MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
FACULTY OF ARCHITECTURE, CIVIL ENGINEERING AND DESIGN
COMPUTER TECHNOLOGIES OF AIRPORT CONSTRUCTION AND
RECONSTRUCTION DEPARTMENT

TO ADMIT TO GUARD

Head of the Department

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BACHELOR THESIS

(EXPLANATORY NOTE)

SPECIALTY 192 «BUILDING AND CIVIL ENGINEERING»

Educational and professional program: «Industrial and civil engineering»

Theme: **Children's leisure center in Lutsk**

Performed by: ______________________ Rafik Seif Essam

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Kyiv 2022

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
ФАКУЛЬТЕТ АРХІТЕКТУРИ, БУДІВНИЦТВА ТА ДИЗАЙНУ
КАФЕДРА КОМП'ЮТЕРНИХ ТЕХНОЛОГІЙ БУДІВНИЦТВА ТА РЕКОНСТРУКЦІЇ АЕРОПОРТІВ

ДОПУСТИТИ ДО ЗАХИСТУ

Завідувач випускової кафедри

_______ О.І. Лапенко

"7" ___06___ 2022 р.

ДИПЛОМНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ БАКАЛАВРА

ЗА СПЕЦІАЛЬНІСТЮ 192 «БУДІВНИЦТВО ТА ЦИВІЛЬНА ІНЖЕНЕРІЯ»

ОСВІТНЬО-ПРОФЕСІЙНА ПРОГРАМА

«ПРОМИСЛОВЕ І ЦИВІЛЬНЕ БУДІВНИЦТВО»

Тема: «Центр дитячого дозвілля у м. Луцьк»

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Київ 2022

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Факультет архітектури, будівництва та дизайну
Кафедра комп'ютерних технологій будівництва та реконструкції аеропортів
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Освітньо-професійна програма: «Промислове і цивільне будівництво»

ЗАТВЕРДЖУЮ
Завідувач кафедри
________ О.І. Лапенко
« 13 » / 04 2022 р.

ЗАВДАННЯ
на виконання дипломної роботи

РАФІК Сейф Ессам Мохамед Сабрі
(П.І.Б. випускника)

1. Тема роботи «Центр дитячого дозвілля у м. Луцьк»
затверджена наказом ректора від «13» квітня 2022р. № 379/ст.

2. Термін виконання роботи: з «23» травня 2022р. по «19» червня 2022р.

3. Вихідні дані роботи: план та переріз житлового будівлі центру дитячого дозвілля, навантаження відповідно до ДБН В.1.2-2:2006 «Навантаження та впливи».

4. Зміст пояснювальної записки:
Вступ, аналітичний огляд, архітектурно-планувальна частина, розрахунково-конструктивна частина, технологічно-організаційна частина, висновки, список використаних джерел.

5. Перелік обов'язкового ілюстративного матеріалу: таблиці, рисунки, діаграми, графіки не менше 4-х креслень та 4-х слайдів:

-фасади, план типового поверху, експлікації

- креслення конструкції, специфікації елементів

-технологічно-організаційні схеми виконання основних будівельних процесів

Content

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1. Architectural and construction chapter

1.1. Characteristics of the area and construction site

The building is located in Lutsk, Volyn’ region.

The temperature regime of the building is characterized:

- Climatic area - II B;
- Average temperature in June -5.8 °C;
- Average temperature of June - 18.3 °C;
- Monthly precipitation - 638 mm;
- Wind speed - 38 kg/m2;
- Weight of snow cover - 50 kg/m2;
- Depth of freezing of the soil - 0.8 m.
- Intrinsic pressure - 470 kPa;
- Snow load - 1360 kPa.

The relief of the construction site is flat, fluctuations of relative marks are insignificant. There is no surface water on the site. Ground water is encountered at a depth of 4 m from the ground surface.

Construction of the facility will be carried out by local workforce.

1.2. Rationale for the adopted construction option

The analysis of the operation of frame buildings shows that, regardless of the number of stories, they have sufficient strength and stability in the presence of a system of vertical longitudinal and transverse, as well as horizontal diaphragms. In frameless buildings, their strength and stability are related to the design solution of the node connections of the plates and bearing walls. Framed systems with the use of prestressed structures, including the subsequent tensioning of slabs at the installation stage, are also a promising solution in terms of satisfying the reliability, cost-effectiveness, manufacturability, architectural expressiveness.

Now the most widespread are two types of floors - solid and hollow. In this case, the support of the floor slabs on the brick walls shall be not less than

120 mm. The reliability of the supporting sections of the flooring, both for the perception of the vertical statistical and horizontal dynamic loads can be achieved by the introduction of the flat welded frameworks in the hollows and their subsequent monolithing for the length of the frameworks installation in them. In practice, the method of hardening of horizontal diaphragms (hollow floor slabs) is used - the arrangement of widened to 140 mm gaps between the precast elements, into which flat welded frames or separate bars are inserted. The gaps are filled with the fine aggregate concrete with vibration. Concrete compressive strength class of not less than C 8/10.

When selecting the types of concrete for the monolithing should be based on compliance with the requirements of their minimum shrinkage. Otherwise, cracks will develop in the contact areas during the operation of the buildings. As a result, the stiffness of the horizontal diaphragm in its plane can be significantly reduced. The best solution to the problem is the use of expanding cements.

1.3. Selection of basic construction materials, products and structures

The following construction materials are used to erect the building:

- precast reinforced concrete pads are used as foundations;
- basement walls - made of concrete blocks;
- external bearing walls are made of ordinary clay bricks on cement-sand mortar;
- columns are made monolithic;
- partitions - brick on the ground floor, reinforced ½ brick, on the other floors of plasterboard;
- overlap and cover are made of precast concrete slabs;
- window and door openings are covered with precast reinforced concrete lintels;
- lumber is used for the pitched roof, metal sheeting is used as a roll roofing material;

- windows - metal-plastic Rehau five-chamber profile and double glazing;
- doors - metal-plastic blank doors;
- flooring: linoleum on the cement screed, ceramic tiles, waterproofing - ruberoid, soundproofing - soft fiberboard, poured floors in the corridors and hallway;
- exterior finish - facing brick
- interior decoration - plaster, and then paint, tile.

1.4. Master Plan

The site has a rectangular shape, size in plan 30x25 (m). To the main winds the building is located at an angle of 45 degrees. The gap with the existing buildings - in accordance with the fire and sanitary standards. The building is located so that the central entrances to the center are on the side of the main street.

The scheme adopted in the project landscaping of the Children's leisure center site provides favorable conditions for stay and recreation of citizens. The area adjacent to the house provides for pedestrian paths and sidewalks with an asphalt surface; a temporary parking area; and a recreation area. The territory also provides elements of landscaping: sowing grass, shrubs, trees, from the side of the main street - flower beds.

Table 1.1. Technical and economic indicators of the master plan

№	**Name**	**Unit**	**Number**
1	Site area	m^2	980
2	Building area		360
3	Building density		12,44
4	Concrete pavement area		91
5	Landscaping area		520

1.5. Space-planning and constructive solution

The projected building has a one-section scheme. Entrance to the building is through the vestibule. The building has non-smoke staircases, which are accessed from each floor through the air zone.

The building is equipped with external fire stairs, there is an emergency exit from the basement, external water drainage and all necessary types of engineering equipment and communications. The building is designed technical attic.

On the ground floor are located ping pong room and weightlifting room.

On the first floor there is a gym, a locker room with showers.

The second floor is a dining room and billiard room.

The third floor with six rooms for rehabilitation.

The building is founded on strip footings of prefabricated reinforced concrete blocks. Walls of the basement - from large concrete blocks.

The foundations of the columns are monolithic.

The foundations are one of the most critical parts of the building. The overall strength, stability and deformability of the building largely depend on its durability and stability. Strap foundations of concrete blocks are used for the exterior walls. For the columns of the building, foundations of the glass type are used.

The foundations are erected on the soil levelled and compacted with crushed stone.

Exterior and interior walls are made of ordinary clay bricks.

Partitions - precast gypsum concrete.

The partitions are made with gypsum plasterboard cladding. These self-supporting partitions can be used for enclosing the premises with normal temperature and humidity conditions and relative air humidity up to 75%. The construction of partitions consists of a frame made of wooden beams or steel profiled strips clad with gypsum plasterboards. Depending on the requirements for sound insulation, the partition walls are made with an air space between the facing sheets or filled with semi-rigid mineral wool or glass wool boards up to 80 mm thick with a density of up to 125 kg/m3. Gypsum plasterboard partitions are classified as slow-burning structures with a flame spread of up to 20 cm in 1 hour.

In the performance of partition walls with a wooden frame, posts of 50x40 mm cross-section bars are fastened to the lower and upper guide bars with a spacing of 600 mm. This creates a partition frame that is clad with cladding sheet.

In the performance of partitions with a steel frame in the form of studs and lower and upper horizontal elements (bent profiles of coiled thin-gauge galvanized steel sheet 0.5-0.6 mm thick), the frame elements and plasterboard partition walls are fastened to one another with self-drilling screws. Fasten the horizontal bottom and top elements of the frame to the flooring panels with plugs. Put gaskets of gernite between the partition structure and the ceiling.

The range of prefabricated partitions for public buildings with typical storey height of 3.6 m contains timber frame panels with sound-insulating properties of 35-42 dB, covered with dry gypsum plaster layers of 0.6-1.2 m and thickness of 104 mm.

The joints of the prefabricated panels of gypsum plasterboard partitions are puttyed with synthetic non-shrinking putty and pasted with fabric or paper tapes.

Surfaces of partitions should be ready for painting or tiling with tiles and other piece materials. When finishing external and internal corners of partitions, PVC strip and corner overlays are used. Surfaces of gypsum board partitions are finished with PVC films, decorative and finishing self-adhesive films, glue-based water emulsion paints and enamels and synthetic paints.

Electrical wiring in gypsum board partitions is placed in the body of the partition or in electrical plinths. Through-holes in the partition are not allowed.

Mount the gypsum board partitions after the overhead floor panel has been installed.

Gypsum plasterboard is produced from gypsum binder with mineral additives and cardboard sheets in 2.5-4.8 m length, 0.6 and 1.2 m width and 8-25 mm thickness. The average density of the sheets is 850-950 kg/m^3, humidity 1%. The strength of the sheets depends on their thickness: 8-mm-thick sheet has a strength of 2.5 KPa, 25-mm-thick - 5.2 KPa.

