609}{4{,}32} + \frac{77{,}35}{1{,}728} = 185{,}8$ KPA;

$F = A \cdot P = 270 \cdot 10^3 \cdot 0{,}186 = 50{,}22 \cdot 10^3$ Н;

We check the condition:

$F = 50{,}22 \cdot 10^3$ Н $< \alpha \cdot R_{bt} \cdot u_m \cdot h = 1 \cdot 0{,}75 \cdot 1{,}1 \cdot 1350 \cdot 300 = 334{,}1 \cdot 10^3$ Н, where $\alpha = 1$ for heavy concrete.

The condition is fulfilled, ie the strength to push the considered face and the height of the first step is sufficient.

3.6. Calculation of the strength of the column

Calculations for normal cross section

The columnar is calculated as an eccentrically compressed element, but with increased hardness:

$$\frac{h_n}{l_n} = \frac{800}{900} = 0{,}9 < 4 \quad \Rightarrow \quad \eta = 1.$$

The strength of the column is checked in the section I - I at the level of the end of the column. The box section is reduced to the equivalent I-beam:

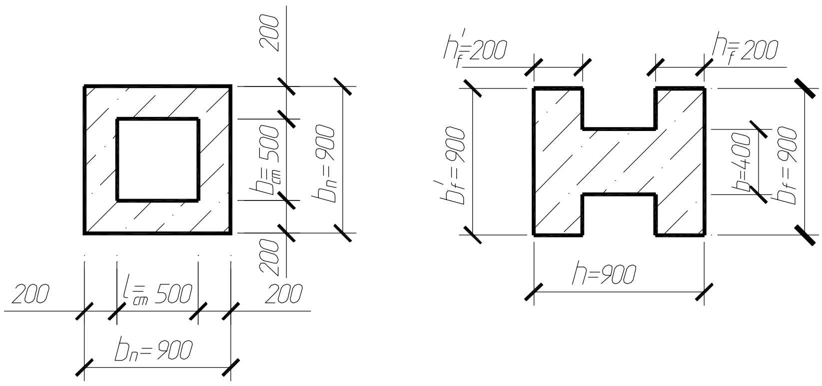


Fig. 2.7.2. To calculations of a subcolumn on normal sections.

Estimated effort:

$N_I = N = 609$ KN;

$M_I = M + Q \cdot h_{cm} = 55 + 14{,}9 \cdot 0{,}8 =$ 66,92 KN·m.

Eccentricity: $e_0 = \dfrac{M_I}{N_I} = \dfrac{66{,}92}{609} = 0{,}11$ m.

We check the condition:

$N_I = 609$ KN $< R_b \cdot b_f^I \cdot h_f^I = 9{,}35 \cdot 10^3 \cdot 0{,}9 \cdot 0{,}2 = 1683$ KN.

Since the condition is met, ie the neutral axis passes within the shelf, the reinforcement is calculated as for a rectangular section width $b_f^/ = 900$ mm.

The height of the compressed zone: $x = \dfrac{N_I}{R_b h_f^/} = \dfrac{609}{9{,}35 \cdot 10^3 \cdot 0{,}2} = 0{,}326$ м.

Eccentricity $e = e_o\eta + h/2 - a_s = 0{,}11 \cdot 1 + 0{,}9/2 - 0{,}05 = 0{,}51$ м.

Working height: $h_0 = h - a_s = 0{,}9 - 0{,}05 = 0{,}85$ м.

Reinforcement area:

$$A_s = A_s^{/} = \frac{N[e-(h_0-0{,}5x)]}{R_s(h_0-a_s^{/})} = \frac{609 \cdot [0{,}51-(0{,}85-0{,}5 \cdot 0{,}326)]}{280 \cdot 10^3 (0{,}85-0{,}05)} < 0.$$

As the armature from calculation is not required, we accept it according to design requirements:

on each face (4 faces) $A_s = A_s^{/} = 0{,}0005 \cdot b_f^{/} \cdot h = 0{,}0005 \cdot 0{,}9 \cdot 0{,}9 = 0{,}000405$ м^2.

We approve the range 4Ø12 A-II с/м^2.

Calculations on an inclined section

Bending moment at the intersection I-I:

$M_I = M + Q \cdot h_{cm} = 55 + 14{,}9 \cdot 0{,}8 =$ 66,92 KN·m.

$$e_I = \frac{M_I}{N_I} = \frac{66{,}92}{609} = 0{,}11 \text{m}.$$

If the condition is met:

$\frac{l_{cm}}{6} = \frac{0{,}5}{6} = 0{,}083\ м \ < \ e_I = 0{,}11\ м \ < \ \frac{h_{col}}{2} = \frac{0{,}4}{2} = 0{,}2\ м$, then the destruction will take place at the intersection II-II.

Bending moment at the intersection II-II:

$M_{II} = M + Q \cdot h_{cm} + 0{,}7 \cdot N \cdot e_I = 55 + 14{,}9 \cdot 0{,}8 + 0{,}7 \cdot 609 \cdot 0{,}11 = 113{,}8$ KN·m.

The cross-sectional area of the transverse working reinforcement of the welded mesh:

$$A_{sw} = \frac{M_{II}}{R_{sw} \cdot \sum_{i=1}^{n} Z_i} = \frac{113{,}8}{225 \cdot 10^3 (0{,}15 + 0{,}35 + 0{,}55 + 0{,}65 + 0{,}7)} = 0{,}000211 \text{м}^2.$$

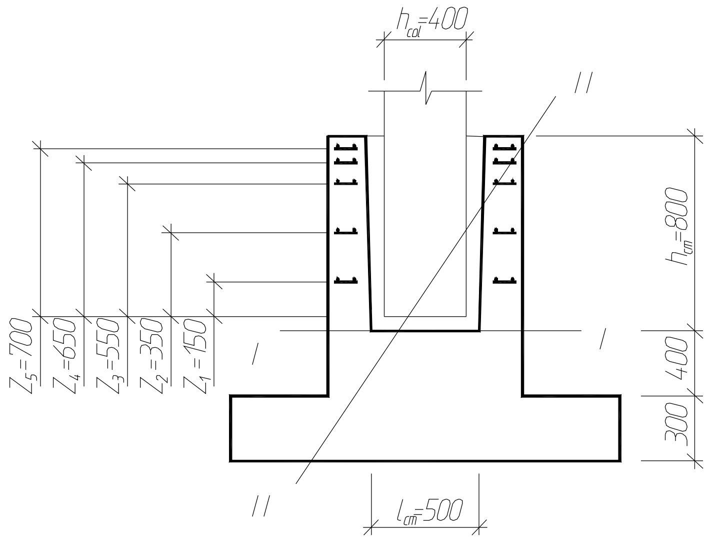


Fig.2.7.3. To calculations of a subcolumn on an inclined section.

We approve the assortment 4Ø10 A-II с Asw = 3,14 см^2.

3.7. Calculation of the strength of the slab part

The step of the foundation under the action of reactive soil pressure works as a cantilever beam driven into the foundation. We will make calculations on durability for the sections passing on a facet of a subcolumn and a step.

The cross-sectional area of the armature is determined by the formula:

$$A_{sl(sb)}=\frac{M_{yi(xi)}}{0,9R_s h_{0i}}$$

Asl – the cross-sectional area of the working valve, which is parallel to the side *l*;

Asb – the cross-sectional area of the working valve, which is parallel to the side*b*;

Myi – bending moment in the i-th section of the foundation relative to the y-axis passing through the center of gravity of the section and the parallel side b;

Mxi – bending moment in the i-th section of the foundation relative to the x-axis, parallel to the side *l*;

h_{0i} – working height of the slab part of the foundation in the i-th section.

During the action of the bending moment in the plane of the transverse frame:

$$M_b=\frac{N\cdot c_l^2}{2\cdot l}\left(1+\frac{6e_0}{l}-4\frac{e_0c_l}{l^2}\right)=\frac{609\cdot 0,6^2}{2\cdot 2,4}\left(1+\frac{6\cdot 0,11}{2,4}-4\cdot\frac{0,11\cdot 0,6}{2,4^2}\right)=55,13\ \text{KN}\cdot\text{m};$$

$$M_l = \frac{N \cdot c_b^2}{2 \cdot b} = \frac{609 \cdot 0{,}6^2}{2 \cdot 1{,}8} = 60{,}9\,\text{KN} \cdot \text{m}.$$

$$h_{01} = h_1 - a = 300 - 45 = 255\,\text{mm}.$$

As the sizes of the base are less than 3 m in the basis we establish only one grid with a step of S = 200 mm in the longitudinal and cross directions..

$$A_{sl} = \frac{55{,}13}{0{,}9 \cdot 280 \cdot 10^3 \cdot 0{,}255} = 0{,}00086\,\text{m}^2.$$

We approve the range 12Ø10 A-II c *Asl* = 0,000942 m^2.

$$A_{sb} = \frac{60{,}9}{0{,}9 \cdot 280 \cdot 10^3 \cdot 0{,}255} = 0{,}000948\,\text{m}^2.$$

We approve the range of fittings 9Ø12 A-II c *Asb* = 0,00102 m^2.

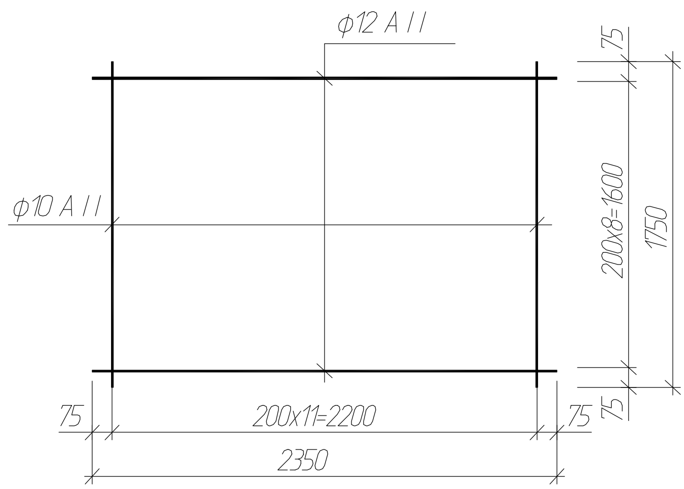


Fig. 3.7.4. Reinforcement of a plate part, a grid 31.

3.8. Calculation of subsidence of the foundation

The calculation of the subsidence of the base is performed in order to establish compliance with the requirements under which the final subsidence of the base and the relative difference in subsidence should not exceed the maximum allowable values adopted in table. 72 [14] depending on the type of construction.

$S \le S_u = 12\ см$; $\Delta S / L \le (\Delta S / L)_u = 0.004$.

The final subsidence of the base S using the calculation scheme in the form of a linear-deformation half-space with a conditional restriction of the compressible thickness is determined by the method of layer-by-layer summation by the formula

$$S = \beta \cdot \sum_{i=1}^{n} \frac{\sigma_{zp,i} \cdot h_i}{E_i},$$

where

β – dimensionless coefficient equal to 0,8;

$\sigma_{zp,i}$ – the average value of the additional vertical stress in i-*тому*elementary layer of soil, which is equal to half the amount of stress at the upper and lower limits*i*¯ тогоelementary layer, kPA;

hi i *Ei* – respectively, the thickness and modulus of deformation of the i-th elementary layer of soil;

n – the number of layers into which the compressible layer of soil is divided.

The breakdown of the compressible layer is carried out into homogeneous elementary layers with a thickness not exceeding 0.4 of the width of the base of the foundation ($hi \le 0{,}4 \cdot b$). We accept the thickness of the elementary layers, which is equal $0{,}2 \cdot b$=0.36*м*.

Additional vertical stresses at depth z from the base of the foundation vertically, passing through the center of the base of the foundation, are determined by the formula

$$\sigma_{zp} = \alpha \cdot P_0,$$

whereα – coefficient that takes into account the distribution of additional stress on the depth specified in table. 55 [14] depending on the ratio of the sides of the base of the foundation□ = *l / b*=1.4and a relative depth that is equal to □ = *2·z / b*; $P_0 = P_{cp}$ - □$zg_{,0}$ = $102 - 18{,}78 \cdot 2{,}3 = 58{,}8\,KPA$ – additional vertical pressure on the base; □$zg_{,0}$ =39,43 *KPA* – vertical stress from its own weight.

In the absence of planning and planning by backfilling, the vertical stress from the own weight of the soil at the level of laying the base of the foundation is adopted.:

□*zg,0* = □*'· dn*,

where□*'* – the proportion of soil located above the sole foundation; d_n – depth of laying the foundation from the natural surface relief.

The vertical stress from the own weight of the soil □zg at a depth of z from the base of the foundation, determined by the formula:

$$\sigma_{zg} = \sigma_{zg,0} + \sum_{i=1}^{m} \gamma_i \cdot h_i \ ,$$

where

hi – respectively, the specific gravity and thickness of the i-th elementary layer;

m – the number of elementary layers located above the depth z.

For layers of permeable soil located below the groundwater level, but above the water resistance, the specific gravity of the soil is determined taking into account the action of water by the formula $\gamma_{sb} = \dfrac{\gamma_s - \gamma_w}{1+e}$.

The lower limit of the compressible thickness of the base (NGST) is adopted at a depth of z = Hc, where the condition

$$\sigma_{zp,i} \leq 0{,}2 \cdot \sigma_{zg,i} \ .$$

3.9. Calculation of the relative settling difference

$$\Delta S / L \leq (\Delta S / L)_u = 0.004$$

(0,086-0,03)/14=0,00392≤0,004

SECTION 4. CONSTRUCTION TECHNOLOGY AND ORGANIZATION

4.1. Technological map for the installation of wall panels

4.1.1. Field of application

The technological map is developed for installation of wall panels of the one-storeyed industrial case with a step of columns of 6 m.

