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Metodological guidelines
for execution of design project №.1 on the subject

"REINFORCED-CONCRETE AND MASONRY STRUCTURES"

Section 3
"Design of brick pier"

(for applicants for higher education in the field of
192 – Construction and civil engineering
Specialty "Industrial and Civil Building")

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CONTENTS

GENERAL GUIDELINES

These recommended practices are complied for students carrying out calculations for stone and reinforced stone structures.

They contain the main provisions of the theory, design and calculation examples, and are executed in accordance with the existing methodology and practice of stone and reinforced stone structures design in accordance with DBN B.2.6-162:2010 “Stone and reinforced stone structures. Main Provisions” and “Eurocode-6”.

1 GENERAL PROVISIONS

In multi-storey industrial and public buildings, internal and external walls, partitions, braces, columns, floor slabs are interconnected making up a spatial system ensuring stability of the structure under the influence of vertical and horizontal loads.

Reinforced concrete floor slabs form horizontal disks, which are supports for the the house walls. They function as beams in the vertical direction.

In the general case of bearing walls calculation, that is, walls that withstand their own weight and external load, two main design schemes are considered: elastic; rigid.

Elastic in most cases refers to one-storey industrial buildings, when the lower part of the wall is compressed, and the upper part has a hinged support, longitudinally, these walls do not have transverse rigid walls at a considerable distance (more than 60 m).

A rigid building design layout will occur if the distance l_w between the transversely stable structures (diaphragms of stiffness, brick and reinforced concrete walls with a thickness of not less than 12 cm, buttresses, etc.) does not exceed the limit values (12 ... 54 m), according to standards depending on the type of the floor slabs and the group of brickwork (table 5, 7 of the Attachment and table 8.1 DBN V.2.6-162:2010).

Due to the complexity of calculating the elements of the buildings spatial system with rigid structural diagram, the regulations [1] allow the calculation of these buildings using a simplified scheme due to joint forces of vertical and horizontal loads.

When determining effort from vertical loads, the wall in is considered with regard to height as simply supported beams with a hinged support at the floor slabs level (fig. 1.1). In this case, the bending moment from the noncentrally applied vertical load of the floor slab, will only affect within one floor. The moment curve has the form of a triangle with a maximal ordinate above $(M_I = N_I \cdot e_{I},)$ and zero value at the bottom.

Load from the weight of the wall is considered centrally applied throughout the height of the partition wall for a constant wall thickness.

When calculating the walls carrying capacity, the loads are calculated from top downward, starting from roofing, inter-floor slabs, etc. The strength of the walls is checked in the most dangerous section, that is, at the level of the top of the first floor windows, since the wall is weakened here by apertures, and the bending moment M_x is close to M_I value.

When determining effort from horizontal (wind) loads, the walls in the vertical direction are considered as whole beams with a hinged resting on inter-floor floor slabs. The bays of the beam are equal to the height of the floors.

Horizontal forces from wind loads are taken into account when checking for an additional combination of loads under the action of wind pressure. Such an inspection is performed if multi-storey buildings are calculated, as well as for buildings located in zones of intense wind pressure (for example, seashores, mountains, steppe areas, etc.).