Ceilings and coverings are of precast concrete hollow-core slabs.

Stairs are of precast reinforced concrete marshes and platforms.

Floors - boarded, linoleum and ceramic tiles.

Attic roof, roofing - metal tile. Attic not exploited.

Roofs provide the perception of loads, protection from rainfall, the necessary thermal protection and is the architectural elements, crowning civilian buildings. Of particular importance are the quality and durability of the roofs. By design it is a rafter roof with a roof made of metal. As a heater covers use mineral wool slabs with a density of γ = 300 kg/m^3. The thickness of the insulation layer 40 mm.

Stairs are designed fully assembled. The stairs within a storey are divided into four prefabricated elements - two flights of stairs and two (storey and intermediate) staircases. Ribbed design marshes with fascia steps are used.

Outer walls and covering are insulated with a rigid mineral wool board.

The structural scheme is adopted with monolithic reinforcements - ties. The stiffness of the precast concrete overlaps and coatings is ensured by:

- connecting the floor and ceiling panels and filling the joints between the panels with cement mortar;

- providing connections between the panels and the elements of the frame or walls, to absorb tensile and shear forces arising in the joints.

The side edges of the floor and roof panels have the embossed surface. For the connection with the anti-seismic belt (or for the connection with the framing elements in the panels), reinforcement or embedded pieces are provided.

In brick and stone buildings, the length of the part of the floor panels resting on the load-bearing walls is not less than 120 mm.

Bearing elements, i.e. partition walls, shall be lightweight (gypsum concrete panels).

Masonry walls are made in the warm season with cement-lime mortar. The distance between the axes of the transverse walls is 6.64 m, and does not exceed the allowable values.

Reinforcement belts shall be installed in all the longitudinal and transverse walls, made of monolithic reinforced concrete, at the level of floors and ceilings. The upper floor belts shall be connected to the masonry by vertical releases of reinforcement.

The reinforcement belt has a longitudinal reinforcement - 6 A240, diameter 10 mm. In the wall junctions, reinforcing grids of longitudinal reinforcement of a total area of not less than 1 cm^2, 1.5 m long by 700 mm in height shall be laid in the masonry.

Lintels shall be arranged to the full thickness of the wall and embedded in the masonry to a depth of at least 350 mm. If the width of the opening is up to 1.5 m, the lintel is allowed to be embedded up to 250 mm.

1.6. Exterior and interior trim

The facades of the building are equipped with a system of hinged panels. The plinths and side walls of the porches are lined with ceramic tiles measuring 250 x 250 mm.

The metal elements of the facades - handrails and fences are painted black.

Fences loggia - metal.

Carpentry - windows, doors are painted with oil paints.

The bottom surface of the loggia slab is painted white with silicate or PVC paint.

Visor entrance plastic sheets on the metal frame.

The steps of the entrance and porch cover - mosaic.

For internal finishing brick walls are plastered, partitions are prepared for pasting or painting, joints of panels on the ceilings are expanded with cement mortar.

Ceilings in all rooms and walls above the oil panels - adhesive whitewash.

The inner surface of the walls of the stairwell is made of tile. Flooring in the living rooms boarded on the floorboards, in kitchens - from linoleum, in the bathrooms - ceramic tiles.

Inside windows and doors are painted white with oil paint, entrance doors to apartments are veneered.

Staircase railings are painted black with oil paints or nitrolacquers.

The walls of the control room - oil paint on the entire height, the floor is cement.

1.7. Thermal calculation of cover and wall

The roof structure consists of a reinforced concrete slab, vapor barrier and insulation.

Prefabricated reinforced concrete slab:

R = 0.181 m^2*°C /Wt

Vapor barrier:

λ = 0,17 Wt / m °C.

R = 0,0147 m^2*°C /Wt

Insulation:

$$R = \frac{X}{0.042}$$

Heat transfer resistance of the building envelope:

$$\boldsymbol{Ro = \frac{1}{\alpha i} + R\kappa + \frac{1}{\alpha o}}$$

$$Ro = \frac{1}{8.7} + 0.181 + 0.0147 + \frac{X}{0.042} + \frac{1}{12} = 3.48$$

X = 0.13 m.

We take the thickness of insulation X = 15 cm.

The building envelope is made of 510 mm thick brick and insulation - rigid mineral wool board.

The moisture regime is dry.

Degree-days of the heating period (DDHP):

DDHP = $(t_i - t_{hp})\ z_{hp}$.,

where, t_i = 20 °C – indoor air temperature;

t_{hp}= -9,5 средняя температура, °C;

z_{hp}= 226 – duration, daily period with an average daily air temperature below or equal to 8°C.

DDHP = [20 - (-9,5)] 226 = 6667 (°C·d).

By interpolation we determine the heat transfer resistance of the enclosing structures:

R_o^n = 3,73 (m^2 *°C / Wt) – for walls,

R_o^n = 5,53 (m^2 *°C / Wt) – for the attic floor.

Masonry:

λ = 0,70 (Wt / m. °C).

Insulation board:

λ = 0,042 (Wt / m. °C).

Plastering layer - cement-sand mortar:

λ = 0,76 (Wt / m °C).

Heat transfer resistance of the building envelope:

$$\boldsymbol{Ro = \frac{1}{\alpha i} + R\kappa + \frac{1}{\alpha o}}$$

where, α_i = 8,7 Wt / (m^2*°C) – heat transfer coefficient of the internal surface of the enclosing structure;

$R_к$ – thermal resistance of the building envelope, m^2*°C/Wt;

α_o = 23 Wt / (m^2*°C) – heat transfer coefficient (for winter conditions) of the outer surface of the enclosing structure;

$$Ro = \frac{1}{8.7} + \frac{0.51}{0.7} + \frac{X}{0.042} + \frac{0.03}{0.76} + \frac{0,008}{0,3} + \frac{1}{23} = 3.73$$

$$0.115 + 0,914 + \frac{X}{0.042} + 0.04 + 0,027 + 0.043 = 3.73$$

X = 0,11 m.

We take the thickness of insulation X = 12 cm.

2. Calculation and construction section

2.1. Calculation of the multi-core slab panel

The precast reinforced concrete multi-hollow floor panel is calculated. Brand of panel PC-60.12, concrete grade C12/15, prestressed reinforcement class A500C, the method of prestressing - electro-thermal, the consumption of concrete 1.18 m^3 steel consumption 44.96 kg, mass of the panel 2.95 tons, nominal length 5.98 m, width 1.19 m, height 0.22 m.

Table 2.1. Loads on the prefabricated intermediate floor

Type of load	Normative loads, N/m^2	Load factor, γ_f	Design loads, kN
Constant loads			
Soundproofing layer of fiberboard δ=0,035 m; ρ=250 kg/m^3	88	1.1	97
1 layer of parchment δ=0,005 m; ρ=600 kg/m^3	30	1.1	33
screed of cement-sand mortar δ=0,07 m; ρ=2400 kg/m^3	1680	1,3	2148
mastic δ=0,01 m; ρ=1400 kg/m^3	140	1.1	154
linoleum on a thermal protection base δ=0,003 m; ρ=1100 kg/m^3	33	1.1	36
reinforced concrete panel own weight	3000	1.1	3300

Total	4971		5804
Temporary loads			
short-term long-term	1200 300	1.3 1.3	1560 390
Total	6471		7399

The design span of the panel we take equal to the distance between the axes of its supports 5980-120=5860 mm.

The following loads, N/m, apply to 1 m of the length of a 1.2 m wide panel:

- short-term normative $p^n = 1200 \cdot 1{,}2 = 1440$
- short-term design $p = 1560 \cdot 1{,}2 = 1872$
- permanent and long-term normative $q^n = 5271 \cdot 1{,}2 = 6325$
- permanent and long-term design $q = 6194 \cdot 1{,}2 = 7433$
- normative total $q^n + p^n = 6325 + 1440 = 7765$
- total design $q + p = 7433 + 1872 = 9305$

Design bending moment from full load

$$M = \frac{(q+p)l_0^2\gamma_n}{8} = \frac{9305 \cdot 5{,}86^2 \cdot 0{,}95}{8} =$$

$$= 37944 \text{ Nm}$$

Calculated bending moment from the full standard load (to calculate deflections and cracking resistance) at $\gamma_f = 1$

$$M^n = \frac{(q^n + p^n)l_0^2\gamma_n}{8} = \frac{7765 \cdot 5{,}86^2 \cdot 0{,}95}{8} =$$

$$= 31664 \text{ Nm}$$

Calculated bending moment from the standard permanent and long-term temporary loads

$$M_{ld} = \frac{q^n l_0^2 \gamma_n}{8} = \frac{6325 \cdot 5{,}86^2 \cdot 0{,}95}{8} =$$

$$= 25792 \text{ Nm}$$

Calculation bending moment from the standard short-term load

$$M_{cd} = \frac{p^n l_0^2 \gamma_n}{8} = \frac{1440 \cdot 5{,}86^2 \cdot 0{,}95}{8} =$$

= 5872 Nm

Maximum shear force on the support from the design load

$$Q = \frac{q l_0 \gamma_n}{2} = \frac{9305 \cdot 5{,}86 \cdot 0{,}95}{2} =$$

= 25900 N

Maximum shear force on the support from the standard load

$$Q^n = \frac{(q^n + p^n) l_0 \gamma_n}{2} = \frac{7765 \cdot 5{,}86 \cdot 0{,}95}{2} =$$

= 21614 N

$$Q_{ld} = \frac{q^n l_0 \gamma_n}{2} = \frac{6325 \cdot 5{,}86 \cdot 0{,}95}{2} =$$