Construction is underway in cairo city EGYPT. Start of work on April 5, 2009. Installation is performed by crane KS-6471 (boom length 20 m), a team of workers consisting of: rigger - 2 people, installer - 3 people, electric welder - 2 people, driver - 1 person.

The technological map takes into account the following types of work: loading and unloading, installation of wall panels, welding, sealing of wall panels.

4.1.2. Organization and technology of works

4.1.2.1. Readiness of the front of works

Before the beginning of installation of panels carry out preparatory operations: one of installers checks correctness of an arrangement of beacons and existence of lines of a geodetic breakdown, clears a basic surface and spreads a solution, and another prepares tools and adaptations, placing them on a workplace. The rigger at this time inspects the wall panel, checks the embedded parts, mounting and lifting hinges, rafters the panel, and then sends a signal to the crane to lift and feed it to the installation site. The installer then secures the struts with the lower grips to the hinges on the mounting beam, and tilts the strut in the direction opposite to the installation location of the panel.

Installation of wall panels is made of cassettes. Filed to the installation site at a height of 30 cm above the level of the lower structure, the wall panel is taken by twoinstallers at its ends. The accepted panel is oriented on marks of a geodetic breakdown and lowered on a soluble bed.

Installers, having convinced of absence of essential deviations of the panel from its design position (correctness of installation on height, observance of width and verticality of a seam, correct position of the panel in the plan and absence of an inclination), start installation of a bottom of a design in design position by means of assembly crowbars and templates.

Following this, the two installers simultaneously begin to temporarily secure the panel. For this purpose each of assemblers takes the brace nearest to it, inclines towards the panel and fixes the top capture for a special assembly loop.

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Having temporarily fixed the panel by means of braces, installers start adjustment of its verticality, using a special rail. By rotating the struts, they bring the panel to a vertical position. The angular external wall panel is temporarily fixed by means of an assembly communication which fastens to earlier established and verified external wall panel and a brace.

After installing the panel in the design position, make a patching of the horizontal seam or cut off the excess solution. Then make project welding of embedded parts of a joint in external panels with the subsequent anticorrosive protection of welded connections.

Welding of metal joints in joints must be carried out in accordance with the project of production of welding works, establishing the sequence of assembly and welding works, welding methods, the order of suturing, requirements for welded materials.

Welded elements must be pre-cleaned.

Electrodes used for welding embedded parts must ensure normal welding, good seam formation, no pores and cracks in welds

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Before starting work, check the correct installation of the panels, the position of the welded parts and the readiness of the joint for welding. To avoid breaking the adhesion of the mortgage parts to the concrete, welding is recommended to be interrupted so that the heating of these parts lasts no more than 5 minutes.

Welded seams must meet the following requirements:

- have a smooth surface without inflows with a smooth transition to the base metal;

- the metal must be dense along the entire length of the seam, without cracks;

- there should be no unwelded craters.

Anti-corrosion protection of welds, places of damage of metal embedded parts is performed after checking the quality of the installation of permanent connections and their acceptance by act.

Applying a protective layer is done no later than 24 hours after welding.

Before applying the anti-corrosion coating on the surface to be protected, they are cleaned to a metallic luster, slag is removed from the welds and the entire surface is cleaned with a metal brush. The thickness of the protective film should be 0.15-0.2 mm. The coating is performed in an even layer without visible bubbles and cracks.

Work on the joint device is performed in two stages:

The first stage - after installation of panels of external walls: do gluing of vertical joints from the room and installation of packages for warming;

perform anticorrosive protection of welds and places of damage of metal embedded parts;

install a horizontal joint that insulates the package between the panels of the outer walls and the floor slabs;

from level of overlapping do filling with concrete of vertical joints between wall panels, seams between plates of overlapping fill with cement mortar

M 100.

The second stage - the work of sealing the vertical and horizontal joints on the outside of the building.The work of the first stage is combined in time with the installation of prefabricated structures, and the work of the second stage is carried out after the installation of wall panels on the entire grip.

If there is a time gap between the installation of the panels and the sealing of the joints, the joints must be covered. The strength of concrete at the joints must be at least 50% of the design strength.

When carrying out works on sealing of joints it is necessary to be guided by DBN 3,03.01-87 "Supporting designs and protecting designs".

Sealing of joints with mastic materials outside the building begins after the installation of the building, dismantling of tower cranes and crane tracks. By this time in the course of installation electric welding and anticorrosive protection of embedded details should be executed.

The surfaces of the structures forming the joint must be in an air-dry state at the time of sealing. It is forbidden to apply sealant on wet surfaces. Drying and heating of the moistened concrete surfaces should be done by hot air.

To ensure good adhesion of the mastic to the surface of the panels, they should be carefully primed with mastic to obtain a solid film. When installing a horizontal seam on the primed upper surface of the outer wall panel, you should stick a gasket with PRP, cover it with mastic insulation and install wall beacons on the next floor. At the device of vertical external seams linings from PRP roll in a seam from an autotower. When installing the panels, do not allow the gaskets to shift from IIFH. Compression of gaskets from PRP in seams on all length should be within 40-50%. the gaskets are rolled into the joint with a roller from top to bottom, preventing them from being pulled out. The gasket with PRP is installed without breaking, their ends are cut "on a mustache" and glued with mastic isol, receding on 0,5 m from a place of crossing of horizontal and vertical joints. The "Stick-20" heating device and syringes with mixed sleeves are used to cover the seams between the panels with mastic. The depth of filling the joints must be at least 20 mm from the edge

wall panel. The mastic roller should be put by a continuous continuous tape and well adhere on all length of a seam.

Performed work on sealing joints must be accepted by the act.

4.1.2.2. Specification of mounting elements, scope of work

Table 4.1.1.

№ п/п	Name of works	Od. vim.	Volume per grip		General Amount
			1	2	
1	2	3	4	5	6
Underground part					
	Grounded works				
1	Cutting of a vegetative layer of soil	100 $м^2$	3,78	7,52	11,3
2	Preliminary rough planning of the site surface	100 $м^2$	3,78	7,52	11,3
3	Preparation by the excavator of the soil of ditches under the bases	100 $м^3$	5,31	12,4	17,71
4	Finishing the soil by hand	100 $м^3$	0,05	0,11	0,16
5	Backfilling of the soil	100 $м^3$	4,13	5,63	9,76
6	Backfill soil compaction	100 $м^3$	4,13	5,63	9,76
	Foundations				
7	Installation of monolithic foundations	100 $м^3$	-	0,15	0,15
8	Installation of the bases under columns and half-timbering	100 pcs	-	0,35	0,35
9	Installation of foundation slabs and blocks	100 pcs	1,37	-	1,37
10	Installation of foundation beams	100 pcs	-	0,33	0,33
Aboveground part					
11	Installation of columns	100 pcs	-	0,38	0,38
12	Installation of half-timbered buildings	100 pcs	-	0,02	0,02
13	Installation of diaphragms of rigidity	100 pcs	-	0,02	0,02
14	Installation of crossbeams of mezzanines	100 pcs	-	0,07	0,07
15	Installation of wall panels inside the building	100 pcs	-	0,16	0,16
16	Installation of wall panels	100 pcs	-	1,89	1,89

17	Installation of floor slabs	100 pcs	0,28	0,37	0,65
18	Installation of rafter structures	100 pcs	-	0,09	0,09
19	Installation of plates of a covering	100 pcs	0,30	0,48	0,78
20	Installation of metal fences	100 м	-	0,42	0,42
21	Installation of stairwells	100 pcs	0,02	-	0,02
22	Installation of stairways	100 pcs	0,03	-	0,03
23	Laying of external walls	100 $м^3$	2,36	0,096	2,456
24	Laying of internal walls	100 $м^3$	1,15	0,22	1,37
25	Laying of partitions	100 $м^2$	3,75	6,79	10,36
26	Installation of lintels	100 pcs	1,23	0,63	1,86
27	Filling window openings	100 $м^2$	0,22	1,32	1,54
28	Filling of doorways	100 $м^2$	0,71	0,64	1,35
	Roof installation				
29	Installation of screeds for alignment	100 $м^2$	2,7	8,64	11,34
30	Installation of vapor barrier	100 $м^2$	2,7	8,64	11,34
31	Installation of thermal insulation	100 $м^2$	2,7	8,64	11,34
32	Installation of a rolled carpet from 3 layers of linochrome	100 $м^2$	2,7	8,64	11,34
	Installation of floors				
33	Soil compaction with gravel	100 $м^2$	2,3	7,56	9,86
34	Installation of concrete floors	1 $м^3$	3,45	11,34	14,79
35	Installation of waterproofing	100 $м^2$	2,42	8,78	11,2
36	Installation of floors from a ceramic tile	100 $м^2$	0,49	0,14	0,63
37	Installation of linoleum floors	100 $м^2$	0,32	0,11	0,43
	Finishing works				
38	Plastering of walls	100 $м^2$	7,52	7,61	15,13
39	Painting with oil compositions	100 $м^2$	4,51	4,3	8,81
40	Facing of walls by a tile	100 $м^2$	0,42	-	0,42
41	Plastering of a facade with decorative solutions	100 $м^2$	3,22	0,18	3,4
42	Wallpapering the walls		-	0,72	0,72

	Other works				
43	Installation of fire escapes	1 т	-	0,42	0,42
44	Installation of stages	100 $м^2$	0,48	1,14	1,62

The construction is divided into two grips, the first grip is a brick two-story part of the building in axes AG and 1-3, the second grip is a frame part of the building in axes А-Г and 3-11.

4.1.2.3. The choice of technological standard set: inventory, devices, working tools (labour tools)

At installation of building designs use load-grabbing devices (slings, captures) for lifting of prefabricated elements; technical means for calibration; the equipment providing convenient and safe work of installers at height.

The choice is made in accordance with the requirements of safety during installation work.

4.1.2.4. Selection of mounting cranes for the construction of the aboveground part of the building

When choosing cranes, it is necessary to determine the required installation characteristics for each of the elements: installation weight (QM); mounting height of the hook ($H_{ктр}$); assembly departure of a hook ($L_{ктр}$).

The calculated required departure of a hook is adjusted taking into account the accepted preliminary apportionment of designs in an assembly zone..

The choice of assembly cranes is made for each design from conditions: QM≤ $Q_К$; $L_{ктр} \le L_к$; $H_{ктр} \le H_к$; де $Q_К$, $L_к$, $H_к$ – respectively load capacity, departure of a hook, height of rise of a hook of the crane.

From the assembly cranes selected for each design it is necessary to form taking into account the accepted methods of installation (serial or flow, differentiated or complex) possible variants of sets of cranes.

When choosing a crane, the compliance of its parametric characteristics with the assembly and design parameters of the object is checked.

The choice of the crane and calculations of technical and economic indicators of sets of cranes we carry out by means of the KRAN_2 program.

Initial data for calculations (1 capture)

Table 4.1.4.

Construction	weight, t	Estimation,m	HeightCK, m	WidthCK, m	Height of slinging
Floor slab	2,8	4,5	0,22	18	3,0
Plate coating	2,1	7,8	0,22	18	3,0

Initial data for calculations (2 captures)

Table 4.1.5.

Construction	weight, t	Estimation, m	HeightCK, m	WidthCK, m	Height of slinging
Resh. Beam	12,1	7,2	1,64	0,28	9,5
Plate coating	2,65	8,84	0,3	6,0	3,0
Wall	5,39	7,2	1,8	0,4	2,0
Panel	2,4	0	5,9	0,4	1,6
Column K60	2,55	4,4	0,37	0,3	2,8
Cross-bar	2,6	4,6	0,22	4,5	3,0

4.1.2.5. Choice of vehicles

- On the basis of the analysis of the volume-planning and constructive decision:
- A) the building is divided into 2 grips:
- 1 grip in axes A - Γ, 1 -3;
- 2 grips in axes A – Γ, 3 -11;

b) we accept the following methods and ways of installation of designs:

- on the directional development of the assembly flow - longitudinal;
- on sequence of installation of elements - combined;
- on sequence of construction of the building on height - building;
- according to the method of bringing structures to the design position - limited-free;
- on a way of preparation of designs for installation - from a warehouse;

c) adopt the following basic construction machines:

- T79 tractor with brush cutter;
- hydraulic single-bucket excavator equipped with EO-4321 shovel;
- T100 bulldozer;
- road rollers hook-on 25 t;
- a set of jib cranes.

4.1.3. Requirements for quality and acceptance of works

The quality of installation work is determined by the results of production control and evaluated in accordance with special instructions for assessing the quality of work. The following stages of quality control of installation works are provided: entrance, operational and receiving. Data on the results of all types of control are recorded in the logs.

Building constructions and the materials arriving on installation have to pass entrance control. This control is performed during the acceptance of structures on the assembly site.

Operational control is carried out after the completion of individual production operations or construction processes. This control timely detects defects in the work and the causes of their occurrence, as well as suggests what measures to take to eliminate and prevent them. Operational control involves systematic control in the process of work and intermediate control in the process of completion.

Systematic control in the process of work is carried out by supervisors or persons who are specially designated for this purpose.

During the control over the quality of installation works check:

- technology and sequence of installation according to the project of carrying out works;
- implementation of existing rules and instructions for the installation of building structures;
- geometric dimensions of the structure;
- quality of registration and fixing of assembly joints and elements (assembly welding, fastening by bolts).

In the course of installation constantly carry out control of performance of works according to cards of operational control.

4.1.4. Calculation of labor costs and machine time. Salary calculation

Calculation of labor costs and machine hours. Wage calculation see in the graphic part (sheet 8-10).

4.1.5. Schedule of work on a separate meter of final products

See the schedule of works in the graphic part. (sheets 8-10).

4.1.6. Material and technical resources

For a list of material and technical resources, see the graphic part (sheet 8).

4.2. Calendar schedule of works on construction of the above-ground part of the building

4.2.1. Statement of work volumes, labor intensity and mechanical consumption of works

Table 4.1.9.