= 17606 N

For the manufacture of the panel adopted:

concrete class C12/15

$E_b = 20{,}5 \cdot 10^3 (МПа),\ R_b = 8{,}5 (МПа),\ \ R_{bt} = 0{,}75 (МПа),\ \ \gamma_{b2} = 0{,}9$;

longitudinal reinforcement of steel class A500C

$R_S = 680 (МПа),\ \ E_S = 190000 (МПа)$

transverse reinforcement of A240C steel with a diameter of 5 mm

$R_S = 410 (МПа),\ \ \ R_{SW} = 260 (МПа)$

welded meshes of A240C steel with a diameter of 4

$R_S = 410 (МПа),$ mm

Design the panel as a six-core. In the calculation, the cross-section of the hollow panel is reduced to an equivalent cross-section. We replace the area of circular voids with rectangles of the same area and the same moment of inertia. Calculate:

$$h_1 = 0{,}9d = 0{,}9 \cdot 15{,}9 = 14{,}3 (см);$$

$$h_f = h'_f = \frac{(h - h_1)}{2} = \frac{(22 - 14.3)}{2} = 3{,}85 (см);$$

specified thickness of ribs

$b = 116 - 6 \cdot 14{,}3 = 30{,}2(см)$

design width of the compressed flange

$b'_f = 116(см)$

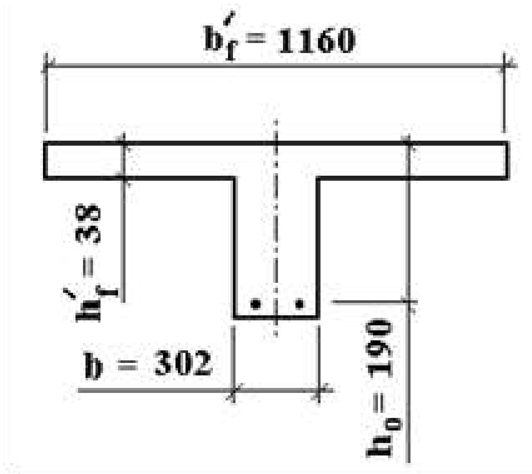

Fig. 2.1. The reduced cross-section of the slab

Calculate the cross-sectional area of the stretched reinforcement:

$$A_S = \frac{M}{\gamma_{S6} R_S \eta h_0} = \frac{3794400}{1{,}15 \cdot 680(100) \cdot 0{,}94 \cdot 19} = 2{,}71(см^2)$$

Structurally, we accept 4 ∅ 12 A500C

$R_S = 4{,}52(см^2)$

Calculation of the strength of the panel in an oblique section:

$Q = 25900(H)$

We check the strength condition for the sloping strip between the sloping cracks

$Q = 25900 \le 0{,}3 \varphi_{W1} \varphi_{b1} R_b \gamma_{b2} b h_0$

$Q = 25900 \prec 0{,}3 \cdot 1 \cdot 0{,}92 \cdot 8{,}5 \cdot 0{,}9 \cdot (100) \cdot 30{,}2 \cdot 19 = 121152(H)$

the condition is satisfied, the size of the cross-section of the panel is sufficient.

Calculate the projection of the calculated inclined section on the longitudinal axis. Effect of compressed flange overhangs (at 7 ribs):

$$\varphi_f = 7 \cdot \frac{0{,}75(3h'_f)h'_f}{bh_0} = 7 \cdot \frac{0{,}75 \cdot 3 \cdot 3{,}8 \cdot 3{,}8}{30{,}2 \cdot 19} = 0{,}4 \prec 0{,}5$$

In the ribs we constructively install frameworks made of reinforcement ∅ 5 of class A240C. According to the structural requirements at h ≤ 450 mm in the supporting section $l_1 = l \ /4 = 628/4 = 157(см)$ rod pitch $S = h/2 = 22/2 = 11(см)$

In the middle half of the panel, the cross bars can be omitted, limiting their placement only in the supporting sections. To ensure the strength of the panel flanges under the local loads, within the voids in the upper and lower zones of the cross-section, there are C - 1 and C - 2 meshes made of reinforcement of class A240C ∅ 4 mm.

Calculation of the strength of the inclined section on the bending moment action is carried out by the condition

$$M = Q \cdot c \leq \sum R_{SP} A_{SP} z_{SP} + \sum R_{SW} A_{SW} z_{SW}$$

where M - the moment from the external load located on one side of the considered inclined section, relative to the axis perpendicular to the plane of moment action and passing through the point of application of the force equalization in the compressed zone;

$\sum R_{SW} A_{SW} z_{SW}, \sum R_{SP} A_{SP} z_{SP} -$ the sum of moments relative to the same axis, respectively, from the forces in the clamps and longitudinal reinforcement;

$z_{SW}, z_{SP} -$ distances from the planes of the clamps and longitudinal reinforcement.

$$\sum R_{SW} A_{SW} z_{SW} = 0{,}5 q_{SW} c^2 = 0{,}5 \cdot 50{,}96 \cdot 0{,}38^2 = 3{,}67(кН \cdot м)$$

$$M = 25{,}90 \cdot 0{,}38 = 9{,}84(кН \cdot м) \prec 680 \cdot 10^3 \cdot 4{,}52 \cdot 10^{-4} \cdot 0{,}184 + 3{,}67 = 60{,}22(кН \cdot м)$$

The bending moment strength of the inclined section is ensured.

Calculation of the panel according to the limit of the second group.

Determine the geometric characteristics of the reduced section:

$$\alpha = E_S / E_b = 190000/20500 = 9{,}27 \ ; \ \alpha A_{SP} = 9{,}27 \cdot 4{,}52 = 41{,}9(см^2)$$

The area of the reduced section:

$$A_{red} = A + \alpha A_{SP} + \alpha A'_{SP} + \alpha A_S + A'_S$$

$$A_{red} = 116 \cdot (3{,}8 + 3{,}8) + (22 - 7{,}6) \cdot 30{,}2 + 41{,}9 + 8{,}29 \cdot 1{,}5 \cdot 2 = 1383(см)$$

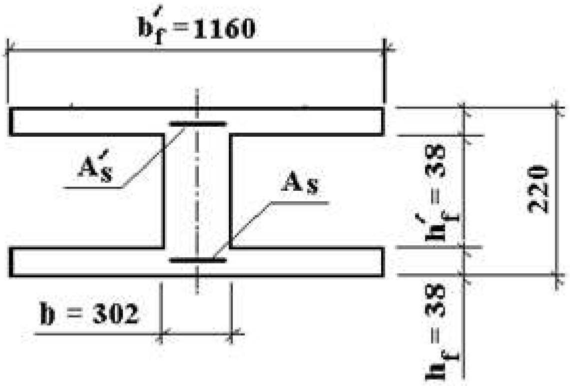

Fig. 2.2. Design cross-section of the plate

The moment of inertia of the reduced section relative to the center of gravity

$$I_{red} = I + \alpha A_{SP} y_1^2 + \alpha A'_{SP} y_1'^2 + \alpha A_S y_2^2 + A'_S y_2^2$$

$$I_{red} = \frac{116 \cdot 3.8^2}{12} + 116 \cdot 3{,}8 \cdot 9{,}1^2 + \frac{116 \cdot 3{,}8^2}{12} + 116 \cdot 3{,}8 \cdot 9{,}1^2 + \frac{30{,}2 \cdot 14{,}4^3}{12} + 45{,}9 \cdot 14{,}4 \cdot 0^2 +$$

$$+ 41{,}9 \cdot 8^2 + 8{,}29 \cdot 1{,}5 \cdot 8^2 + 8{,}29 \cdot 1{,}5 \cdot 8^2 = 77593(см^4)$$

Moment of resistance for the tensile face of the section:

$$W_{red}^{\inf} = I_{red} / y_0 = 77593/11 = 7054(см^3)$$

the same, along the compressed face of the section:

$$W_{red}^{\sup} = I_{red} /(h - y_0) = 77593/11 = 7054(см^3)$$

Distance from the core point furthest from the tensile zone (top) to the center of gravity of the reduced section:

$$r^{\sup} = \varphi_n (W_{red}^{\inf} / A_{red}) = 0{,}8(7054/1383) = 4{,}08(см)$$

$$\varphi_n = 1{,}6 - \sigma_b / R_{b,ser} = 1{,}6 - 0{,}75 = 0{,}85;$$

the same, the farthest from the stretched zone (bottom)

$$r^{\inf} = \varphi_n (W_{red}^{\sup} / A_{red}) = 0{,}8(7054/1383) = 4{,}08(см)$$

2.1. Calculation of the solid frame

Collecting loads

I. Constant loads:

Loads on frame struts from roof:

On the columns:

P_n= 0.55*4*4.5=10 kN

P_r=10*1,1=11 kN

Loads on the frame beams from the floor slabs:

On the transoms of the upper floors:

Q_n= 8,32*4,5=37,44 kN

Q_r=9,52*4,5=42,84 kN

Loads on the basement floor from the basement floor structure:

On the basement floor:

q_n= 0.2*24*4.5=19.64 kN/m

q_p=19,64*1,1=21,6 kN/m

II. Temporary loads:

Loads on the frame struts from the roof:

On the columns:

R_n= 1*6*4,5=22,9kN

P_r=22,9*1,1=25,2kN

Loads on the frame beams from the roof slabs:

On the transoms of the upper floors:

Q_n= 4*4,5=18kN

Q_r=4.8*4.5=21.6kN

Loads on the basement floor from the basement floor structure:

On the basement floor:

q_n= 2*4,5=8,2kN/m

q_p=8,2*1,1=9 kN/m

III. Overall loads

Loads on the frame struts from the roof:

On the columns:

R_n= 15.3+10=25.3kN

P_r=16,8+11=27,8kN

Loads on the frame beams from the roof slabs:

On the transoms of the upper floors:

Q_n= 18+37,44=55,44kN

Q_p=21,6+42,84=64,44кН

Loads on the basement floor from the basement floor structure:

On the basement floor:

q_n= 8.2+19.64=27.84kN/m

q_p=9+21,6=30,6kN/m

Internal frame forces are determined by finite element modeling methods.

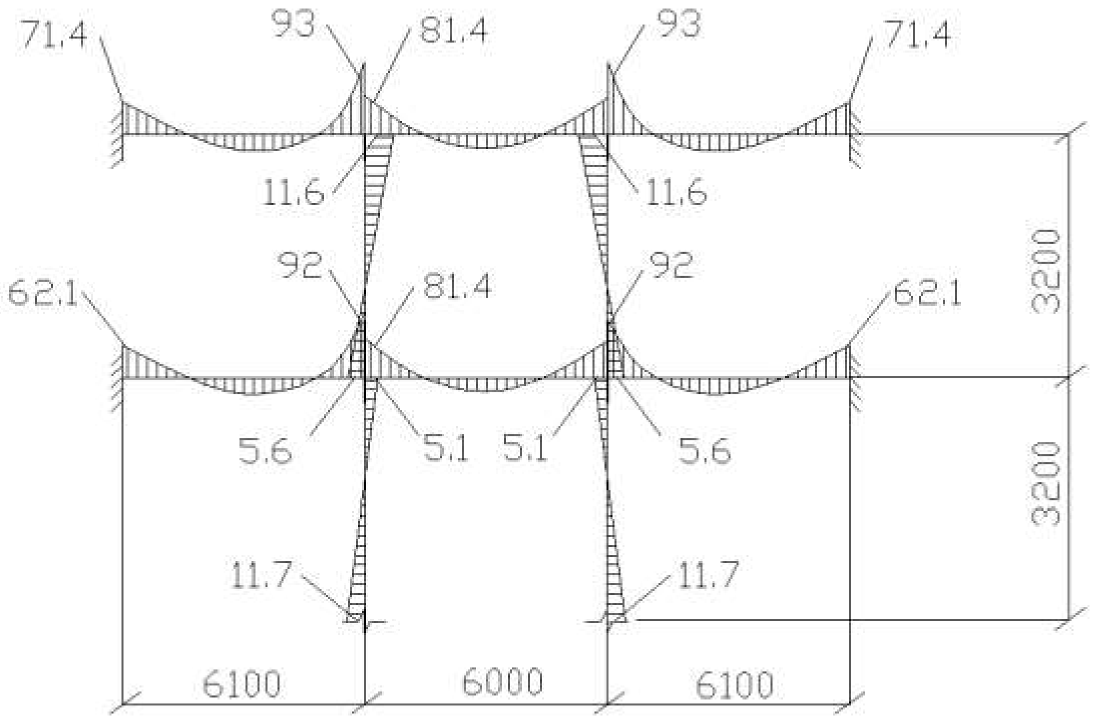

Fig. 2.3. Frame internal force diagram

Stand calculation

For the selection of reinforcement, we take two sections with the maximum longitudinal force and with the maximum bending moment.

Element cross-section sizes b = 400 mm, h = 400 mm; a = a' = 40 mm; heavy class concrete C20/25 (E_b = 2.7 · 10^4 MPa); symmetrical reinforcement class A400C (R_s = R_{sc} = 365 MPa; E_s = 2 · 10^5 MPa); longitudinal forces and bending moments: from the loads N = 156.8 kN, M = 55.76 kN-m; rated length l_0 = 3.6 m.

h_0 =400 – 40 = 360 mm

Determine the relative eccentricity:

$$e_o = \frac{M}{Nh} = \frac{55,76}{156,8 \cdot 0,4} = 0,89 > 0,3$$

l_0/h = 360/40 = 9 < 10

It means that the section works with high eccentricity.

Determine the moment of force N relative to the axis of the stretched reinforcement by the formula:

$$Ne = M + N\frac{h_0 - a'}{2} = 55,76 + 156,8\frac{0,36 - 0,04}{2} = 80,85 \text{ kNm;}$$

Determine the cross-sectional area of the compressed reinforcement by the formula:

$$A_s^/ = \frac{Ne - 0,4bh_o^2R_b}{R_s(h_o - a)} = \frac{80,85 - 0,4\cdot 0,4\cdot 0,36^2\cdot 16\cdot 10^3}{365\cdot 10^3(0,36 - 0,04)} < 0$$

We put compressed reinforcement for structural reasons with a minimum percentage of reinforcement $\mu^/ = 0,2\%$. We accept 2 Ø 20 with A_s=6,28 cm^2

The area of the tensile reinforcement is determined by the formula:

$$A_s = \frac{0,55bhR_b - N}{R_s} = \frac{0,55\cdot 0,4\cdot 0,36\cdot 16\cdot 10^3 - 156,8}{365\cdot 10^3} = 24,60 см^2$$

We accept 4 Ø 32 with A_s=24,63см^2

Calculation of the column cross-section on the action of transverse forces

Check the strength of the inclined section for the action of shear force along the inclined crack is carried out from the condition

$$Q \le Q_b + Q_{sw},$$

where Q=28,42 kN — shear force from external load; Q_b — shear force absorbed by the concrete.

The diameter of the cross rods is taken from the condition of weldability with the longitudinal rods ø16 mm and take ø4 mm of the class A240C, R_{sw}=290MPa, the number of frames is two, A_{sw}=2*0,126=0,252cm^2.

Step transverse bars under constructive conditions s = h/2 = 30/2 = 15cm, but no more than 15cm. in the middle of the span s = (3/4)h = (3/4)40 = 30cm, we accept s = 30cm.

$$Q_{b\min} = \varphi_{b3}(1 + \varphi_f)R_{bf}bh_o = 0,6\cdot 1,1\cdot 0,9\cdot 1,05\cdot 10^3\cdot 0,4\cdot 0,36 = 89,8кН$$

Condition q_{sw}=48,72kN>Q_{bmin}/2=89,8/2=44,9 kN is satisfied.

$$s_{\max} = \frac{\varphi_{b4} R_{bt} b h_o^2}{Q_{\max}} = \frac{1{,}5 \cdot 0{,}9 \cdot 1{,}05 \cdot 10^3 \cdot 0{,}4 \cdot 0{,}36^2}{28{,}42} = 258{,}6 см > s = 15 см -$$ satisfied.

$$c_0 = \sqrt{\frac{M_b}{q_{sw}}}, = \sqrt{\frac{119{,}8}{48{,}72}} = 1{,}57 м$$

We take c=157 cm.

$$Q_{sw} = q_{sw} c_0 = 48{,}72 \cdot 1{,}57 = 76{,}5 кН$$

$$Q_b = \frac{M_b}{c} = \frac{119{,}8}{1{,}57} = 76{,}31 кН$$

The strength condition Q_b+Q_{sw}=75.6+76.31=151.91kN>Q=28.42kN - provided.

Rigel calculation

At the negative moment M=93.12kNm the cross-section works as a rectangular cross-section. The beam is solid, hence the maximum moment occurs at the support. The tensile forces occur in the upper chord.

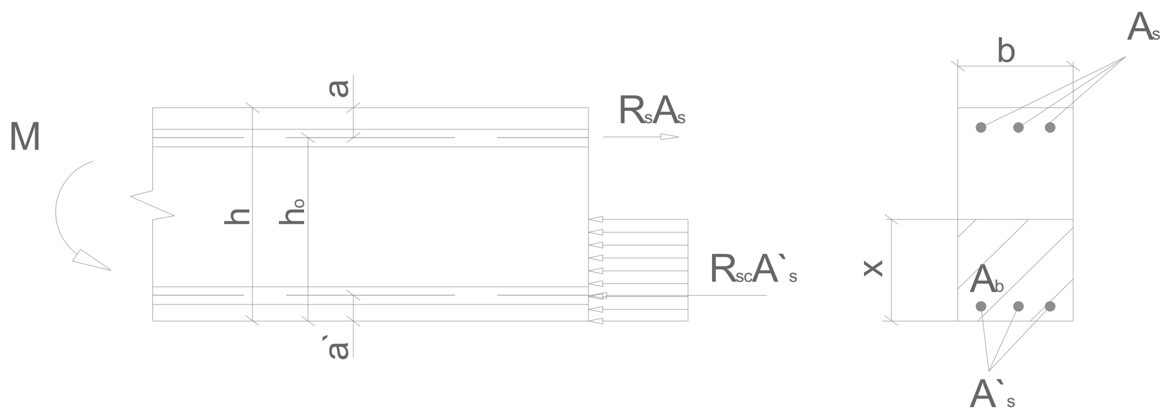

Fig. 2.4. Scheme of forces in a transverse rectangular cross-section of a bended reinforced concrete element

h_0 =500 – 40 = 460 мм.

$$\alpha_m = \frac{M}{R_b b h_0^2} = \frac{93{,}12}{0{,}9 \cdot 14{,}5 \cdot 10^3 \cdot 0{,}25 \cdot 0{,}46^2} = 0{,}13$$

$$A_s = \frac{M}{R_s \zeta h_0} = \frac{93{,}12}{341{,}12 \cdot 10^3 \cdot 0{,}925 \cdot 0{,}46} = 6{,}41 см^2$$

Accept two rods 2ø22 A400C with A_s=7,6 cm^2

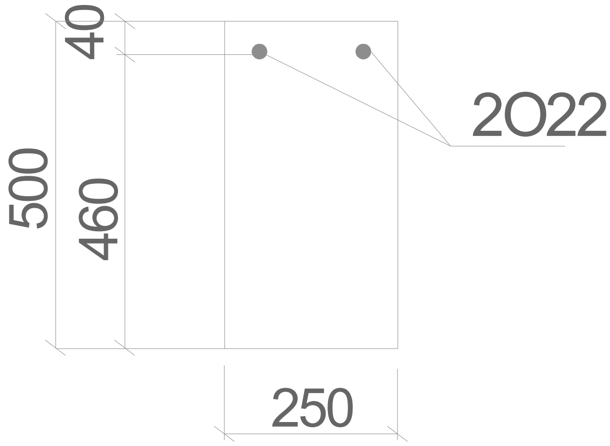

Fig. 2.5. Section reinforcement

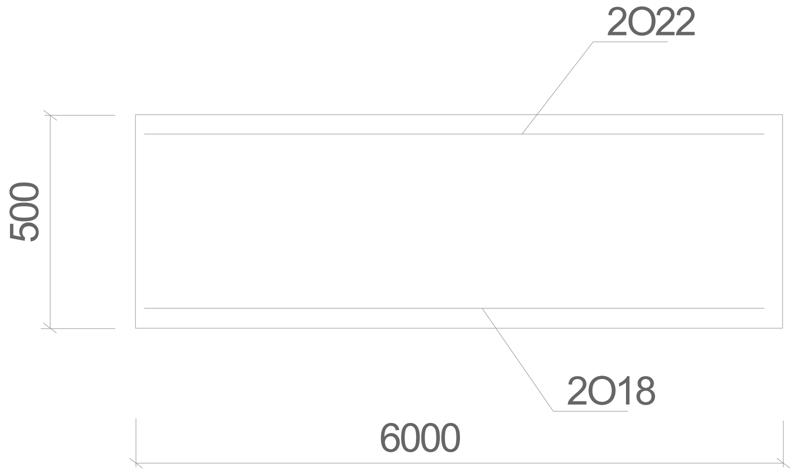

Fig. 2.6. Rigel reinforcement scheme

3. Basics and foundations

3.1. Foundations calculation of the designed building

Table 3.1. Collection of loads on the exterior wall

Type of load	Normative loads, N/m^2	Load factor, γ_f	Design loads, kN
Constant loads			
1. From the roof rafters	2,5	1,3	2,75
2. From the insulation (mineral	0,23	1,3	0,3

wool panels) ρ=50kg/m^3, δ=150mm			
3. From the vapor barrier	0,18	1,3	0,23
4. From reinforced concrete slabs	33,6	1,1	36,96
5. From the construction of the floor (linoleum)	0,6	1,3	0,8
6. From the brick partition ρ=1800kg/м^3, δ=120mm	31,8	1,1	34,98
7. From masonry ρ=1800kg/м^3, δ=640mm	136,4	1,1	150,04
8. Weight of the plinth	45	1,1	49,5
Total	250,31		275,56
Temporary loads			
1. From the snow	3	1,4	4,2
2. From between the floor slabs	6	1,4	8,4
3. From the attic floor	2,1	1,4	2,94
Total	11,1		15,54
Summary	261,41		291,1