№ п/п	Name of the work	Od. vim	Volume per grip		Total volume
			1	2	
1	2	3	4	5	6
Підземна частина					
	Earthworks				
1	Cutting of a vegetative layer of soil	100 $м^2$	3,78	7,52	11,3
2	Preliminary rough planning of the site surface	100 $м^2$	3,78	7,52	11,3
3	Preparation by the excavator of the soil of ditches under the bases	100 $м^3$	5,31	12,4	17,71
4	Finishing the soil by hand	100 $м^3$	0,05	0,11	0,16
5	Backfilling of the soil	100 $м^3$	4,13	5,63	9,76
6	Backfill soil compaction	100 $м^3$	4,13	5,63	9,76
	Foundations				
7	Installation of monolithic foundations	100 $м^3$	-	0,15	0,15
8	Installation of the bases under columns and half-timbering	100 pcs	-	0,35	0,35
9	Installation of foundation slabs and blocks	100 pcs	1,37	-	1,37
10	Installation of foundation beams	100 pcs	-	0,33	0,33
Aboveground part					
11	Installation of columns	100 pcs	-	0,38	0,38
12	Installation of half-timbered buildings	100 pcs	-	0,02	0,02
13	Installation of diaphragms of rigidity	100 pcs	-	0,02	0,02
14	Installation of crossbars of mezzanines	100 pcs	-	0,07	0,07
15	Installation of wall panels inside the building	100 pcs	-	0,16	0,16

16	Installation of wall panels	100 pcs	-	1,89	1,89
17	Installation of floor slabs	100 pcs	0,28	0,37	0,65
18	Installation of rafter structures	100 pcs	-	0,09	0,09
19	Installation of plates of a covering	100 pcs	0,30	0,48	0,78
20	The device of metal protections	100 pcs	-	0,42	0,42
21	Installation of stairwells	100 pcs	0,02	-	0,02
22	Installation of stairways	100 pcs	0,03	-	0,03
23	Laying of external walls	100 $м^3$	2,36	0,096	2,456
24	Laying of internal walls	100 $м^3$	1,15	0,22	1,37
25	Laying of partitions	100 $м^2$	3,75	6,79	10,36
26	Installation of jumpers	100 pcs	1,23	0,63	1,86
27	Filling window openings	100 $м^2$	0,22	1,32	1,54
28	Filling of doorways	100 $м^2$	0,71	0,64	1,35
	Roof installation				
29	Installation of leveling screeds	100 $м^2$	2,7	8,64	11,34
30	Installation of vapor barrier	100 $м^2$	2,7	8,64	11,34
31	Installation of thermal insulation	100 $м^2$	2,7	8,64	11,34
32	Installation of a rolled carpet from 3 layers of linochrome	100 $м^2$	2,7	8,64	11,34
	Installation of floors				
33	Soil compaction with gravel	100 $м^2$	2,3	7,56	9,86
34	Installation of concrete floors	1 $м^3$	3,45	11,34	14,79
35	Installation of waterproofing	100 $м^2$	2,42	8,78	11,2
36	Installation of floors from a ceramic tile	100 $м^2$	0,49	0,14	0,63
37	Installation of linoleum floors	100 $м^2$	0,32	0,11	0,43
	Finishing works				
38	Plastering of walls	100 $м^2$	7,52	7,61	15,13
39	Painting with oil compositions	100 $м^2$	4,51	4,3	8,81
40	Facing of walls by a tile	100 $м^2$	0,42	-	0,42

41	Plastering of a facade with decorative solutions	100 м^2	3,22	0,18	3,4
42	Wallpapering the walls		-	0,72	0,72
	Other works				
43	Installation of fire escapes	1 т	-	0,42	0,42
44	Installation of stages	100 м^2	0,48	1,14	1,62

This construction is divided into two grips, the first grip is a brick two-story part of the building in axes AG and 1-3, the second grip is a frame part of the building in axes А-Г and 3-11.

4.2.2. Determining the duration of the complex process of erection of the aboveground part of the building

It is necessary to calculate the composition of the complex team for a specialized flow for a typical capture or tiered capture for the installation of the integrated method. The need for calculations is caused by: the difference in the composition of the links recommended by ENiR for the installation of various elements, filling seams and other processes, both in number and in qualification and profession of workers; expediency of rhythmic flow design. Thus the professional and qualified structure has to provide performance of all processes. Qualification of crane drivers is established by types and parameters of cranes.

It is advisable to provide 2 streams (НП):

- installation of elements and electric welding of joints;

- anti-corrosion coating, sealing of joints, pouring, insulation, sealing, sealing of seams.

The first state of emergency. Determine the regulatory duration $П^{н}_{(у)}$ works of link №1, which performs the installation of elements in shifts:

$$П^{н}_{(у)} = \frac{T^{н}_{(у)}}{Ч_{(у)} \cdot 8} = \left(\frac{225{,}33}{4} + \frac{589{,}05 + 25{,}2}{5} + \frac{76{,}76 + 100{,}8}{4} \right) / 8 \approx 28 смен,$$

where $T^{н}_{(у)}$ - the total regulatory complexity of the installation of elements;

$Ч_{(у)}$ - the number of workers in the link that sets the elements.

Let's turn the normative duration into the rhythm of the flow $K_{(у)} = П^{н}_{(у)} = 28 смен$.

Let's determine the level of work duration:

$$У_{ПТ(у)} = \frac{T^{н}_{(у)}}{T_{(у)}} 100\% = \frac{28}{28} 100\% = 100\%,$$

where $T_{(у)} = K_{(у)} \cdot Ч_{(у)} \cdot 8$ - projected process duration.

Then set the estimated number of electric welders:

$$Ч^{р}_{(э)} = \frac{T^{н}_{(э)}}{K_{(у)} \cdot 8} = \frac{833{,}16 + 306{,}54}{28 \cdot 8} \approx 6 человек.$$

The second state of emergency. Determine the estimated number of workers in the chain №2:

$$Ч^{р}_{(а)} = \frac{T^{н}_{(а)}}{K_{(у)} \cdot 8} = \frac{142{,}46 + 52{,}42 + 70{,}31 + 5{,}08 + 63{,}25 + 44{,}69 + 110{,}5 + 10{,}01 + 3{,}03}{28 \cdot 8} +$$
$$+ \frac{142{,}32 + 43{,}09 + 57{,}09 + 55{,}25}{28 \cdot 8} \approx 4 человека$$

The results of the calculations are summarized in table 10.

Table **6 – The results of the calculations of the complex team**

№ НП	Name of the procces	Specialty of workers	Sec.	Number of workers	
				In chan ges	Per day
1	Installation (laying) of overlapping plates, panels of external and internal walls, stairways and platforms, balcony plates, electric welding of joints	structural assemblers (МК) … … Electric welder crane driver	5 4 3 2 6 6	1 1 1 1 1 1	2 2 2 2 2 2
2	Anticorrosive coating, закладення	carpenterМК –	4	1	2

	joints, pouring, isolation, sealing, sealing of seams of plates of a covering, balcony plates, wall panels.	тесля МК	3 4	1 2	2 4

4.2.3. Calculation of the numerical and professional qualification of the complex team

Calculations of a complex team.

Determine the duration of the complex process

$$t = \frac{T_M}{t_{см}} = \frac{184{,}57}{15{,}4} = 11{,}98 \approx 12 \text{ дней}$$

where

T_M – mechanical capacity of a complex process

$t_{см}$ – time of clean operation of the crane during the day;

$t_{см} = 15{,}4$ *часа* (two - shift work on installation).

Quantitative composition of the complex team:

$$N = \frac{T_{тр} \cdot 100}{t_{см} \cdot t \cdot \alpha} = \frac{852{,}11 \cdot 100}{7{,}8 \cdot 12 \cdot 110} = 9 \text{ человек}.$$ Weaccept 11 *чіл.*

where

$T_{тр}$ – complexity of the complex process;

α – the percentage of compliance; $\alpha = 110\%$;

$t_{см}$ – duration of change; $t_{см} = 7{,}8$ *ч.*

t –the duration of the process in days, which is performed by one crane, $t = 12$ *дн.*

4.3. Construction technological zone (situational plan of the construction site)

Situational plan of the construction site can be seen in the graphic part (sheet ___).

4.3.1. Calculation of the boundaries of the danger zone

For installation of building designs, binding of axes of movement of the assembly crane is carried out according to loading height characteristic and a method of installation.

The dangerous zone of work of the crane Rop is called space where falling of freight at its movement taking into account possible scattering at falling is possible.

$R_{оп} = L_{max} + ½ \cdot l_{эл} + l_{max} + \Delta L$

where

L_{max} – maximum departure of the crane hook, m;

l_{max} – maximum length of the mounted element (in the plan);

$l_{эл}$ – length of the mounted element (in the mounting plane);

ΔL – the distance, taking into account the scattering in the fall, is determined by ДБН 12.03-2001.

For the first capture.

Work areas:

- coating plate $r_{раб1}$ = 15,03 м

Distance taking into account the scattering in the fall:

- coating plate $\Delta L1$ = 3,12 (when evaluating the installation h = 7,8 м)

Danger zone:

- coating plate $r_{оп1}$ = 15,03+½·6+ 6 + 3,12 = 27,15 м

For the second capture.

Work areas:

- coating plate $r_{раб2}$ = 13,18 м;

- beam $r_{раб3}$ = 8 м;

- wall panel rраб4 = 5,5 м.

Distance taking into account the scattering in the fall:

- coating plate ΔL2 = 3,54 (when evaluating the installation h = 8,84 м);
- resh. beam Δl3 = 2,88 (when evaluating the installation h = 7,2 м);
- wall panel Δl4 = 2,88 (when evaluating the installation h = 7,2 м)

Danger zone:

- coating plate rоп2 = 13,18+½·6+ 6 + 3,54 = 25,72 м;
- resh. beam rоп3 = 8+½·1,64+ 18 + 2,88 = 29,7 м;
- wall panel rоп4 = 5,5+½·1,8+ 6 + 2,88 = 15,28 м

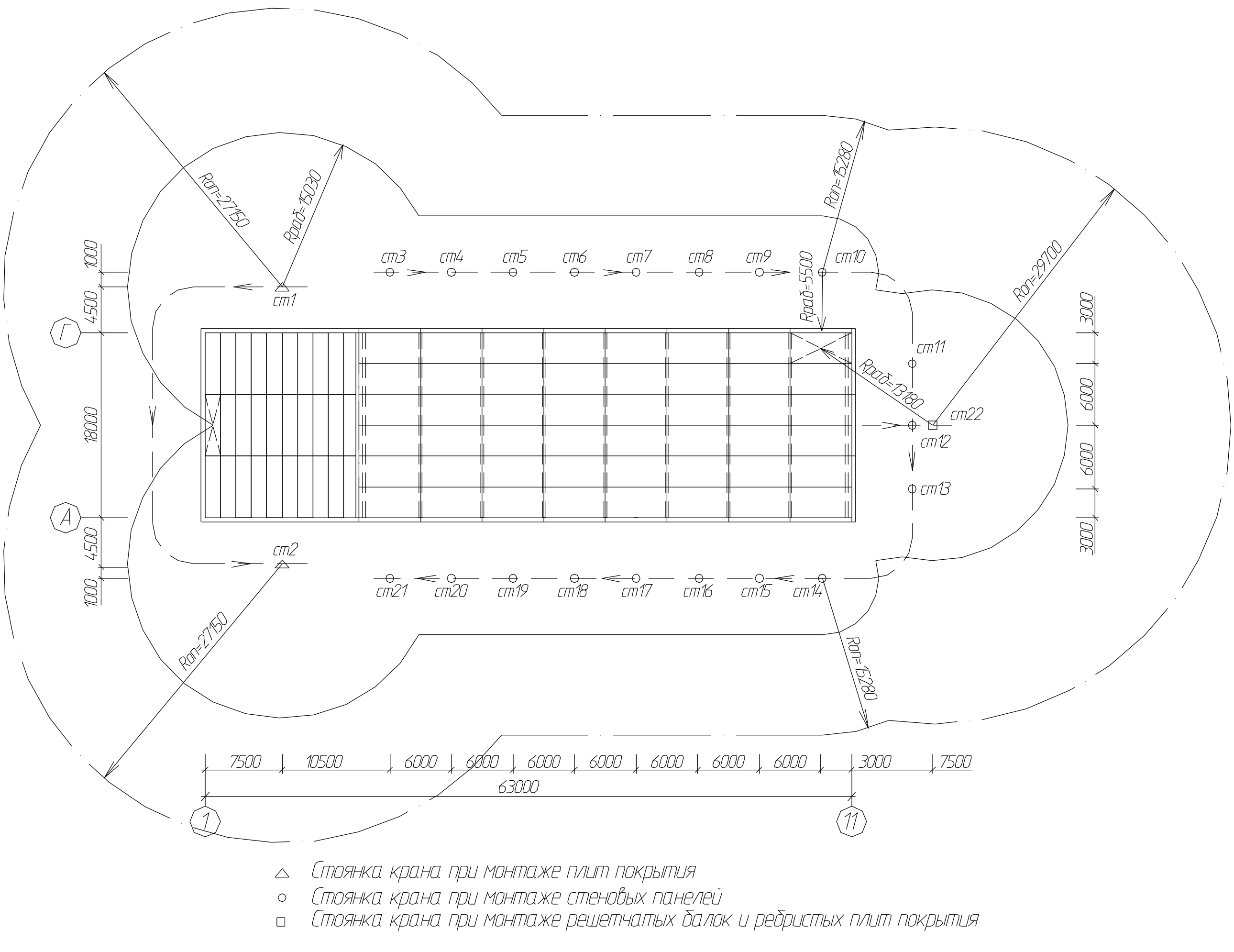

Fig. 4.3.1. Crane parking, danger zone.

4.3.2. Determining the minimum size and situation of the construction site

The width and length of the technological zone are shown on the situational plan (sheet ____).

The minimum sizes of a construction site are defined in the plan by borders of a dangerous zone with addition to them on 1 m from each party for safe passage of people with freights..

SECTION 4.4. OCCUPATIONAL SAFETY WHEN PERFORMING INSTALLATION WORKS

In this diploma project it is necessary to develop a technological map for the installation of a reinforced concrete frame of the building. According to the constructive decision the dairy plant in cairo represents: the framework consisting of columns, beams, communications. The floor consists of monolithic reinforced concrete and non-removable formwork - corrugated board.

Construction area - cairo; season - spring. This period is characterized by: average daily air temperature - 10.5 ° C; maximum air temperature - 20.5 ° C; maximum wind speed - 6.2 m / s; the average monthly relative humidity at 13 h is 61%. Data are accepted in accordance with ДБН В.1.2-2:2006.

To develop engineering solutions for the prevention and reduction of injuries on the construction site, it is first necessary to identify the causes of accidents in combination with production factors that cause injuries. These can be: collapse or fall of structures, equipment, tools, fall of installers from a height, electric shock. Identifying the causes of accidents is associated with methods of production of work performed, means of mechanization, but primarily with the type of building.

SECTION 5.1. CIVIL DEFENSE.

5.1.1. Increasing the sustainability of electricity, water and gas supply in the Mining region in the context of the use of nuclear weapons

Improving the resilience of electricity, water and gas supply systems plays a significant role in the life of the economy, so it is necessary to increase the resilience of electricity, water and gas supply of the facility and the area as a whole, in terms of nuclear explosion to the nearest energy and industrial facilities. projects.

In order to organize and carry out measures to protect objects and eliminate the consequences of the use of weapons of mass destruction by the enemy, it is first of all necessary to know the impressive nuclear action of the probable enemy.

Depending on the type of mass destruction used by the enemy, foci of nuclear damage and areas of radioactive destruction may be formed. Outbreaks appear to be exacerbated by conventional means of defeating the enemy. When exposed to two or more types of weapons of mass destruction, a focus of combined defeat is formed. The initial actions of the striking factors of the WMD and other means of attack of the enemy can lead to explosions, fires, flooding of the area and the spread of dangerous chemicals. At the same time the secondary centers of defeat are formed.

Improving the resilience of these systems plays a significant role in the life of industrial areas and facilities. An example of this is the so-called "accident of the century", which occurred in the power systems of the United States and Canada in 1965. During this accident for 10-12 hours cut off electricity in an area of more than 200 thousand km2, home to more than 30 million people . The accident paralyzed the northeastern regions of the United States and the southeastern regions of Canada, New York. Work at enterprises and institutions ceased, ground and underground electric trains stopped, airports, telephones, radio and television did not work, and even the alarm system did not work. Hundreds of thousands of peoplewere closed in the cabins of elevators, in some places there were accidents, panic began among the population.

OUTPUT DATA

The plant building is located in cairo and serves the population of this and nearby areas, in general it is a one- and two-storey, heated, rectangular building.

On average, the plant is serviced by 50 workers.

At a distance of 8 km is a strategically important object №.

Networks are connected to the building:

from the south-east the gas pipeline;

from the east a water supply system;

from the northeast electrical network.

When this object is attacked by nuclear munitions with a capacity of 500 kt at a projected distance of 8 km, a wave of excess pressure with a force of 30 kPa is formed.

MAIN PART

All these networks fall into the zone of excess wave damage at a pressure of 30 to 80 kPa at which the load-bearing structures of the networks come into a state unsuitable for normal operation.

It is necessary to prevent a condition unsuitable for normal operation:

In power supply networksto take measures to transfer overhead power lines to underground.

When installing electrical networks, install circuit breakers, which in case of short circuits and in case of overvoltages will disconnect the damaged areas. Overvoltages in power lines can occur as a result of destruction or damage to individual elements of the district's power supply systems, as well as under the influence of electromagnetic fields of a nuclear explosion.

Water supply of the object will be more stable and reliable if the object is connected to several systems or to two or three independent sources, separated from each other at a safe distance. Guaranteed water supply can only be provided from a protected source with an autonomous and protected energy source.

Для більшої надійності на випадок руйнування на об'єктах створюються обвідні лінії й влаштовуються перемички, по яких подають воду в обхід damaged areas, destroyed buildings and structures. Fire hydrants that disconnect devices are placed in an area that will not be flooded in the event of destruction of buildings and structures. Introduction of automatic and semi-automatic devices that disconnect damaged areas without disrupting the operation of another part of the network. On the objects of the considered area, consuming a large amount of water, the circulating water supply with reuse of water for technical purposes is used. This technology reduces the overall water demand and increases the sustainability of the water supply of the facility.

An important and complex measure is the protection of water from infection. In the area the water intended for drinking is cleared and disinfected in the clearing devices which are at water stations. At treatment facilities, I envisage additional measures to purify water coming from contaminated water bodies. In the private sector of this area, underground water sources (mine wells, springs, etc.) are widespread. They can penetrate radioactive substances. Therefore, it is necessary to carry out engineering measures to protect water intakes on underground water sources.

To ensure a stable and reliable supply of gas to the enterprise its supply to the gas network of the district from gas control points is provided. When designing, building and reconstructing gas networks, looped systems are created.

In the event of failure of gas control points and bypass lines are installed. All nodes and gas supply lines are located underground, because the deepening of communications significantly reduces their damage by the shock wave of a nuclear explosion and other means of attack by the enemy.

In addition, sheltering underground gas supply systems significantly reduces the possibility of secondary damage factors.

To reduce the fire hazard, measures are taken to reduce the possibility of gas leaks. Automatic shut-off devices of remote control are installed on gas pipelines, which allow to disconnect networks or switch the gas flow in case of pipe rupture directly from the control point.

Measures to increase the stability of the sewer systemare developed separately for storm, industrial and economic (fecal) sewage of the considered area. The projected building of the shopping center is not equippedless than two outlets with connection to city sewers, and also outlets for emergency dumpings of untreated waters in the ravines adjoining to object and other natural and artificial deepenings are arranged. For dumping build wells with emergency latches and establish them on object collectors with an interval

50 m.

CONCLUSIONS

The projected building has two branches of power supply - the main and spare, located underground. A copper three-core cable is used, the cross-sectional area of one core A = 50 mm2, which is connected to the transformer of the HPP 1600 by 3.3 kW. The transformer is located in the production part of the building on the ground floor, the entrance to the room where the transformer is located, only from the outside of the building. The cable is laid in a trench to a depth of 2 m, on a sand preparation 200 m thick, which was previously compacted. After laying the cable in the trench, it is covered with reinforced concrete slabs (thickness 50 mm, length 1000 mm, width 300 mm) or laid on top of bricks. After laying the protective material in the trench fall asleep layer by layer, the thickness of one layer is 500 mm, the first layer is sand, the next layers are earthen soil, each layer is compacted. In places where the cable passes through highways, the cable is placed in a metal pipe with a diameter of 3 times the diameter of the cable, the protective material on top of the pipe is not laid.

The cables should be checked periodically, the check should be done twice in

year - autumn and spring. The cable routing locations are shown in Figure 1.

The building also has two branches of cold water supply, which are used simultaneously for half of its capacity, and one branch of hot water. In case of damage of one of water supply systems use the second water supply system on its full force. Water pipes should be located at a depth of 1.5 m (below the freezing depth of the soil). Laying water pipes with cold water is similar to laying cables.

Water pipes with hot water should be laid in a special protective insulating device, consisting of a U-plate in which the pipes are laid, and the plates of which close the pipe. Before laying pipes in the first plate, pour heat-insulating material - slag 100 mm thick, then put a pipe and fill up it with heat-insulating material so that from above pipes there was a layer.slag not less than 200 mm. Pipes from high-pressure polyethylene HDPE d = 110x5 are applied. The location of the plumbing is shown in Figure 1.

Gas supply is provided for one gas pipeline, because gas consumption is low. The gas pipeline is located underground at a depth of 3 m. Backfilling is performed similarly to backfilling the cable: the first layer is sand, the next is earthen soil, each layer is compacted. The locations of the gas pipeline should be indicated on the general plan. The building provides a supply of gas cylinders in the amount required for the operation of the enterprise for one month.

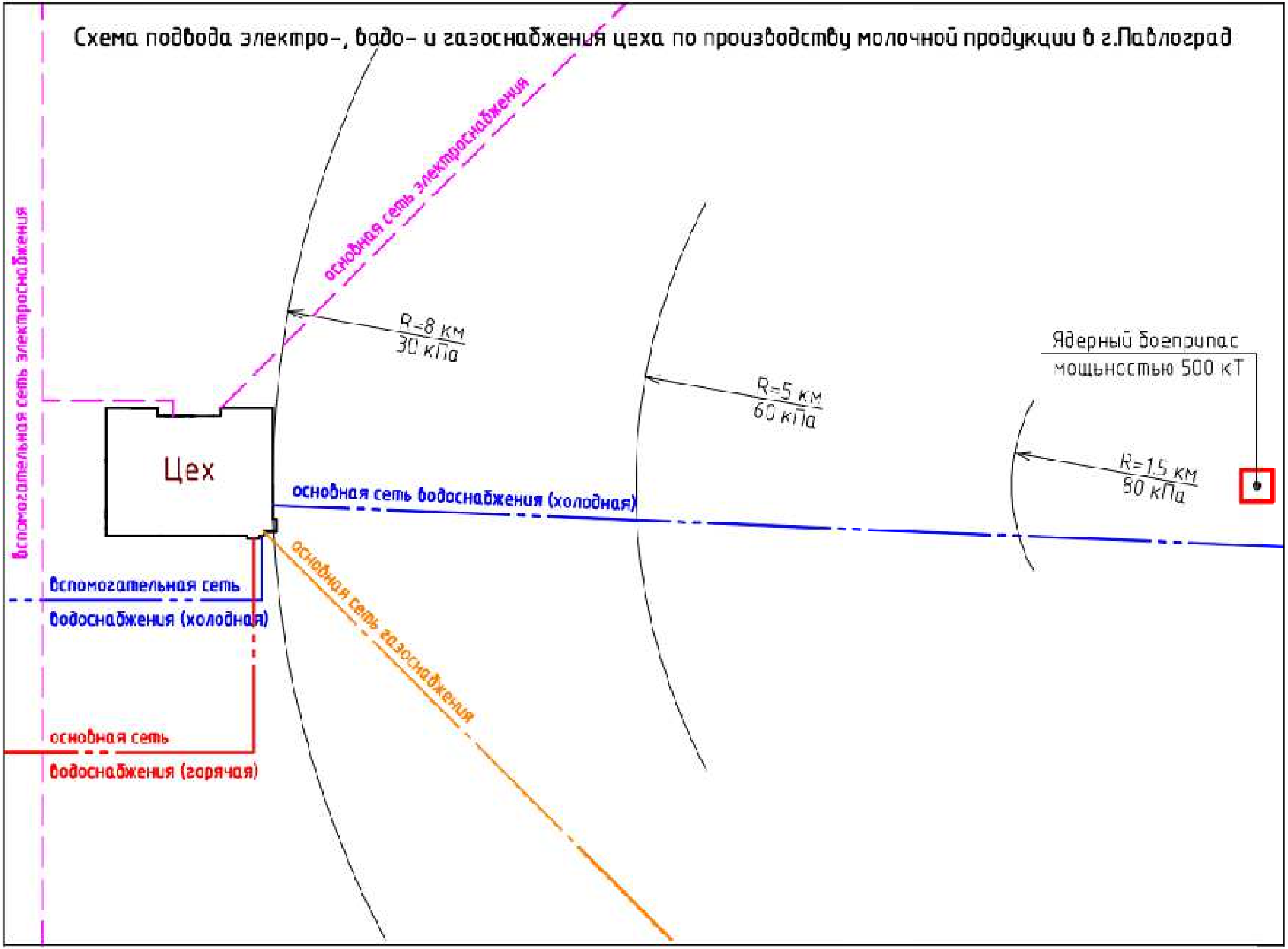
Схема подвода электро-, водо- и газоснабжения цеха по производству молочной продукции в г.Павлоград
основная сеть электроснабжения
вспомогательная сеть электроснабжения
R=8 км
30 кПа
R=5 км
60 кПа
R=1,5 км
90 кПа
Ядерный боеприпас
мощностью 500 кТ
Цех
основная сеть водоснабжения (холодная)
вспомогательная сеть
водоснабжения (холодная)
основная сеть газоснабжения
основная сеть
водоснабжения (горячая)

SECTION 5.2. ENVIRONMENTAL IMPACT ASSESSMENT

5.2.1. Environmental requirements for the construction site

1. The size of the sitein the plan are chosen as the minimum, ie within its area there is only the building under construction and in addition the minimum necessary area for travel, placement of assembly mechanisms and household rooms. The existing soil layer within the pit will be removed in advance and transported to the place of its storage (for further use for landscaping), and the soil-vegetation layer and vegetation near the future facility are fully preserved and protected from contamination and destruction..

2. Roads.

Temporary roads are not designed. Permanent roads are designed as temporary, which will be used in the future during operation. Road width 6 m; sidewalks 1.5 m. After construction, all roads will be permanent, after which the road surface will be completed.

3. Lifting and transport equipment. As the hoisting-and-transport equipment the self-propelled - jib crane (for installation of columns and beams) and the self-propelled - jib crane (for installation of the bases) are applied. Only these cranes will be used on the construction site.

4.Equipment for excavation and organization of foundations. When conducting excavations, tillage with excavators is provided ЭО-3122 and ДЗ -43 bulldozers that excludes dynamic and shock loadings.

5. Tools. Hand power tools are used (circular saw, screwdrivers, surface vibrators, ramming). At welding of metalwork installations for welding are used.