Table 3.2. Collection of loads on the interior wall

Type of load	Normative loads, N/m^2	Load factor, γ_f	Design loads, kN
Constant loads			
1. From the roof rafters	3,01	1,3	2,75
2. From the insulation (mineral	0,34	1,3	0,44

wool panels) ρ=50kg/m³, δ=150mm			
3. From the vapor barrier	0,27	1,3	0,35
4. From reinforced concrete slabs	50,4	1,1	55,44
5. From the construction of the floor (linoleum)	0,9	1,3	1,17
6. From the brick partition ρ=1800kg/м³, δ=120mm	25,3	1,1	27,8
7. From masonry ρ=1800kg/м³, δ=640mm	82,8	1,1	91,1
8. Weight of the plinth	30	1,1	33
Total	193,02		212,01
Temporary loads			
1. From the snow	4,5	1,4	6,3
2. From between the floor slabs	9	1,4	12,6
3. From the attic floor	3,2	1,4	4,5
Total	16,7		23,4
Summary	209,72		235,41

Normative depth of soil freezing d_{fn}=0.8 m,

Determine the design depth of soil freezing by the formula:

$$d_f=K_h\ d_{fn}=0.5*0.8=0.4 \text{ m},$$

where K_h=0,5.

As the building has a basement, the depth of foundation is determined by the height of the storey. In this case, foundations should be deepened by 2.3 m, which is more than the estimated frost penetration depth.

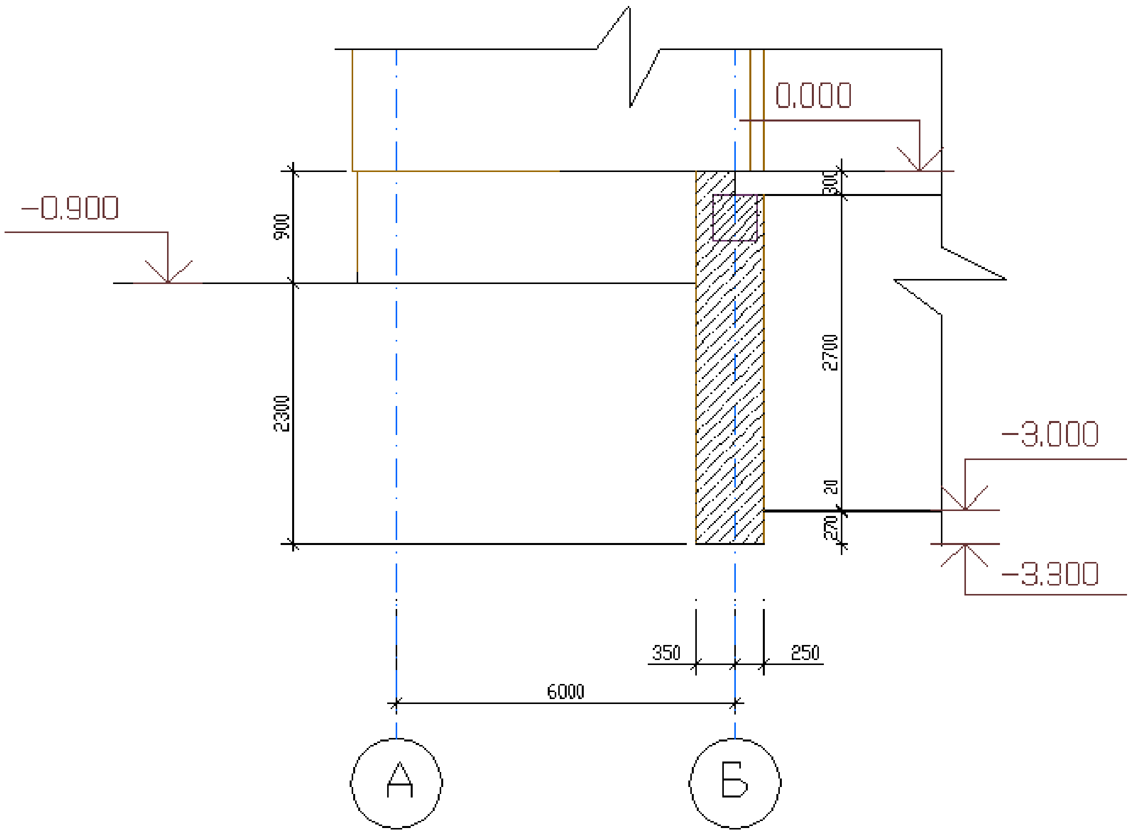

Fig. 3.1. Foundation element along axis B

The width of the foundation is taken:

for the outer wall - 600mm;

L/H=42/22,4=1,88.

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

where γ_{c1} and γ_{c2} - operating conditions; k - factor is taken as equal to: k_1 = 1, if the strength characteristics of the ground (φ and c) determined by direct testing; M_γ, M_q, M_c - coefficients; k_z - the coefficient, which is taken as equal to: at $b < 10$ m - $k_z = 1$, when $b \geq 10$ m - $k_z = z_0/b + 0,2$ (here $z_0 = 8$ m); b - width of the base of the foundation, m; γ_{II} - average design value of the specific weight of soils below the foundation's underside (in the presence of groundwater is determined taking into account the weighting effect of water), kN/m^3; γ'_{II} - the same, located above the foot; c_{II} - calculated value of specific adhesion of the soil under the foundation's underside, kPa; d_1 - depth of foundations of basement-less structures from the level of leveling or the reduced depth of the external and internal foundations from the basement floor, determined by the following formula

$$d_1 = h_s + h_{cf}\gamma_{cf} / \gamma'_{II},$$

where h_s - thickness of the soil layer above the basement footing on the basement side, m; h_{cf} - basement floor structure thickness, m; γ_{cf} - calculated value of specific weight of the basement floor structure, kN/m^3; d_b - basement depth - the distance from the level of planning to the basement floor, m (for structures with a basement width of $B \leq 20$ m and more than 2 m in depth is accepted $d_b = 2$ m, with a basement width of $B > 20$ m - $d_b = 0$).

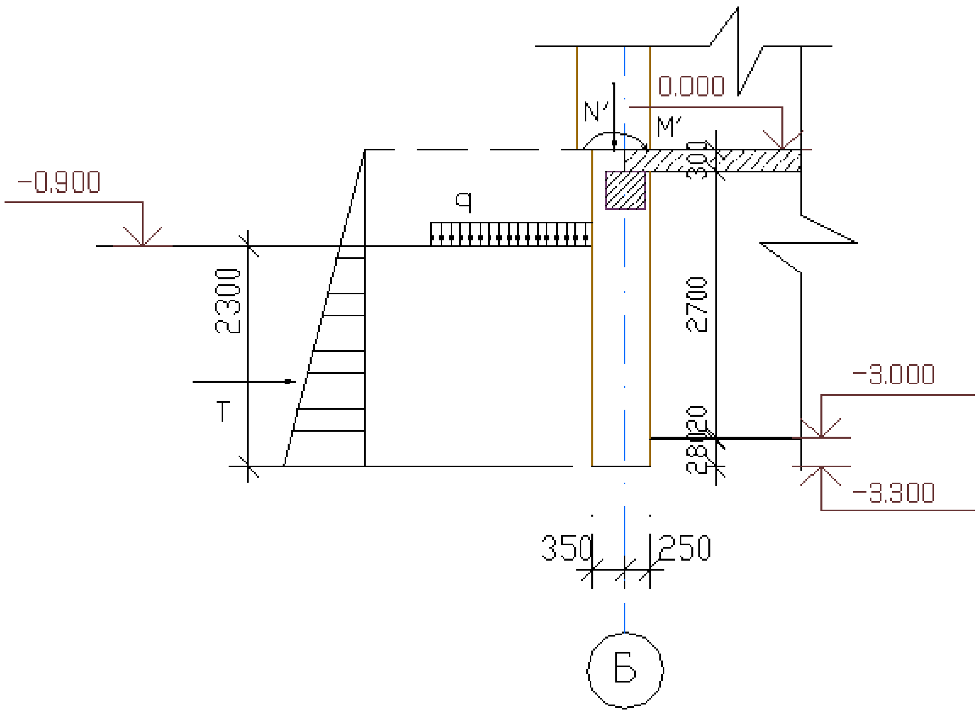

Fig. 3.1. Calculation diagram of the off-center loaded foundation

For the exterior wall.

γ_{c1} and γ_{c2}=1,4;

k_z=1;

b=0,60 m;

M_γ=3,12;

M_q=13,46;

M_c=13,37;

γ_{II}=19,9kN/m^3;

γ'_{II}=19,3 kN/m^3;

c_{II}=2kPa;

$$d_1 = 0{,}27 + \frac{0{,}1 \cdot 22}{19{,}3} = 0{,}38m.$$

d_b=2,3m.

$$R = \frac{1{,}4 \cdot 2}{1{,}1}[3{,}12 \cdot 1 \cdot 0{,}6 \cdot 19{,}9 + 13{,}46 \cdot 0{,}38 \cdot 19{,}3 + (13{,}46 - 1)2{,}3 \cdot 19{,}3 + 13{,}37 \cdot 2] = 1{,}82MPa$$

Determine the equilibrium of the active soil pressure on 1 m of the foundation wall:

$$T = \left(qd + \frac{\gamma'_{II} d^2}{2}\right) tq^2\left(45 - \frac{\phi}{2}\right) = \left(10 \cdot 2,3 + \frac{19,3 \cdot 2,3^2}{2}\right) tq^2\left(45 - \frac{43}{2}\right) = 13,35\ kN,$$

$$h_{np} = \frac{q}{\gamma'_{II}} = \frac{10}{19,3} = 0,52m,$$

$$a_o = \frac{d}{3} \cdot \frac{d + 3h_{np}}{d + 2h_{np}} = \frac{2,3}{3} \cdot \frac{2,3 + 3 \cdot 0,52}{2,3 + 2 \cdot 0,52} = 0,89m,$$

$$M_T = Ta_o = 13,35 \cdot 0,89 = 11,88kN/m.$$

At the level of the planned level the forces act:

M$'$=2,6kNm; N$'$=213,2 kN.