6. Temporary buildings and structures. All temporary buildings and constructions it is expedient to carry out in the form of the blocks with full internal finishing, brought on a platform and established on point support over a surface of the earth, at the height providing growth of a grass and small bushes.

7. Heat, electricity, water supply. For temporary supply of a construction site constant networks of water and power supply are used, the sewerage of a construction site is deduced in a sewer collector..

8. Construction waste. All construction waste in the form of battle bricks, concrete, glass, tiles, containers, paints and varnishes, etc. collected in special containers and taken for disposal.

5.2.2. Calculation of emissions of harmful substances into the atmosphere during the construction of the facility

Calculations are performed to determine the amount of harmful substances emitted into the atmosphere during welding, painting work, as well as emissions of harmful substances by road.

The initial data for calculations are:

- Final statement of resources to the local budget № 2-1-1 for construction and installation work in cairo.
- Local estimate № 2-1-1 for construction and installation work in cairo.

Calculations of harmful substances emitted into the atmosphere during welding

During the installation of the metal frame, 31 kg of type electrodes were issued Э-42, АНО-11. Determine the amount of harmful substances released into the atmosphere.

The gross value of emissions of harmful substances into the atmosphere is determined by the formula:

$G=g*M_э$,

where:

g – specific emissions, g / kg;

$M_э$ – consumption of electrodes, kg.

The specific release of pollutants during welding and surfacing of metals (g / kg) is found in the table № 5.2.1.

Table 5.2.1 - Specific release of pollutants during welding and surfacing of metals.

Electrodes	Welding aerosol	Including [g / kg]				gas
		manganese and its oxide	chromium oxides	Others		Hydrogen fluoride
				Name	Kil-V	
АНО-11	10	1,0	1,43	fluorides	1,50	0,001

Після розрахунків по формулі викидів (у грамах), дані вносимо в таблицю № 5.2.2.

Electrodes	Welding aerosol	Including [g]				gas
		manganese and its oxide	chromium oxides	others		Hydrogen fluoride
				Name	Kil-V	
АНО-11	250	25	35,75	fluorides	37,5	0,025

Calculations of emissions of harmful substances by road.

The construction site uses vehicles that run on both gasoline and diesel fuel..

Fuel consumption:

gasoline – 15 т;

diesel fuel – 20 т.

The mass emission of the j-th harmful substance (t) by the rolling stock of motor transport, which has n groups of cars of the k-th type, for the period t is determined by the formula:

$$M_j^t = \sum_{i=1}^{n} (g_{j2i} * G_{2i}^t) * K_t * 10^{-3},$$

where: gj_{2i} – specific emission of the j-th harmful substance per unit mass of fuel consumed by cars of the k-th type in traffic outside the city and settlements, kg / t;

Gt_{2i} – fuel consumption by cars of the k-th in the conditions of movement out of cities and settlements;

$K_т$ – coefficient taking into account the influence of the technical condition of cars on the value of specific emissions of carbon oxides C, hydrocarbons C_mH_n, nitrogen oxides NO and soot C. For sulfur oxide SO2 and Pb compounds, this coefficient is equal to 1.0.

Gasoline trucks with internal combustion engines:

M_{co}=152*5*1,7*10-3=3.876 т

M_{cH}=34,2*5*1,8*10-3=0,924 т

M_{NO2}=28,5*5*0,9*10-3=0,384

M_{SO2}=0,6*5*1*10-3=0,01 т

M_{Pb}=0,23*5*1*10-3=0,0033 т

Trucks with diesels:

M_{co}=29,3*10*1,5*10-3=0,879 т

M_{cH}=5,3*10*1,4*10-3=0,1484 т

M_{NO2}=33,7*10*0,95*10-3=0,6404 т

M_{SO2}=5,0*10*1*10-3=0,1 т

M_{Pb}=3,85*10*1,8*10-3=0,1386 т

Total emissions for each type of harmful substances:

M_{co}=3.876+0.879=4.755 т

$M_{сн}$=0.924+0.1484=1.0724 т

M_{NO2}=0.384+0.6404=1.0734 т

M_{SO2}=0,01+0,1=011 т

M_{Pb}=0,0033+0.1386=0.1419 т

CALCULATIONS OF HARMFUL SUBSTANCES RELEASED INTO THE ATMOSPHERE DURING PAINTING WORKS

As initial data for calculations of allocation of pollutants at various ways of drawing a paint and varnish covering we accept: actual or planned expenses of a painting material, a share of components of a paint and varnish material allocated in the course of painting and during drying.

Paints are used in the production of painting works ПЭ-265 – 300 kgand ПФ-002 – 150 kg.

The composition of paints ПЭ-265 and ПФ-002 includes the following components:

The composition of paints ПЭ-265 and ПФ-002

Table 5.2.3

Enamel	Components, %					
	butyl acetate	aceton e	styrene	solvent	volatile part, %	dry residue, %
ПЭ-265	5	1	2		8	92
ПФ-002				25	25	75

FOR PAINT ПФ-002

Determine the amount of harmful substances released during the application of paint on the surface in the form of an aerosol of paint according to the formula:

$$П_{ок}^{a} = m_{к} * \delta_{a} / 10^{2}.$$

Where $m_к$ – weight of paint used for coating, kg;

δ_a=30% – the proportion of paint lost in the form of an aerosol, during pneumatic spraying.

$П^{а}_{ок} = 150 * 30 / 10^{2} = 45 кг$

Determine the mass of harmful substances released in the form of solvent vapor according to the formula:

$П^{пар}_{ок} = m_{к} * f_{p} * \delta'_{p} / 10^{4}$,

where fp – the proportion of the volatile part (solvent) in the paint material, %;

δ'_{p} – the proportion of solvent released during coating, %.

$П^{пар}_{ок} = 150 * 25 * 25 / 10^{4} = 9{,}37 кг$

The mass of substances released during the drying of painted products is determined based on the condition that in this process of forming the coating is almost complete transition of the volatile part of the paint material (solvent) in the vapor state:

$П^{пар}_{c} = m_{к} * f_{p} * \delta''_{p} / 10^{4}$

where fp – the proportion of the volatile part (solvent) in the paint material, %;

δ''_{p} – the proportion of solvent released during drying of the coating, %.

$П^{пар}_{c} = 150 * 25 * 75 / 10^{4} = 28{,}125 кг$

Therefore, in the process of painting with paint PF-002 is the release of the following harmful substances:

- spray paint: $П^{а}_{ок}$=45 kg
- solvent: $П^{пар}$=37,4 kg.

FOR PAINT ПЭ-265

Determine the mass of harmful substances released during the application of paint on the surface in the form of an aerosol of paint according to the formula:

$П^{а}_{ок} = m_{к} * \delta_{a} / 10^{2}$

$П^{а}_{ок} = 300 * 30 / 10^{2} = 90 кг$

Determine the mass of harmful substances released in the form of solvent vapor according to the formula:

$П^{пар}_{ок} = m_{к} * f_{p} * \delta'_{p} / 10^{4}$

$П^{пар}_{ок} = 300 * 5 * 25 / 10^{4} = 3{,}75 кг$ - butyl acetate;

$П_{ок}^{пар} = 300 * 1 * 25 / 10^4 = 0{,}75 кг$ - acetone;

$П_{ок}^{пар} = 300 * 2 * 25 / 10^4 = 1{,}5 кг$ - styrene.

The mass of substances released during the drying of painted products is determined based on the condition that in this process of forming the coating is almost complete transition of the volatile part of the paint material (solvent) in the vapor state:

$П_{c}^{пар} = m_к * f_p * \delta_p'' / 10^4$

$П_{c}^{пар} = 300 * 5 * 75 / 10^4 = 11{,}25 кг$ - butyl acetate;

$П_{c}^{пар} = 300 * 1 * 75 / 10^4 = 2{,}25 кг$ - acetone;

$П_{c}^{пар} = 300 * 2 * 75 / 10^4 = 4{,}5 кг$ - styrene.

Therefore, in the process of painting with PE-265 paint, the following harmful substances are released:

- spray paint: $П^{а}_{ок}$=142,5 kg
- butyl acetate: $П^{пар}$=15 kg
- acetone: $П^{пар}$=3 kg
- styrene: $П^{пар}$=6 kg

Masses of harmful substances released during the drying of painted products with paints ПЭ-265 і ПФ-002.

Table 5.2.4

Enamel	Quantity, kg				
	butyl acetate	acetone	styrene	solvent	volatile part (aerosol),%
ПЭ-265	15	3	6		142,5
ПФ-002				37,4	45

SECTION 6. CONSTRUCTION ECONOMICS

6.1. Local estimate

на зведення залізобетонного каркаса будинку

Кошторисна вартість: **5911.740** **тыс. грн.**

Нормативная трудомісткість: **8.483** **тыс.чол.г**

Кошторисна заробітна плата: **267.597** **тыс. грн.**

Складена в поточних цінах на 05. 2021 р. Таблиця 6.1.1.

№ поз.	Шифр, номер норматива, код ресурса	Найменування работ и затрат, характеМалтика оборудования, Маса	Единица измерения / Кол-во механиза-торов	Количество: на единицу измерения	Количество: по проектным данным	Сметная стоимость в текущих ценах: на единицу измерения	Сметная стоимость в текущих ценах: общая
1	2	3	4	5	6	7	8
	ПОДЗЕМНАЯ ЧАСТЬ						
	ЗЕМЛЯНЫЕ РАБОТЫ						
1.	**E01-01-030-2**	**Срезка растительного слоя грунта**	**1000 м3**		**0.17**	**2 433.341**	**414**
1. 1.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*12.65*	*2.1505*		
1. 2.	X07-0148	Бульдозеры при работе на других видах строительства (кроме водохозяйственного) 59 (80) кВт (л.с.)	маш.ч (1)	12.65	2.1505	192.359	414
		Накладные расходы				95%	
		Сметная прибыль				50%	
		Всего с НР и СП					414
2.	**E01-02-027-2**	**Планировка площадей механизированным способом, группа грунтов 2**	**1000 м2**		**1.13**	**334.166**	**378**
2. 1.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*1.1*	*1.243*		
2. 2.	X07-0149	Бульдозеры при работе на других видах строительства	маш.ч	0.67	0.7571	251.040	190

1	2	3	4	5	6	7	8
		(кроме водохозяйственного) 79 (108) кВт (л.с.)	(1)				
2. 3.	Х12-0202	Автогрейдеры среднего типа 99 (135) кВт (л.с.)	маш.ч (1)	0.43	0.4859	385.974	188
		Накладные расходы				80%	
		Сметная прибыль				50%	
		Всего с НР и СП					378
3.	**Е01-01-003-14**	**Разработка грунта в отвал экскаваторами "драглайн" или "обратная лопата" с ковшом вместимостью 0,5 (0,5-0,63) м3, группагрунтов 2**	**1000 м3**		**1.771**	**9 734.900**	**17 241**
3. 1.	3000-1002-0	Рабочие-строители (средний разряд 2.0)	чел.ч	13.57	24.03247	35.210	846
3. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*29.5*	*52.2445*		
3. 3.	Х06-0247	Экскаваторы одноковшовые дизельные на гусеничном ходу при работе на других видах строительства (кроме водохозяйственного) 0,5 м3	маш.ч (1)	29.5	52.2445	313.800	16 394
		Накладные расходы				95%	804
		Сметная прибыль				50%	423
		Всего с НР и СП					18 468
4.	**Е01-02-057-2**	**Добор грунта вручную** ***Начисления: Н5=1.2***	**100 м3**		**0.16**	**6 506.808**	**1 041**
4. 1.	3000-1002-0	Рабочие-строители (средний разряд 2.0)	чел.ч	184.8	29.568	35.210	1 041
		Накладные расходы				80%	833
		Сметная прибыль				50%	521
		Всего с НР и СП					2 394
5.	**Е01-01-033-2**	**Засыпка траншей и котлованов с перемещением грунта до 5 м бульдозерами мощностью 59 (80) кВт (л.с.), 2 группа грунтов**	**1000 м3**		**0.876**	**1 706.224**	**1 495**
5. 1.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*8.87*	*7.77012*		
5. 2.	Х07-0148	Бульдозеры при работе на других видах строительства (кроме водохозяйственного) 59 (80) кВт (л.с.)	маш.ч (1)	8.87	7.77012	192.359	1 495
		Накладные расходы				95%	
		Сметная прибыль				50%	
		Всего с НР и СП					1 495
6.	**Е01-02-005-1**	**Уплотнение грунта пневматическими трамбовками, группа грунтов 1, 2**	**100 м3**		**8.76**	**1 270.245**	**11 127**

1	2	3	4	5	6	7	8
6. 1.	3000-1003-0	Рабочие-строители (средний разряд 3.0)	чел.ч	12.53	109.7628	38.620	4 239
6. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*3.04*	*26.6304*	*49.970*	*1 331*
6. 3.	Х05-0102	Компрессоры передвижные с двигателем внутреннего сгорания давлением до 686 кПа (7 ат) 5 м3/мин	маш.ч (1)	3.04	26.6304	196.930 *49.970*	5 244 *1 331*
6. 4.	Х33-1101	Трамбовки пневматические	маш.ч	12.18	106.6968	15.408	1 644
		Накладные расходы				80%	4 456
		Сметная прибыль				50%	2 785
		Всего с НР и СП					18 368
	ФУНДАМЕНТЫ						
7.	**Е06-01-001-5**	**Устройство железобетонных фундаментов общего назначения под колонны объемом до 3 м3**	**100 м3**		**0.32**	**323 696.336**	**103 583**
7. 1.	3000-1003-0	Рабочие-строители (средний разряд 3.0)	чел.ч	785.88	251.4816	38.620	9 712
7. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*31.3*	*10.016*	*49.970*	*500*
7. 3.	Х02-0129	Краны башенные при работе на других видах строительства (кроме монтажа технологического оборудования) 8 т	маш.ч (1)	30.35	9.712	298.190 *49.970*	2 896 *485*
7. 4.	Х02-1141	Краны на автомобильном ходу при работе на других видах строительства (кроме магистральных трубопроводов) 10 т	маш.ч (1)	0.68	0.2176	367.480 *49.970*	80 *11*
7. 5.	Х03-0101	Автопогрузчики 5 т	маш.ч (1)	0.27	0.0864	305.340 *49.970*	26 *4*
7. 6.	Х11-1100	Вибраторы глубинные	маш.ч	37.72	12.0704	5.962	72
7. 7.	Х33-1532	Пилы электрические цепные	маш.ч	0.87	0.2784	10.261	3
7. 8.	Х40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч (1)	0.99	0.3168	303.710	96
7. 9.	С101-0253	Известь строительная негашеная комовая, сорт 1	т	0.027	0.00864	2 123.440	18
7. 10.	С101-0797	Катанка горячекатаная в мотках диаметром 6.3-6.5 мм	т	0.0375	0.012	12 118.140	145
7. 11.	С101-0816	Проволока светлая диаметром 1.1 мм	т	0.0061	0.001952	29 488.200	58
7. 12.	С101-1668	Рогожа	м2	153	48.96	29.488	1 444
7. 13.	С101-1805	Гвозди строительные	т	0.0238	0.007616	31 142.800	237
7. 14.	С102-0061	Пиломатериалы хвойных пород. Доски обрезные длиной 4-6.5 м, шириной 75-150 мм, толщиной 44 мм и более III сорта	м3	0.74	0.2368	3 052.896	723
7. 15.	С203-0511	Щиты из досок толщиной 25 мм	м2	64.1	20.512	102.717	2 107
7. 16.	С204-0100	Арматурная горячекатаная класса А-I, А-II, А-III для монолитных железобетонных конструкций	т	4.5	1.44	16 334.150	23 521

1	2	3	4	5	6	7	8
7. 17.	С401-0066	Бетон тяжелый, крупность заполнителя 20 мм, класс В 15 (М200)	м3	101.5	32.48	1 922.515	62 443
7. 18.	С411-0001	Вода	м3	0.441	0.14112	4.570	1
		Накладные расходы				120%	12 254
		Сметная прибыль				77%	7 863
		Всего с НР и СП					123 701
8.	**Е07-01-001-7**	**Укладка фундаментов под колонны при глубине котлована до 4 м, Масса конструкций более 3,5 т**	**100 шт.**		**0.15**	**65 173.109**	**9 776**
8. 1.	3000-1003-4	Рабочие-строители (средний разряд 3.4)	чел.ч	308.58	46.287	40.470	1 873
8. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*91.12*	*13.668*	*49.970*	*683*
8. 3.	Х02-1244	Краны на гусеничном ходу при работе на других видах строительства (кроме магистральных трубопроводов) 25 т	маш.ч (1)	85.56	12.834	390.720 *49.970*	5 015 *641*
8. 4.	Х03-0101	Автопогрузчики 5 т	маш.ч (1)	4.35	0.6525	305.340 *49.970*	199 *33*
8. 5.	Х05-0102	Компрессоры передвижные с двигателем внутреннего сгорания давлением до 686 кПа (7 ат) 5 м3/мин	маш.ч (1)	1.21	0.1815	196.930 *49.970*	36 *9*
8. 6.	Х33-1101	Трамбовки пневматические	маш.ч	4.81	0.7215	15.408	11
8. 7.	Х40-0102	Тягачи седельные 15 т	маш.ч (1)	17	2.55	332.189	847
8. 8.	Х40-0131	Полуприцепы-тяжеловозы 40 т	маш.ч	17	2.55	89.904	229
8. 9.	С408-0122	Песок природный для строительных работ средний	м3	39.5	5.925	264.270	1 566
		Накладные расходы				155%	3 962
		Сметная прибыль				100%	2 556
		Всего с НР и СП					16 294
9.	**С441-1311**	**Фундаменты железобетонные 3-лучевые стаканного типа**	**м3**		**31.5**	**3 384.609**	**106 615**
10.	**Е07-01-001-15**	**Укладка балок фундаментных длиной до 6 м**	**100 шт.**		**0.33**	**38 403.223**	**12 673**
10. 1.	3000-1003-8	Рабочие-строители (средний разряд 3.8)	чел.ч	416.25	137.3625	42.450	5 831
10. 2.	*31000-0001*	Затраты труда машинистов	*чел.ч*	*32.94*	*10.8702*		
10. 3.	Х02-1243	Краны на гусеничном ходу при работе на других видах строительства (кроме магистральных трубопроводов) до 16 т	маш.ч (1)	32.94	10.8702	321.331	3 493
10. 4.	Х11-1100	Вибраторы глубинные	маш.ч	2.58	0.8514	5.962	5
10. 5.	Х40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч (1)	8.2	2.706	303.710	822
10. 6.	С101-0962	Смазка солидол жировой "Ж"	т	0.00934	0.0030822	27 931.396	86

1	2	3	4	5	6	7	8
10. 7.	С101-1805	Гвозди строительные	т	0.00276	0.0009108	31 142.800	28
10. 8.	С102-0058	Пиломатериалы хвойных пород. Доски обрезные длиной 4-6.5 м, шириной 75-150 мм, толщиной 32-40 мм IV сорта	м3	0.01	0.0033	2 919.910	10
10. 9.	С102-0062	Пиломатериалы хвойных пород. Доски обрезные длиной 4-6.5 м, шириной 75-150 мм, толщиной 44 мм и более IV сорта	м3	0.05	0.0165	2 226.070	37
10. 10.	С203-0511	Щиты из досок толщиной 25 мм	м2	5.65	1.8645	102.717	192
10. 11.	С401-0086	Бетон тяжелый, крупность заполнителя 10 мм, класс В 15 (М200)	м3	3.05	1.0065	1 922.515	1 935
10. 12.	С402-0002	Раствор готовый кладочный цементный, марка 50	м3	0.42	0.1386	1 694.300	235
		Накладные расходы				155%	9 038
		Сметная прибыль				100%	5 831
		Всего с НР и СП					27 542
11.	**С442-6001**	**Балки железобетонные фундаментные**	**м3**		**19.8**	**5 513.513**	**109 168**
	НАДЗЕМНАЯ ЧАСТЬ (каркасная часть здания)						
12.	**Е07-01-011-3**	**Установка колонн прямоугольного сечения в стаканы фундаментов зданий при глубине заделки колонн до 0,7 м, Маса колон до 3 т**	**100 шт.**		**0.14**	**81 621.039**	**11 427**
12. 1.	3000-1003-8	Рабочие-строители (средний разряд 3.8)	чел.ч	658.56	92.1984	42.450	3 914
12. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*93.68*	*13.1152*		
12. 3.	Х02-1243	Краны на гусеничном ходу при работе на других видах строительства (кроме магистральных трубопроводов) до 16 т	маш.ч (1)	93.68	13.1152	321.331	4 214
12. 4.	Х11-1100	Вибраторы глубинные	маш.ч	7.22	1.0108	5.962	6
12. 5.	Х40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч (1)	13.42	1.8788	303.710	571
12. 6.	С102-0120	Пиломатериалы хвойных пород. Доски обрезные длиной 2-3.75 м,шириной 75-150 мм, толщиной 44 мм и более II сорта	м3	0.3	0.042	3 605.077	151
12. 7.	С401-0088	Бетон тяжелый, крупность заполнителя 10 мм, класс В 22,5 (М300)	м3	8.6	1.204	2 135.177	2 571
		Накладные расходы				155%	6 067
		Сметная прибыль				100%	3 914
		Всего с НР и СП					21 408
13.	**Е07-01-011-4**	**Установка колонн прямоугольного сечения в стаканы фундаментов зданий при глубине заделки колонн до 0,7 м, Маса колон до 4 т**	**100 шт.**		**0.22**	**94 149.116**	**20 713**

1	2	3	4	5	6	7	8
14. 1.	3000-1003-8	Рабочие-строители (средний разряд 3.8)	чел.ч	762.72	167.7984	42.450	7 123
14. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*104.72*	*23.0384*		
14. 3.	X02-1243	Краны на гусеничном ходу при работе на других видах строительства (кроме магистральных трубопроводов) до 16 т	маш.ч (1)	104.72	23.0384	321.331	7 403
14. 4.	X11-1100	Вибраторы глубинные	маш.ч	8.15	1.793	5.962	11
14. 5.	X40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч (1)	0.18	0.0396	303.710	12
14. 6.	X40-0102	Тягачи седельные 15 т	маш.ч (1)	14.75	3.245	332.189	1 078
14. 7.	X40-0131	Полуприцепы-тяжеловозы 40 т	маш.ч	14.75	3.245	89.904	292
14. 8.	C102-0120	Пиломатериалы хвойных пород. Доски обрезные длиной 2-3.75 м,шириной 75-150 мм, толщиной 44 мм и более II сорта	м3	0.3	0.066	3 605.077	238
14. 9.	C401-0088	Бетон тяжелый, крупность заполнителя 10 мм, класс В 22,5 (М300)	м3	9.7	2.134	2 135.177	4 556
		Накладные расходы				155%	11 041
		Сметная прибыль				100%	7 123
		Всего с НР и СП					38 877
15.	**C442-1000**	**Колонны железобетонные**	**м3**		**46.7**	**12 330.202**	**575 820**
16.	**E09-03-002-2**	**Монтаж колонн одноэтажных и многоэтажных зданий и крановых эстакад высотой до 25 м цельного сечения массой до 3,0 т**	**т**		**0.3**	**56 334.958**	**16 900**
16. 1.	3000-1003-6	Рабочие-строители (средний разряд 3.6)	чел.ч	6.44	1.932	41.470	80
16. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*1.17*	*0.351*	*49.970*	*18*
16. 3.	X02-0403	Краны козловые при работе на монтаже технологического оборудования 32 т	маш.ч (1)	0.04	0.012	334.520 *49.970*	4 *1*
16. 4.	X02-1141	Краны на автомобильном ходу при работе на других видах строительства (кроме магистральных трубопроводов) 10 т	маш.ч (1)	0.16	0.048	367.480 *49.970*	18 *2*
16. 5.	X02-1244	Краны на гусеничном ходу при работе на других видах строительства (кроме магистральных трубопроводов) 25 т	маш.ч (1)	0.97	0.291	390.720 *49.970*	114 *15*
16. 6.	X04-0504	Аппараты для газовой сварки и резки	маш.ч	1.01	0.303	2.710	1
16. 7.	X04-1000	Преобразователи сварочные с номинальным сварочным током 315-500 А	маш.ч	0.44	0.132	24.870	3
16. 8.	X33-0301	Машины шлифовальные электрические	маш.ч	0.06	0.018	4.170	
16. 9.	X40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч	0.23	0.069	303.710	21

1	2	3	4	5	6	7	8
			(1)				
17. 10.	С101-0309	Канаты пеньковые пропитанные	т	0.0001	0.00003	109 568.900	3
17. 11.	С101-0324	Кислород технический газообразный	м3	0.7	0.21	13.310	3
17. 12.	С101-0797	Катанка горячекатаная в мотках диаметром 6.3-6.5 мм	т	0.00003	0.000009	12 118.140	
17. 13.	С101-1019	Швеллеры N 40, сталь марки Ст0	т	0.00194	0.000582	14 229.050	8
17. 14.	С101-1513	Электроды диаметром 4 мм Э42	т	0.0018	0.00054	24 375.000	13
17. 15.	С101-1714	Болты строительные с гайками и шайбами	т	0.00015	0.000045	20 972.800	1
17. 16.	С101-1805	Гвозди строительные	т	0.00001	0.000003	31 142.800	
17. 17.	С101-9412-2	Шлифкруги 230х5х22	шт.	0.01	0.003	106.390	
17. 18.	С102-0023	Пиломатериалы хвойных пород. Бруски обрезные длиной 4-6.5 м,шириной 75-150 мм, толщиной 40-75 мм I сорта	м3	0.00103	0.000309	3 383.000	1
17. 19.	С113-0021	Грунтовка ГФ-021 красно-коричневая	т	0.00031	0.000093	45 157.000	4
17. 20.	С113-0156	Растворитель марки Р-4	т	0.0006	0.00018	27 233.000	5
17. 21.	С201-0756	Отдельные конструктивные елементы зданий и сооружений с преобладанием горячекатаных профилей, средняя Маса сборочной единицы свыше 0.1 до 0.5 т	т	0.0007	0.00021	22 295.000	5
17. 22.	С537-0097	Канат двойной свивки типа ТК оцинкованный из проволок марки В, маркировочная группа 1770 н/мм2, диаметром 5.5 мм	10 м	0.0187	0.00561	145.210	1
17. 23.	С542-0042	Пропан-бутан, смесь техническая	кг	0.21	0.063	24.520	2
17. 24.	с201-9002	Конструкции стальные	т	1	0.3	25 000.000	7 500
17. 25.	с201-0778	Прочие индивидуальные сварные конструкции, Маса сборочной единицы до 0.1 т	т	1	0.3	30 379.000	9 114
		Накладные расходы				90%	88
		Сметная прибыль				85%	83
		Всего с НР и СП					17 072
18.	**Е07-01-034-1**	**Установка панелей наружных стен**	**100 шт.**		**2.05**	**79 451.369**	**162 875**
18. 1.	3000-1004-1	Рабочие-строители (средний разряд 4.1)	чел.ч	630.56	1292.648	44.100	57 006
18. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*101.18*	*207.419*	*49.970*	*10 365*
18. 3.	Х02-1141	Краны на автомобильном ходу при работе на других видах строительства (кроме магистральных трубопроводов) 10 т	маш.ч (1)	7.1	14.555	367.480 *49.970*	5 349 *727*
18. 4.	Х02-1244	Краны на гусеничном ходу при работе на других видах строительства (кроме магистральных трубопроводов) 25 т	маш.ч (1)	94.08	192.864	390.720 *49.970*	75 356 *9 637*
18. 5.	Х04-0502	Установки для сварки ручной дуговой (постоянного тока)	маш.ч	56.77	116.3785	15.450	1 798
18. 6.	Х40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч	10.65	21.8325	303.710	6 631