Determine the edge pressures of the foundation for the exterior wall

$$\rho_{max} = \frac{N}{A} + \frac{M}{W} = \frac{224{,}3}{0{,}6} + \frac{2{,}6 \cdot 6}{0{,}6^2} = 0{,}42M\Pi a$$

$$\rho_{min} = \frac{224{,}3}{0{,}6} - \frac{2{,}6 \cdot 6}{0{,}6^2} = 0{,}374M\Pi a,$$

$$\rho_{cp} = \frac{N}{A} + \beta\gamma_{\phi} d = \frac{224{,}3}{0{,}6} + 20 \cdot 2{,}3 = 0{,}42M\Pi a < R = 1{,}82M\Pi a.$$

The condition is satisfied.

3.2. Calculation of the foundation for internal columns

Table 3.2. Collection of loads on the interior wall

Type of load	Normative loads, N/m^2	Load factor, γ_f	Design loads, kN
Constant loads			
1. From the roof rafters	18,06	1,3	16,6
2. From the insulation (mineral wool panels) ρ=50kg/m^3, δ=150mm	2,04	1,3	2,64
3. From the vapor barrier	1,62	1,3	2,1
4. From reinforced concrete slabs	302,4	1,1	332,64
5. From the construction of the floor (linoleum)	5,4	1,3	7,02
6. From the brick partition ρ=1800kg/м^3, δ=120mm	151,8	1,1	166,8
7. From masonry ρ=1800kg/м^3, δ=640mm	496,8	1,1	546,6
8. Weight of the plinth	180	1,1	198
Total	1158,12		1272,06
Temporary loads			
1. From the snow	27	1,4	37,8
2. From between the floor slabs	54	1,4	75,6
3. From the attic floor	19,2	1,4	27
Total	100,2		140,4

Summary	1258,32		1412,46

Determine the area of the foundation using the formula:

$$A = \frac{N}{R - \beta\gamma_{\Phi}d} = \frac{1258{,}32}{400 - 20 \cdot 2{,}3} = 1{,}77m^2$$

where $b = \sqrt{A} = \sqrt{1{,}77} = 1{,}33m.$,

R=0.4MPa - the nominal design resistance of soils.

Take a monolithic columnar foundation with a side of 1.35 m. Determine the design coresistance by the formula:*b=1,35m.*

$$R = \frac{1{,}4 \cdot 2}{1{,}1}[3{,}12 \cdot 1 \cdot 1{,}35 \cdot 19{,}9 + 13{,}46 \cdot 0{,}38 \cdot 19{,}3 + (13{,}46 - 1)2{,}3 \cdot 19{,}3 + 13{,}37 \cdot 2] = 1{,}94MPa$$

.

Determine the edge pressures of the foundation:

$$\rho_{cp} = \frac{N}{A} = \frac{1258{,}32}{2{,}7} = 0{,}47MPa < R = 1{,}94MPa.$$

The condition is satisfied

Guidelines for the arrangement of foundations

All surface water shall be diverted from the site or construction site through a permanent stormwater network outside the built-up area. The storm drain network shall ensure the passage of the highest flow of storm water.

Backfill excavations at foundations and trenches under communications should be made of local loess-like loam, clay, and in their absence - from sandy loam.

The soil in the backfill shall be backfilled with optimum moisture in separate layers and compacted to the density of dry soil not less than 1.6 t/m3.

The thickness of the layers is determined in accordance with the compaction ability of the used soil-compaction equipment.

The layout of the site or construction area to be built should be carried out using the ways of natural drainage of atmospheric waters. The use of sandy soils, debris and other drainage materials for planning embankments on sites with soil conditions of type II on subsidence is not allowed.

4. Construction technology

4.1. Works of the preparatory period

The removed top layer of vegetative soil must be preserved and used for landscaping work on its acquisition areas. If the removed topsoil is not removed immediately, it must be stored in a separate place on the construction site.

The stock of bulk construction materials (bricks, rubble stone, sand, crushed stone, lime, etc.) delivered by vehicles must provide a three-day requirement.

The total area of the warehouse consists of the useful area directly occupied by the materials, as well as auxiliary - passages, aisles, office space. Useful area of the warehouse depends on the type and quantity of stored material, method (manual or mechanized) and the nature of stacking (in bulk, stacked, in bins and hoppers). Different quantities of materials can be stacked on 1 m^2 of useful storage area.

Table 4.1. Norms of storing materials

Materials	**Units**	**Norm of storage per 1m²**	**Way of laying**	**Type of storage**
Crushed stone, gravel, sand	m^3	2-4	stack	open
Bricks	pcs.	700	cages	open
Lime lump	t	2	bulk	closed
Cement	t	2-7	pantries, bunkers	closed
	t	2-3	bags	
Sawed timber	m^3	1,2-1,8	stack	closed

Reinforced concrete beams, slabs,	m^3	0,4-0,8	stack	open

At the construction site, the temporary facilities provided for in the construction project and specified on the construction plan shall be erected. Temporary facilities include service rooms (foreman's room, workshops, warehouses, storage rooms) and amenities for workers (locker rooms, showers, eating rooms, and toilets). Temporary facilities are erected from prefabricated collapsible panels or install mobile tractor trailers, caravans-huts on metal frame.

All temporary facilities are placed in an area that will not be built up with permanent buildings, to avoid multiple relocation of temporary facilities in new places. When placing temporary structures on the construction site, it is necessary to comply with fire safety rules regarding the gaps between individual buildings and structures.

Local materials and products manufactured near the construction site are delivered by road transport, which has great advantages over other modes of transport since it can deliver materials directly to the site without additional reloading. Trucks are also used to transport cargo to the construction site - mortar, concrete mix, components, structures, and materials to the site under construction, removal of construction debris and excessive soil during the excavation work. Transportation of goods at the construction site and at a distance of 3-5 km, as well as off-road is advisable to produce tractors on wheeled and tracked tracks with trailers. Tractors have great maneuverability and high cross-country ability, yielding only to motor vehicles in speed of movement.

For mechanization of loading and unloading operations and preservation of transported cargo in construction, different types of containers, pallets, etc. are used.

At the construction site is laid a road, which has its own entrance and exit to the common highway. The width of the highway - 7 m.

Covering of temporary roads - a layer of gravel with a thickness of 12-16 cm.

Electricity shall be supplied from the existing power grids.

Temporary water supply for the construction is carried out by connecting to the existing water supply systems located near the construction site.

To the lifting and erecting mechanisms include mobile jib cranes.

4.2. Earthworks and foundation construction

The construction "zero cycle" begins with excavation: breaking and digging trenches and pits for foundations, laying pipelines and cable network, transportation of soil (loading, moving, unloading), backfilling and embankment with compaction.

Earthworks are labor-intensive and should be performed mechanized. Manual excavation is not permitted.

Digging of trenches and pits: on the obnoustics of the building, the width of the foundation is set aside from the wall axes and a wire, hammered in these places, is strung, which will determine the location of the inner and outer surfaces of the foundation. The axes and dimensions of trenches and foundation pits from the stretched wires are transferred to the ground with a plumb line, by hammering in the pegs.

Digging of pits, trenches, road cuttings, canals, embankment arrangement is performed by sets of machines - excavators, bulldozers, tractors with trailers, dump trucks.

When backfilling trenches and pits, fasteners must be dismantled.

The following types of machines are used for excavation work in construction: earthmoving machines, excavators and auxiliary machines.

Prefabricated concrete and reinforced concrete foundations reduce the volume of masonry and allow their installation to be mechanized. Prefabricated foundations consist of a pillow - reinforced concrete blocks (plates) of rectangular shape, laid on the rammed sand preparation that is 0.15 m thick, and a vertical wall of concrete blocks. Blocks (plates) - pillow is 300 mm thick, 0.8 m wide, wall blocks - 0.6 m wide, 580 mm high, 2.38 m long.

Foundations are subjected to moisture from atmospheric moisture or groundwater seeping through the ground. The access of moisture to the walls is prevented by waterproofing. The insulation layer consists of two layers of tar paper glued together with bitumen mastic. In addition, the external walls of the building's foundation are waterproofed. In order to protect the soil from moistening the surface waters near the walls of the building are arranged blind area width of at least 0.8 m with a slope of the building 0,02-0,1.

After the device foundations and plinth demarcation axes with obnovoski transferred directly to the structure under construction (obnovoska further may not be kept). During this period, work on the laying of intra-block and yard permanent underground utilities of water supply, sewerage, heating network, etc. should be completed.

4.3. Technological map for installation works and masonry

The bricklayer can normally work at a masonry height of up to 1.2 m, so as the wall is being erected, the mason shall arrange a pier platform to move the mason with the materials and tools.

The working area for masonry must have a width of at least 2.4 m with the placement of three zones: the working - width 0.6 m with free space between the walls being erected and prepared material, the zone of 0.6 m wide materials with a reserve of their two-hour demand, transport area width of 1.2 m for transporting materials and workers passage. When submitting materials directly to the workplace by crane, the width of the transport zone may be 0.6-0.75 m. When laying walls, the stock of bricks (blocks, stones) are placed against the partitions, boxes with mortar - against the openings.

The use of scaffolding for the floor requires masons to stop working after the end of the masonry tier to increase or transfer the scaffolding.

Window and door openings in the masonry walls are blocked with prefabricated products in the form of reinforced concrete beams and slabs, steel girders.

Prefabricated reinforced concrete bars and slabs for bridging the openings with a span of 1-2.5 m are laid on the mortar with the ends embedded in the masonry at 12 or 25 cm.

Erection of the walls of buildings made of bricks can not be regarded as a process of producing only one masonry.