1	2	3	4	5	6	7	8
			(1)				
18. 7.	С101-1529	Электроды диаметром 6 мм Э42	т	0.1	0.205	23 560.000	4 830
18. 8.	С201-0777	Конструктивные елементы вспомогательного назначения	т	0.2	0.41	29 040.095	11 906
		Накладные расходы				155%	104 425
		Сметная прибыль				100%	67 371
		Всего с НР и СП					334 671
19.	**С443-1100**	**Панели железобетонные**	**м3**		**348.9**	**7 121.689**	**2 484 757**
20.	**Е07-01-012-1**	**Установка фахверка**	**100 шт.**		**0.02**	**192 658.685**	**3 853**
20. 1.	3000-1003-6	Рабочие-строители (средний разряд 3.6)	чел.ч	1142.4	22.848	41.470	948
20. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*186.14*	*3.7228*		
20. 3.	Х02-1243	Краны на гусеничном ходу при работе на других видах строительства (кроме магистральных трубопроводов) до 16 т	маш.ч (1)	186.14	3.7228	321.331	1 196
20. 4.	Х11-1100	Вибраторы глубинные	маш.ч	30.41	0.6082	5.962	4
20. 5.	Х40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч (1)	21.58	0.4316	303.710	131
20. 6.	С102-0120	Пиломатериалы хвойных пород. Доски обрезные длиной 2-3.75 м,шириной 75-150 мм, толщиной 44 мм и более II сорта	м3	0.4	0.008	3 605.077	29
20. 7.	С401-0088	Бетон тяжелый, крупность заполнителя 10 мм, класс В 22,5 (М300)	м3	36.2	0.724	2 135.177	1 546
		Накладные расходы				155%	1 469
		Сметная прибыль				100%	948
		Всего с НР и СП					6 270
21.	**С442-1100**	**Стойки**	**м3**		**2.72**	**2 417.454**	**6 575**
22.	**Е09-03-012-12**	**Монтаж опорных стоек**	**т**		**0.84**	**31 808.834**	**26 719**
22. 1.	3000-1003-4	Рабочие-строители (средний разряд 3.4)	чел.ч	6.59	5.5356	40.470	224
22. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*2.09*	*1.7556*	*49.970*	*88*
22. 3.	Х02-0403	Краны козловые при работе на монтаже технологического оборудования 32 т	маш.ч (1)	0.88	0.7392	334.520 *49.970*	247 *37*
22. 4.	Х02-1141	Краны на автомобильном ходу при работе на других видах строительства (кроме магистральных трубопроводов) 10 т	маш.ч (1)	0.15	0.126	367.480 *49.970*	46 *6*
22. 5.	Х02-1244	Краны на гусеничном ходу при работе на других видах строительства (кроме магистральных трубопроводов) 25 т	маш.ч (1)	1.06	0.8904	390.720 *49.970*	348 *44*
22. 6.	Х04-0504	Аппараты для газовой сварки и резки	маш.ч	2.24	1.8816	2.710	5

1	2	3	4	5	6	7	8
22. 7.	X04-1000	Преобразователи сварочные с номинальным сварочным током 315-500 А	маш.ч	0.09	0.0756	24.870	2
22. 8.	X40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч (1)	0.23	0.1932	303.710	59
22. 9.	С101-0309	Канаты пеньковые пропитанные	т	0.0001	0.000084	109 568.900	9
22. 10.	С101-0324	Кислород технический газообразный	м3	1.95	1.638	13.310	22
22. 11.	С101-0797	Катанка горячекатаная в мотках диаметром 6.3-6.5 мм	т	0.00003	0.0000252	12 118.140	
22. 12.	С101-1019	Швеллеры N 40, сталь марки Ст0	т	0.00194	0.0016296	14 229.050	23
22. 13.	С101-1513	Электроды диаметром 4 мм Э42	т	0.0004	0.000336	24 375.000	8
22. 14.	С101-1714	Болты строительные с гайками и шайбами	т	0.004	0.00336	20 972.800	70
22. 15.	С101-1805	Гвозди строительные	т	0.00001	0.0000084	31 142.800	
22. 16.	С102-0023	Пиломатериалы хвойных пород. Бруски обрезные длиной 4-6.5 м,шириной 75-150 мм, толщиной 40-75 мм I сорта	м3	0.00103	0.0008652	3 383.000	3
22. 17.	С113-0021	Грунтовка ГФ-021 красно-коричневая	т	0.00031	0.0002604	45 157.000	12
22. 18.	С113-0156	Растворитель марки Р-4	т	0.0006	0.000504	27 233.000	14
22. 19.	С201-0756	Отдельные конструктивные елементы зданий и сооружений с преобладанием горячекатаных профилей, средняя Маса сборочной единицы свыше 0.1 до 0.5 т	т	0.005	0.0042	22 295.000	94
22. 20.	С537-0097	Канат двойной свивки типа ТК оцинкованный из проволок марки В, маркировочная группа 1770 н/мм2, диаметром 5.5 мм	10 м	0.0187	0.015708	145.210	2
22. 21.	С542-0042	Пропан-бутан, смесь техническая	кг	0.59	0.4956	24.520	12
22. 22.	С201-0778	Прочие индивидуальные сварные конструкции, Маса сборочной единицы до 0.1 т	т	1	0.84	30 379.000	25 518
		Накладные расходы				90%	281
		Сметная прибыль				85%	265
		Всего с НР и СП					27 265
23.	**Е07-05-023-7**	**Установка диафрагм жесткости**	**100 шт.**		**0.02**	**280 890.220**	**5 618**
23. 1.	3000-1004-2	Рабочие-строители (средний разряд 4.2)	чел.ч	1322.09	26.4418	44.780	1 184
23. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*119.81*	*2.3962*	*49.970*	*120*
23. 3.	X02-0129	Краны башенные при работе на других видах строительства (кроме монтажа технологического оборудования) 8 т	маш.ч (1)	119.81	2.3962	298.190 *49.970*	715 *120*
23. 4.	X04-0502	Установки для сварки ручной дуговой (постоянного тока)	маш.ч	190.26	3.8052	15.450	59
23. 5.	X04-0504	Аппараты для газовой сварки и резки	маш.ч	5.12	0.1024	2.710	

1	2	3	4	5	6	7	8
23. 6.	Х11-1100	Вибраторы глубинные	маш.ч	11.7	0.234	5.962	1
23. 7.	Х40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч (1)	4.96	0.0992	303.710	30
23. 8.	С101-0063	Ацетилен растворенный технический марки А	т	0.001	0.00002	70 256.200	1
23. 9.	С101-0324	Кислород технический газообразный	м3	5.2	0.104	13.310	1
23. 10.	С101-0783	Поковки из квадратных заготовок массой 2.825 кг	т	0.007	0.00014	18 565.900	3
23. 11.	С101-0804	Проволока наплавочная диаметром 3 мм, марка ПП-Нп-19СТ	т	0.012	0.00024	58 687.300	14
23. 12.	С101-1529	Электроды диаметром 6 мм Э42	т	0.31	0.0062	23 560.000	146
23. 13.	С101-1714	Болты строительные с гайками и шайбами	т	0.0298	0.000596	20 972.800	12
23. 14.	С101-1805	Гвозди строительные	т	0.00381	0.0000762	31 142.800	2
23. 15.	С102-0011	Лесоматериалы круглые хвойных пород для выработки пиломатериалов и заготовок (пластины) толщиной 20-24 см III сорта	м3	0.22	0.0044	1 590.050	7
23. 16.	С102-0060	Пиломатериалы хвойных пород. Доски обрезные длиной 4-6.5 м, шириной 75-150 мм, толщиной 44 мм и более II сорта	м3	0.6	0.012	2 626.800	32
23. 17.	С201-0777	Конструктивные елементы вспомогательного назначения	т	4.7	0.094	29 040.095	2 730
23. 18.	С401-0088	Бетон тяжелый, крупность заполнителя 10 мм, класс В 22,5 (М300)	м3	13.1	0.262	2 135.177	559
23. 19.	С402-0006	Раствор готовый кладочный цементный, марка 200	м3	3	0.06	2 008.420	121
		Накладные расходы				155%	2 021
		Сметная прибыль				100%	1 304
		Всего с НР и СП					8 943
24.	**С443-2100**	**Диафрагма жесткости железобетонные**	**м3**		**2.6**	**7 221.718**	**18 776**
25.	**Е07-05-007-7**	**Укладка ригелей массой до 3 т**	**100 шт.**		**0.07**	**102 259.055**	**7 158**
25. 1.	3000-1004-2	Рабочие-строители (средний разряд 4.2)	чел.ч	552.24	38.6568	44.780	1 731
25. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*64.94*	*4.5458*	*49.970*	*227*
25. 3.	Х02-0129	Краны башенные при работе на других видах строительства (кроме монтажа технологического оборудования) 8 т	маш.ч (1)	64.94	4.5458	298.190 *49.970*	1 356 *227*
25. 4.	Х04-0502	Установки для сварки ручной дуговой (постоянного тока)	маш.ч	124.33	8.7031	15.450	134
25. 5.	Х40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч (1)	3.48	0.2436	303.710	74
25. 6.	С101-0816	Проволока светлая диаметром 1.1 мм	т	0.0004	0.000028	29 488.200	1

1	2	3	4	5	6	7	8
25. 7.	С101-0871	Сетка проволочная крученая с шестиугольными ячейками N 50 светлая	м2	4.4	0.308	9.829	3
25. 8.	С101-0965	Сортовой и фасонный горячекатаный прокат из стали углеродистой обыкновенного качества, круглый и квадратный размером 52-70 мм, сталь марки Ст3кп	т	0.065	0.00455	13 096.230	60
25. 9.	С101-1517	Электроды диаметром 4 мм Э50	т	0.225	0.01575	29 956.542	472
25. 10.	С101-0409	Краски для наружных работ: коричневая	т	0.0138	0.000966	51 451.011	50
25. 11.	С201-0777	Конструктивные элементы вспомогательного назначения	т	1.564	0.10948	29 040.095	3 179
25. 12.	С402-0004	Раствор готовый кладочный цементный, марка 100	м3	0.79	0.0553	1 787.630	99
		Накладные расходы				155%	3 035
		Сметная прибыль				100%	1 958
		Всего с НР и СП					12 151
26.	**С442-2200**	**Ригели железобетонные**	**м3**		**8.4**	**7 091.623**	**59 570**
27.	**Е07-05-011-6**	**Установка панелей перекрытий с опиранием на 2 стороны площадью до 10 м2**	**100 шт.**		**0.37**	**44 526.316**	**16 475**
27. 1.	3000-1003-9	Рабочие-строители (средний разряд 3.9)	чел.ч	313.88	116.1356	42.960	4 989
27. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*45.41*	*16.8017*	*49.970*	*840*
27. 3.	Х02-0129	Краны башенные при работе на других видах строительства (кроме монтажа технологического оборудования) 8 т	маш.ч (1)	45.41	16.8017	298.190 *49.970*	5 010 *840*
27. 4.	Х04-0502	Установки для сварки ручной дуговой (постоянного тока)	маш.ч	28.12	10.4044	15.450	161
27. 5.	Х40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч (1)	2.22	0.8214	303.710	249
27. 6.	С101-1529	Электроды диаметром 6 мм Э42	т	0.05	0.0185	23 560.000	436
27. 7.	С101-0409	Краски для наружных работ: коричневая	т	0.009	0.00333	51 451.011	171
27. 8.	С201-0777	Конструктивные элементы вспомогательного назначения	т	0.106	0.03922	29 040.095	1 139
27. 9.	С402-0004	Раствор готовый кладочный цементный, марка 100	м3	6.53	2.4161	1 787.630	4 319
		Накладные расходы				155%	9 035
		Сметная прибыль				100%	5 829
		Всего с НР и СП					31 339
28.	**С444-1000**	**Плиты покрытий железобетонные**	**м3**		**65.5**	**4 331.585**	**283 719**
29.	**Е07-05-011-10**	**Установка панелей типа "ТТ" площадью до 25 м2**	**100 шт.**		**0.48**	**71 240.216**	**34 195**
29. 1.	3000-1004-1	Рабочие-строители (средний разряд 4.1)	чел.ч	513.93	246.6864	44.100	10 879
29. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*49.01*	*23.5248*		
29. 3.	Х02-1243	Краны на гусеничном ходу при работе на других видах	маш.ч	49.01	23.5248	321.331	7 559