The mason's work front can only be ensured if the intermediate floor slabs, scaffolding, etc. are arranged in time. Therefore, when designing the production of masonry works it is necessary to develop and ways to produce related works, which include the installation of intermediate floors and stairs, filling window and door openings and scaffolding, delivery of materials and products from the warehouses on site to the workplace.

The external walls of the building, which are 77 cm thick, are plastered. The floor slabs and stairs are made of precast reinforced concrete.

Calculation of the volume and labor intensity of the masonry and installation work is given for one floor. The storey height (from floor to floor) 3.3 m, 18 window apertures measuring 2.68 * 1.76 m, 12 pcs. measuring 2.07 * 1.76 m, and 16 pcs. measuring 1.78 * 1.76 m, 32 door apertures measuring 2.2 * 0.9 m. The volume of masonry of one floor minus the openings is 131 m^3.

4.4. Roofing works

Covers of buildings with roll-fed roofs consist of the following elements: foundation (bearing structure), vapor barrier layer, thermal insulation, levelling layer (screed), which is the basis for the waterproofing mat, the waterproofing mat itself, protective layer protecting the roll-fed waterproofing mat from atmospheric influences and mechanical damages of coating layer to reduce the effect of solar radiation on the surface of the roll mat.

The foundations for roll roofs are arranged of precast concrete slabs.

Vapor barrier layer is made under the project in one or two layers of roll material on mastic.

Thermal insulation layer is arranged from insulating plates. Prior to the levelling layer (screed) under the roll carpet insulation layer must be protected from precipitation by light portable shelters. Slopes of flat roofs for the organization of the wo-dostok created by changing the thickness of the insulating layer. Plate heaters are stacked on mastic with a tight fit to the vapor barrier layer and seal the joints with a crumb of insulation material.

Leveling layer (screed) is made of cement-sand mortar. The thickness of the cement-sand screed is taken on the plate heat insulation - 15-20 mm. The surface of the cement-sand screed for better bonding of the bottom layer of roll carpet must be primed with mastic. It is recommended to prime with the help of special settings during the curing of mortar. The roll mat is glued on after the primer dries out in about 10 - 12 hours.

Waterproofing layer (roll mat). The design of a waterproofing layer depends on the slope of the roof, the purpose of the building (residential, public, industrial).

Rolled roofs arranged in three layers.

The protective layer on the unexploited roofs perform gravel or light-colored sand, embedded in a mastic containing additives against sprouting plants.

The outer layer of carpet all joints are placed so that all edges are on the leeward side with respect to the direction of the prevailing wind.

To protect the glued-down carpet from damage, its gluing should be started from the most distant parts of the covering.

4.5. Flooring works

Boarded floors are laid from planed boards with a thickness of at least 37 mm and a width of 120-150 mm. The material of the plank floors is pine, spruce, larch and other species with humidity at the time of laying not more than

12%. The floors of the first floor laid on the ground. Board floors are spliced with staples and compressive wedges.

First, nailed only every 4-5 board and after a year of operation (drying boards) is recommended to bond the floors again with nailing each board. Along the walls are nailed skirting boards. On the inter-storey floors are flooring on the beams laid across the beams, ribs, slabs or other supports. On the smooth surfaces of reinforced concrete structures are stacked on the floor boards pads equalizing. Boards are nailed to the joists with nails 2-2.5 times longer than the thickness of the boards, by sinking the heads into the wood. Roughness of the boards are eliminated with a planer (electric planer).

Gaps between the floor and wall closed skirting or fillets to ventilate the basement set special skirting or ventilation grates.

After laying the floors is recommended to cover the hot oil, and paint the floor to do at the end of all work in the room.

Ceramic and stone tile floors are laid on a concrete underlayment.

Placing tile floors begin with the installation of the corners of the premises on the square and level marks of tiles, departing from the wall one to two rows for the frieze. Between the marks on the contour of the premises along the cord and batten pave beacon rows, then the intermediate mark and beacon rows in the central part of the floor. Tiles are laid on the cords fixed by the pins hammered into near the lighthouse rows. Tiles are laid on a layer of cement mortar, bitumen or tar mastic.

The thickness of the layer of mortar should be 10-15 mm, the width of the seams between the tiles up to 200 mm in size on the sides of 1 no more than 2 mm and with tiles of larger size - 3 mm. The tiles are laid on the prepared mortar and settle by blows of the handle of trowel or hammer under the cord, stretched along the Maya rows. Printed tiles covered with a layer of wet sawdust, and after 1-2 days, the seams that were empty are filled with liquid cement paste or mortar composition 1:1. After the mortar has set (in 7 days) at the seams the tiled floor surface is wiped with wet sawdust and washed with water.

Concrete grade for coatings must be at least 150.

Composition mosaic (terraced) mix grade 150: 1:2 (cement M-400: stone chips - marble: pigment) at V / C = 0.5, which is laid on the preparation of the cement-sand mortar composition of 1:3. For the mosaic floors are available marble crumb three brands: a large MK with a grain size of 10-15 mm, the average MS - grains 5-10 mm, a fine MM - grains 2,5-5 mm. For the preparation of the mosaic mixture is used a coarse and fine marble aggregate in a ratio of 3:1.

To give a different color mosaic coatings cement mixed with pigments (dry mineral paints) in an amount not exceeding 15% of the weight of the cement.

Overlay concrete, cement-sand and mosaic monolithic coatings are made in strips 3-4 m wide lighthouse boards, and the strips are placed in one with their maturing them at least one day, the layers compacted by surface vibrators or vibrating rods.

Evenness of the floor is checked with a 2-meter ruler and level in all directions.

4.6. Installation and finishing works

When checking the condition of precast structures and elements establish the presence on them marks and stamps of the manufacturer, compliance of their geometric dimensions with the working drawings, the absence of concrete cracks, potholes and surface sores exceeding the tolerances, the presence and correctness of embedded parts and axial marks, the center of gravity of complex and asymmetric elements, the presence on one-sided reinforced elements signs indicating the correct position of the elements during lifting and installation. The prefabricated elements with the detected defects are rejected or subject to correction.

For the purpose of comfortable and safe execution of works during installation of structures, their furnishing is made with devices, scaffolding, ladders, stepladders.

Slinging and lifting of precast elements shall be performed in accordance with the rules:

- pads shall be installed under the steel wire ropes in the areas around the elements in order to prevent damage to the concrete and wire;

- heavy and long structures should be lifted on balancing beams in order to avoid tearing out of the slinging loops;

- feed in the designed position wall panels and columns - vertically, floor and roof panels - horizontally, staircases - obliquely.

Lifting of precast elements and structures is carried out in two steps: firstly to a height of 20-30 cm and after checking the reliability of slings continue further lifting. Guiding the installed elements to the design axes is performed with the help of suspenders (made of hemp or steel wire rope). When installing the columns one pulling is sufficient, when installing the horizontal elements requires two pulling.

The blocks are installed on a bed of mortar. The basement blocks are aligned on the inner plane.

When installing the beams, purlins controlled design level of supports and their upper surface by leveling, the correct location in the plan and conjugation of the elements on the supports. The distance between beams and purlins is checked in the axes using steel tape measures or templates.

Once the prefabricated elements are in their designed position, they are temporarily secured with straps, wedges and conductors to release the assembly mechanisms. After the design position of the temporarily secured prefabricated elements has been verified, they are finally fastened. The final anchoring of the structures is done by welding of the fittings or embedded parts of the elements being joined and sealing of the joints with the help of sealants and grouting.

In the places where columns, floor slabs, beams, runs, etc. are installed, joints are monolithing with cement-sand mortar of 1:1 or 1:1.5 with water-cement ratio of 0.35-0.4 with careful sealing of the mortar.

Glass work in construction is carried out before painting and wallpapering work begins. Surfaces of walls, ceilings, windows and doors must be pre-prepared before finishing work: cleaned of dirt, dust, stains of mortar, grease, efflorescence, etc., all the small cracks dilated with putty filled to a depth of at least 2 mm.

In painting works use compositions: water (adhesive, lime, silicate, emulsion) and non-aqueous (oil, enamel, synthetic). Paint compositions are recommended to cover various surfaces.

Enamel, enamel and synthetic paint compositions are used only factory-made. Other paint compositions in most cases are prepared in paint shops or are additionally prepared from factory-made semi-finished products.

The surfaces before painting cleaned of dirt, dust, stains of mortar, grease, efflorescence, etc., small cracks dilated with putty at least 2 mm deep, rough surfaces smooth out. Silicate primer or potassium glass water solution (1:3) with dry white silicate paint is used to remove stains that are difficult to wash off. Metal surfaces are cleaned of rust and grease stains, knots on the wooden cut to a depth of 3 mm with subsequent sealing putty.

In the production of painting work it is necessary to observe technological pauses between individual operations, ensuring drying and hardening of individual coatings, so that each subsequent coating was applied only after drying and hardening of the previous one.

Painting is carried out from top to bottom, first painting the ceiling, then the walls. When painting the ceiling light direction is taken into account, the first brush strokes are applied perpendicular to the light rays, and the second - parallel.

When oil painting plank floors pre-cut knots and cracks sealed with putty, then made paint at least two coats of paint. Each coat of paint, except for the last, should be cleaned with sandpaper or glass paper.

Glass work includes cutting glass to the required dimensions, preparing putty, inserting, reinforcing and wiping glass in the bindings of windows and skylights and doors.

Glass cutting is carried out with a diamond or glass cutter on a special table, upholstered with cloth or felt, equipped with a flat bar and an angle for marking the glass.

Before inserting glass rebates wooden covers are cleaned, oiled and dried. Between the glass and the board of the rebate should be a gap of 2 mm, a layer of putty between them 2-3 mm thick is placed evenly, without tearing along the length of the fold. On the facet is smeared putty, the glass is pressed to the folds and fixed steel studs blows chiseled. After hammering studs completely filled the facet putty, trowel smooth until shiny and even trim at the point of contact with the glass. The pins are placed one from the other at a distance of 300 mm at an angle of not more than 45 ° to the surface of the glass. When inserting large glasses, they are fixed with glazing beads - wooden slats, instead of caulking use U-shaped rubber pads. Glazing bars are fixed with nails or screws, the number of them on each edge of the glass is not less than two.

After glazing the contaminated glasses are wiped down and washed. For heavy contamination the glasses are covered with chalk solutions or mixture of chalk and kerosene, wiped with a rag as it dries and washed.

5. Health and safety

The movement of people as a function is inherent in all rooms of buildings and structures associated with human occupancy. For the majority of spaces, the movement of people is an auxiliary function and for its implementation there are special areas within the premises (passages between equipment, entrances and exits), but for a large part of the premises, called communication spaces or communication spaces (corridors, stairs, lobbies, foyers, lounges, etc.), the movement of people is the main functional process. Communication spaces in buildings occupy a significant area which in some cases is 30% or more of the working area of the building. For a large group of buildings and structures, the movement of people is the main functional process, and their rational space planning solution depends on its correct organization.

Unlike other functions, the movement of people has the peculiarity that its significance sharply varies at different periods of operation of the building. So, even in rooms where this function is only auxiliary, the movement of people becomes the main function during the loading and evacuation of premises. The simultaneous movement of a large number of people in one direction during occupancy and evacuation of a building is characteristic.

The movement of people during a fire in the building, an accident or some natural disaster takes on special significance. In this case, people's lives depend on the proper organization of movement and the condition of communication rooms. Since the occurrence of fire is possible in any room, the consideration of emergency evacuation of people is mandatory for any room and in the whole building or structure.

The building materials used meet toxicity and radiation safety requirements. If used correctly, they cannot harm workers.

Fire protection measures are carried out throughout the entire period of construction work. First of all, the appropriate fire resistance of building structures for different categories of buildings and structures must be ensured.

Protection of wooden structures against fire can be made by painting with special fire protective paints, impregnation in solutions of special salts, creation of thin-layer coatings and thermal jackets. Flame retardant coatings complicate the emergence and slow down the spread of fire. Fire-retardant paints are applied with brushes or a spray gun. Paints containing clay are applied with a mop brush, with at least three passes. Fire retardant coatings shall be applied by hand, protected by a thick canvas glove. If small cracks appear on the coating, after it dries, the secondary coating with a thinner layer and more liquid solution shall be carried out. The thickness of the coating should be 2-6 mm.

On construction sites, roads and driveways should not be cluttered with construction materials and equipment, each of the auxiliary or main building and facilities should not be located from the roads and driveways at a distance greater than 25 m. At night, roads and driveways on the construction site, the location of water sources and fire stations shall be illuminated. Timber shall be stacked, making fire breaks 15-30 m from the buildings or temporary structures under construction.

Combustible construction materials, wood chips, sawdust, and other materials must be removed daily to designated places at a distance of at least 50 m from the timber yards, buildings, and structures.

Depending on their capacity and method of storage, warehouses of flammable and combustible liquids, varnishes and paints shall be arranged with fire breaks of 18-36 m. Keeping flammable and combustible liquids in basements and semi-basements is prohibited. When storing varnishes and paints, the biggest fire hazard is posed by soluble olive oil, white spirit, alcohol, etc.

Cylinders with gases can be stored in special covered warehouses and in open warehouses under sheds with fire breaks of at least 20 m, with a distance to the warehouses with flammable and combustible liquids of at least 50 m. The territory of the open storage area shall be fenced. Oxygen cylinders and cylinders with combustible gases shall not be stored in one room. Filled and empty containers should be stored separately. Cylinders for different gases must have a distinctive colouring and an inscription indicating the gas. Cylinders with safety valves should be stored and issued. Indoors, cylinders with combustible gases from the radiators are installed at a distance of 1.5 m.

Lime extinguishing pits are located at a minimum distance of 5 m from the warehouse and at least 15 m from other buildings and constructions. Unquenched lime must be stored in covered, protected from the atmospheric precipitations non-combustible warehouses with the floor elevated at least 20 cm above the ground. The use of water and foam fire extinguishers in these warehouses as fire extinguishing agents is not allowed, dry sand and carbon dioxide fire extinguishers should be used.

Temporary wiring at the construction site is carried out with insulated wire on solid supports at a height of at least 2.5 m above the workplace, 3.5 m - over the aisles and 6 m - over the passages. Suspending wiring at a height of less than 2.5 m is permitted only in pipes or boxes. Electric lamps for general lighting are used 127 and 220 V with the location of lighting fixtures at a height of at least 2.5 m, at a lower height of the location of lighting fixtures should use voltage of electric current not exceeding 36 V.

Construction sites shall be provided with primary fire extinguishing equipment.

In order to quickly notify about the fire and call the fire department at the construction site must be telephone communication.

Table 5.1. Standards for primary fire extinguishing equipment for buildings under construction

Buildings and structures	Units	Fire extinguisher	Sandbox $0,5 m^3$ and shovel	250L barrel with water and 2 buckets
Constructed buildings	at 200 m^2	1	1	—
Scaffolding	at 20m	1	—	—
	at 100 m	—	—	1
Woodworking workshops	at 100 m^2 of floor	1	1	1
Warehouses for timber and combustible materials		1	—	1

Warehouses of non-combustible materials, cylinders	at 200 m^2 of floor	1	1	-

According to DBN B.1.1.7-2002, the fire resistance rating of a house is established depending on its purpose, category of fire and explosion hazard, height (storey), floor area within a fire compartment. The floor area within a fire compartment means the floor area of the house or the area of a part of the floor separated from the other part by a type 1 fire wall.

The degree of fire resistance of a building is determined by the fire resistance limits of its building structures and the limits of fire spread through those structures according to Table 4 of the DBN B.1.1.7-2002.

All structural elements of the cooperated building have fire resistance limits not lower than those specified in Table 1 of the DBN B.1.1.7-2002 for buildings of the 2nd degree.

In the middle of the building, cabinets with fire hydrants and hoses are arranged on each floor near the stairwells and along the corridor.

Primary fire extinguishing means are provided to extinguish a possible local fire:

- 4 hand (powder) fire extinguishers OP-5, two fire extinguishers in each cabinet with a fire hydrant;
- 1.5x2m asbestos fire blanket - 1 pc;
- a standard set of firefighting tools (crowbar, shovel, bugle, bucket).

During the assembly (disassembly) works in the conditions of the operating enterprise the operated electric networks and other operating engineering systems in the work zone should be, as a rule, disconnected, shorted, and the equipment and pipelines released from explosive, combustible and harmful substances.

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

Cleaning of structural elements to be installed from dirt and hollow should be done before their rise.

Elements to be mounted during movement must be kept from swinging and rotating by flexible pulls.

It is not allowed for people to be on the structural elements during their lifting or moving.

During breaks in work it is not allowed to leave the raised elements of designs and the equipment in a hanging position.

Installers are not allowed to move on the installed structures and their elements.

The elements installed in the design position must be fixed in such a way as to ensure their stability and geometric invariance.

It is not allowed for people to be under the elements that are mounted before they are installed in the design position and fixed. If it is necessary for workers to be under the equipment (structures) to be mounted, as well as on the equipment (structures), special measures must be taken to ensure the safety of workers.

Painting and corrosion protection of structures and equipment in cases where they are performed on the construction site, should be done, as a rule, before their rise to the design assessment.

In the process of installation of structures or buildings, installers must be on previously installed and securely fastened scaffolding, as it serves to safely perform work at a height of monads 1 m above ground level.

The buildings, as a rule, use inventory scaffolding, scaffolding, cradles, which have passports of enterprises that manufacture them. Non-inventory paving means are used in exceptional cases with the permission of the chief engineer of the construction and installation organization, if the height of non-inventory scaffolding is more than 4 m, they are built according to the approved project.

Scaffolding is used to perform construction work within one floor. They are installed in the middle of the building and transferred by crane from one floor to another.

Analysis of accidents when working on scaffolding shows that accidents occur mainly due to loss of stability of scaffolding, which is caused by various reasons:

- incorrect and insufficient fastening of scaffolding to walls, uneven support of racks on the ground;
- overload due to the accumulation of materials and construction parts on the scaffolding, which exceeds the allowable values;
- dynamic impact on the elements of structures, scaffolding and loss of strength of their individual elements.

The general safety requirements for the operation of scaffolding and scaffolding include:

- strength of structures and their reliability during assembly and operation;
- stability during installation and in operation;
- presence of a strong protection that excludes a possibility of falling of people and separate subjects from height, and continuous floorings, safe rise

workers and materials.

The design of scaffolding should be designed for stability, and individual elements - for strength. Calculations of load-bearing elements, supports, decks, rungs are performed, taking into account the mass of workers (mass of materials, containers, transwriting tools, etc.).

To ensure the stability of the scaffolding in the transverse direction, they must be securely fastened to the wall with anchors.

Prefabricated protective fence consists of three main parts: the handrail, the intermediate element and the side board at least 15 cm wide. All boards must be nailed on the inside.

The railing must withstand a concentrated load of 500 N. The minimum height of the fence is 110 cm. It is known that the center of gravity of a person is at 110-130 cm, and when a person falls on a sloping curve, he moves lower, so this height protects the person from falling .

Dismantling of scaffolding is carried out in the reverse sequence of its installation, when all materials, tools and vehicles are removed from the decking, the descent of the scaffolding elements is carried out using cranes.

A lightning rod is provided to protect people on the scaffolding from direct lightning strikes.

There are a number of works in construction where fencing is impossible (on the edge of the floor, cornice, etc.), in these cases only rope protection and mounting belts are used.

This diploma project envisages re-equipment of basements under the radiation protection shelter (RPS).

Premises that can be adapted for radiation protection are subject to the following requirements:

- external enclosing constructions of houses or constructions should provide the necessary multiplicity of attenuation of gamma radiation;

- openings and openings must be prepared for bookmarking in case of transfer of the room to the shelter mode;

- premises should be located close to the places of residence of the majority of the population to be hidden;

- there should be no large reservoirs with highly toxic substances, water and sewage mains near the sites, the destruction of which may endanger the hiding personnel, poisoning or flooding;

- in the premises located directly above the shelter, there should be no heavy objects and equipment.

Improving the protective properties of buildings and structures is achieved:

- choice of spatial planning and constructive solution;

- reducing the width of the contaminated area adjacent to the house;

- taking into account the relief of the house, which adapts to the RPS.

In RPS, which have mechanical ventilation, it is necessary to provide ventilation rooms, the dimensions of which are determined by the dimensions of the equipment and the area required for its maintenance. At the manual drive of the fan dust filters should have the protective screen which excludes a possibility of direct irradiation of service personnel.

Premises for storage of contaminated street clothes should be provided at one of the exits and separated from the premises for those hidden by fire partitions. Their total area is determined at the rate of not more than 0.07 m^2 per person.