1	2	3	4	5	6	7	8
		строительства (кроме магистральных трубопроводов) до 16 т	(1)				
29. 4.	Х04-0502	Установки для сварки ручной дуговой (постоянного тока)	маш.ч	72	34.56	15.450	534
29. 5.	Х40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч (1)	0.54	0.2592	303.710	79
29. 6.	Х40-0102	Тягачи седельные 15 т	маш.ч (1)	18.73	8.9904	332.189	2 987
29. 7.	Х40-0131	Полуприцепы-тяжеловозы 40 т	маш.ч	18.73	8.9904	89.904	808
29. 8.	С101-1529	Электроды диаметром 6 мм Э42	т	0.01	0.0048	23 560.000	113
29. 9.	С101-9785-1	Ткань для проклейки швов	м2	62.9	30.192	39.028	1 178
29. 10.	С201-0777	Конструктивные елементы вспомогательного назначения	т	0.58	0.2784	29 040.095	8 085
29. 11.	С402-0004	Раствор готовый кладочный цементный, марка 100	м3	2.3	1.104	1 787.630	1 974
		Накладные расходы				155%	16 862
		Сметная прибыль				100%	10 879
		Всего с НР и СП					61 936
30.	**С444-1000**	**Плиты покрытий железобетонные**	**м3**		**51.4**	**4 331.585**	**222 643**
31.	**Е07-01-019-2**	**Укладка в одноэтажных зданиях и сооружениях балок перекрытий(при свободном опирании) массой до 15 т и высоте здания до 25 м**	**100 шт.**		**0.09**	**71 460.141**	**6431**
31. 1.	3000-1003-8	Рабочие-строители (средний разряд 3.8)	чел.ч	153.44	13.8096	42.450	586
31. 2.	*31000-0001*	*Затраты труда машинистов*	*чел.ч*	*26.66*	*2.3994*	*49.970*	*120*
31. 3.	Х02-1244	Краны на гусеничном ходу при работе на других видах строительства (кроме магистральных трубопроводов) 25 т	маш.ч (1)	26.66	2.3994	390.720 *49.970*	937 *120*
31. 4.	Х04-0502	Установки для сварки ручной дуговой (постоянного тока)	маш.ч	11.09	0.9981	15.450	15
31. 5.	Х40-0001	Автомобили бортовые грузоподъемностью до 5 т	маш.ч (1)	4.1	0.369	303.710	112
31. 6.	С101-0797	Катанка горячекатаная в мотках диаметром 6.3-6.5 мм	т	0.0007	0.000063	12 118.140	1
31. 7.	С101-0962	Смазка солидол жировой "Ж"	т	0.0084	0.000756	27 931.396	21
31. 8.	С101-1529	Электроды диаметром 6 мм Э42	т	0.02	0.0018	23 560.000	42
31. 9.	С101-1805	Гвозди строительные	т	0.0003	0.000027	31 142.800	1
31. 10.	С101-0409	Краски для наружных работ: коричневая	т	0.005	0.00045	51 451.011	23
31. 11.	С102-0058	Пиломатериалы хвойных пород. Доски обрезные длиной 4-6.5 м, шириной 75-150 мм, толщиной 32-40 мм IV сорта	м3	0.25	0.0225	2 919.910	66
31. 12.	С401-0086	Бетон тяжелый, крупность заполнителя 10 мм, класс В 15 (М200)	м3	0.7	0.063	1 922.515	121

1	2	3	4	5	6	7	8
		Накладные расходы				155%	1 094
		Сметная прибыль				100%	706
		Всего с НР и СП					3 726

. РАЗОМ ПО КОШТОРИСУ	**5 505 970**
ВАРТІСТЬ ЗАГАЛЬНОБУДІВЕЛЬНИХ РОБІТ -	**5 397 455**
. МАТЕРІАЛІВ -	**4 306 039**
. НАКЛАДНІ ВИТРАТИ -	**185 932**
. КОШТОРИСНИЙ ПРИБУТОК -	**119 838**
УСЬОГО, ВАРТІСТЬ ЗАГАЛЬНОБУДІВЕЛЬНИХ РОБІТ -	**5811740**
ВАРТІСТЬ МЕТАЛЛОМОНТАЖНЫХ РОБІТ -	**121 524**
. НАКЛАДНІ ВИТРАТИ -	**14684**
. КОШТОРИСНИЙ ПРИБУТОК -	**13868**
УСЬОГО, ВАРТІСТЬ МЕТАЛЛОМОНТАЖНЫХ РОБІТ -	**150 076**
. УСЬОГО ПО КОШТОРИСУ	**5 911 740**
УСЬОГО НАКЛАДНІ ВИТРАТИ	**200 616**
УСЬОГО КОШТОРИСНИЙ ПРИБУТОК	**133 706**

6.6. Об'єктний кошторис

Будівельний обсяг будинку – 10886,40 куб.м.

Складена в цінах:

За станом на 1-ий квартал 2021 р.

№ п/п	№ Сметного расчета	Найменування работ и затрат	Сметная стоимость в тыс. грн.					Нормативная трудоемкость, тыс. ч-ч	Сметная з/плата, тыс. грн	Показатели единичной стоимости
			Строительных работ	Монтажных работ	Оборуд., мебели и инвентаря	Прочих затрат	Всего			
1	2	3	4	5	6	7	8	9	10	11
1.	1	**ОБЩЕСТРОИТЕЛЬНЫЕ РАБОТЫ**	10422,59				10422,59	12,38	505,66	0,96
2.		**НЕУЧТЕННЫЕ ОБЩЕСТРОИТЕЛЬНЫЕ РАБОТЫ 15%**	1563,39				1563,39	1,85	75,85	0,14
3.		**САНТЕХНИЧЕСКИЕ РАБОТЫ 10%**	1042,26				1042,26	1,23	50,57	0,10
4.		**ЭЛЕКТРОТЕХНИЧЕСКИЕ РАБОТЫ 5%**		521,13			521,13	0,62	25,29	0,05
		ВСЕГО ПО СМЕТЕ:	13028,24	521,13			13549,37	16,08	657,37	1,25

6.7. Зведений кошторисний розрахунок вартості будівництва

Складений у цінах за станом на 1-й квартал 2021 р.

Таблиця 6.7.1.

№ п-п	Номера смет	Найменування глав объектов, работ и затрат	Сметная стоимость (в тыс.руб)				
			Строительные работы	Монтажные работы	Оборудования, пМалпособлений, мебели и инвентаря	Прочих затрат	Общая сметная стоимость
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Глава 2- Основные объекты строительства							
1	Об.см.1	Цех по производству молокопродуктов	13028,24	521,13			13549,37
		Итого по гл.2	**13028,24**	**521,13**			**13549,37**
Глава 7 –Благоустройство и озеленение территории							
2		Благоустройство территории 3% от общестроительных работ	312,68				312,68
		Итого по главе 7	312,68				312,68
		Итого по главе 2-7	**13340,92**	**521,13**			**13862,05**
Глава 8 –Временные здания и сооружения							
3	ГСН81-05-01-01	Временные здания – 3% .	400,23	15,63			415,86
		Итого по главе 8	**400,23**	**15,63**			**415,86**
Глава 9 – Прочие затраты							
4	ГСН81-05-02-01	Удорожание в зимнее время – 2,3х1,1=2,53%	347,65	13,58			361,23
5	расчет	Подготовка к сдаче объекта 0,5% От общестроительных работ				67,75	67,75
		Итого по главе 9	347,65	13,58		67,75	428,98
		Итого по главам 2-9	**14088,80**	**550,34**		**67,75**	**14706,89**
6	ДБН – 11-01-95	Непредвиденные затраты - 3%	422,66	16,51		2,03	441,20
		Итого	**14511,46**	**566,85**		**69,78**	**15148,09**
		НДС 18%	2612,06	102,03		12,56	2726,65
		ВСЕГО ПО СМЕТЕ	**17123,52**	**668,88**		**82,34**	**17874,74**
		В.т.ч. возврат материалов:					
		1. от разборки временных зданий 15%					62,38

6.8. Calculation of technical and economic indicators

The construction volume of the buildings is 10886.40 m3

Table 6.8.1.

Name of costs	Unit	In the prices of 2021
Total construction cost:	thousand UAH	17,874.74
Including	thousand UAH	17,792.40
Construction and installation works, including:	thousand UAH	10,422.59
General construction works	thousand UAH	1.64
(taken into account)	UAH / hour	8892.91
The cost is 1 m3	thousand h-year	16.08
Production	thousand UAH	657,37

GENERAL CONCLUSIONS

The design of the stage "PROJECT" of the plant for the production of dairy products in the city of cairo was performed in the work.

During the performance of this qualification work according to the task the following tasks are solved:

1. For the designed building the volume - planning and constructive decisions are developed.

2. The analysis of thermal engineering calculation of an inversion roof in comparison with a classical flat design is executed. The advantages of an inversion roof over a classical flat roof are received, and also constructive decisions of inversion roofs are analyzed.

3. The transverse frame of the production part of the building is calculated, where the static calculation is performed and the calculated forces in the frame elements are determined.

4. According to the obtained efforts, the calculation and construction of the column K8, the foundation FM-1 and the coating plate P-14 were performed.

5. On the basis of the given engineering-geological conditions the area of a sole of the base, depth of laying of the base, the calculated sediment, and then its comparison with admissible, concerning the next columns received.

6. Developed a technological map for the installation of structures of the production part in the axes 3-11.

7. The calculation of harmful emissions from vehicles, painting and welding.

8. Measures have been developed to increase the sustainability of electricity, water and gas supply of the building in terms of the use of nuclear weapons.

9. The necessary design and estimate documentation has been completed, local estimates for general construction works have been calculated; for internal sanitary and electrical work; for the purchase of inventory, equipment and its installation; calculated object estimate №1. The calculation of the contract price of construction of the object is performed and the estimated calculation of the construction cost is summarized.

10. Technical and economic indicators of the project were:

The area of the projected part of the building is 2268 m2

Estimated cost of construction - 4 million 145 thousand UAH.

The contract price for the construction of the facility is UAH 4 million 178 thousand.

The cost of construction of 1 m2 - 1843 UAH.

The average salary of workers is - 489 UAH. per day.

LIST OF LITERATURE

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14. DBN B.2.6-160: 2019. Constructions of buildings and structures. Reinforced concrete structures.
15. DBN B.2.6-161: 2019. Constructions of buildings and structures. Wooden structures.
16. DBN B.2.6-162: 2019. Constructions of buildings and structures. Stone and reinforced stone structures.

17. DBN B.2.6-163: 2019. Steel structures. Standards of design, manufacture and installation.
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32. DBN B.2.6-14-97. Covering of buildings and structures. (Volumes 1, 2, 3).
33. DBN B.2.6-22-2001. Arrangement of coverings with application of dry construction mixes.
34. DBN B.2.6-31: 2006. Constructions of households and buildings. Thermal insulation of buildings.
35. DBN B.2.6-33: 2008. Constructions of housedolds and buildings. Constructions of external walls with front thermal insulation. Requirements for design, installation and operation.
36. DBN B.1.1-24: 2009. Protection against dangerous geological processes. Basic design provisions.
37. DSTU B D.1.1-1: 2013 Rules for determining the cost of construction
38. DSTU-N B B.2.6-192: 2013 Guidelines for the estimated assessment of thermal and moisture condition of enclosing structures.
39. DSTU B A.2.4-4: 2009 Basic requirements for design and working documentation
40. DSTU B A.3.1-22: 2013 Determination of the duration of construction of facilities.
41. DSTU-N B D.1.1-2: 2013 Guidelines for determining direct costs in the cost of construction.
42. DSTU B B.2.6-8-95 Building structures steel profiles bent closed welded square and rectangular.
43. DSTU B B.2.6-189: 2013 Methods of selection of thermal insulation material for building insulation.
44. DCTU-N B B.1.2-16: 2013 Definition of the class of consequences (responsibility) and the category of complexity of construction objects.
45. DSTU B B.1.1-36: 2016 Definition of categories of premises, buildings, installations on explosion and fire danger.
46. Project DSTU-N B B.1.2-16 Determining the class of consequences of buildings and structures.

47. DSTU B B.2.6-205: 2015 Guidelines for the design of monolithic concrete and reinforced concrete structures of buildings and structures.
48. DSTU B B.2.5-38: 2008 Arrangement of lightning protection of buildings and structures
49. DSTU A.2.2-12: 2015 Energy efficiency of buildings.
50. DSTU 4163-2003 Requirements for registration of documents.
51. DSTU 8302: 2015 Information and documentation. Bibliographic link.
52. DSTU B B.2.8-44: 2011 Sites and stairs for construction m.

APPENDIX A.
GRAPHIC PART

APPENDIX B.
STATEMENT OF QUALIFICATION MATERIALS

№	Format	Marking	Name	Number of sheets	Note
1	A4		Title page of the work	1	
2	A4		TASKS for qualifying work	1	
3	A4		ABSTRACT for qualification work	2	
4	A4		Explanatory note		
5	A1	A	Graphic part		
6	A4	B	Statement of qualification materials	1	
7	A4	C	Feedback from the head	1	

APPENDIX C.
FEEDBACK FROM THE HEAD

"Milk plant in Cairo City (Egypt)" by students of the group 192-17-ICAbdelhafez Mohamed Ashraf Mohamed 192 "Construction and Civil Engineering".

Diploma project Abdelhafez Mohamed Ashraf Mohamed is devoted to the design of a Milk plant in Cairo City (Egypt).

Prefabricated reinforced concrete industrial buildings are currently in the 2nd wave of relevance, so the selected object for the diploma work is relevant, and research in the field of inversion roofs is a promising direction.

The content and its compliance meet higher education standards and NQF descriptors.

The obtained results are not innovative enough for the world scientific community, but their systematization and actualization on the Ukrainian realities of construction are quite significant.

The practical significance of the obtained results will allow the contractor to better understand the latest construction technologies.

It is especially necessary to note quality of registration of work - excellent.

However, the diploma project has the following remarks:

a) sheet 3:

- there is no binding of doorways;
- Incorrect image name "Plan scheme for 0.000";

b) sheet 5:

- incorrect name of schemes of arrangement of designs;
- in the notes it is specified as material C255, and in "Sheets of elements" this steel is absent;

c) sheet 7 - incorrect letter name.During the implementation of the diploma project student Abdelhafez Mohamed Ashraf Mohamed and demonstrated the ability to work with normative literature, skills of work in modern software complexes used in the field of construction.

The work is done competently and at a high level, and with the appropriate protection **deserves a score of "good - 80 points",** and Abdelhafez Mohamed Ashraf Mohamed - awarding a bachelor's degree in Constructionand Civil Engineering.

Ph.D., Associate Professor of
Construction, Geotechnics and
Geomechanics Department

Nechytailo O.Ye.