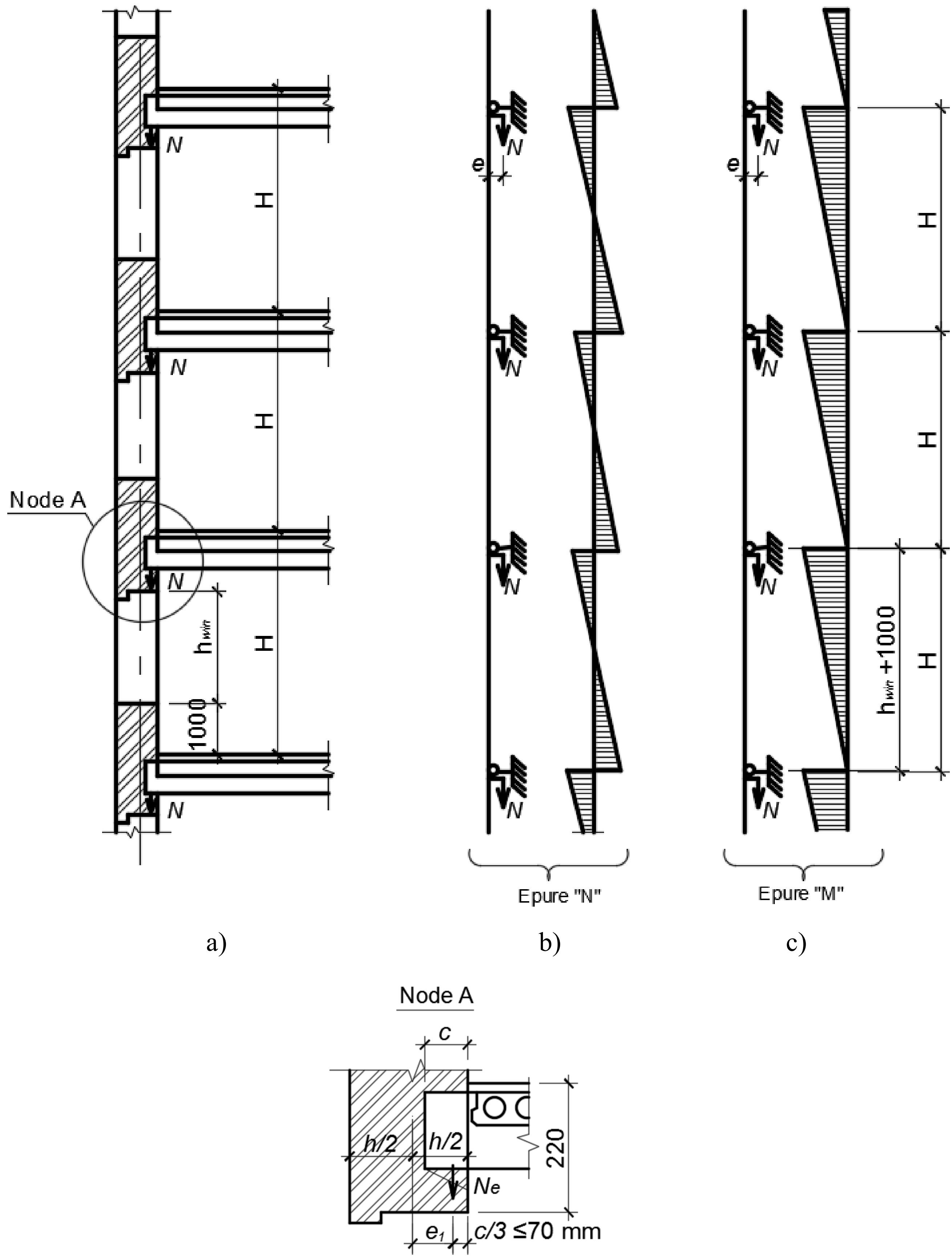

Figure 1.1 – Design scheme of the building:
a – design scheme; b – whole beam (actual); c - simply supported beam (simplified)

2 STONE STRUCTURES CALCULATION FEATURES

The strength of the brickwork depends on many factors that can effect either raising it or lowering it significantly. Regulations recommend to determine the strength of the brickwork on the basis of brickwork samples laboratory tests.

As a result, the theoretical characteristic strength of the brickwork can be determined from the equation:

$$f_k = K f_b^{a} f_m^{\beta}, \tag{2.1}$$

where f_k – characteristic (design) compressive strength of the brickwork, N/mm^2 (MPa);

K – constant which depends on the brickwork group, the building mortar thickness and its type, is given in table 2.1;

α, β – constants which can be assumed α = 0,7; β = 0,3;

f_b – normalized average compressive strength of the brickwork elements, (MPa) N/mm^2;

f_m – building mortar compressive strength, (MPa) N/mm^2.

For a thin-layer brickwork the brickwork strength can be determined as

$$f_k = K f_b^{0,85} \text{ or } f_k = K f_b^{0,7}. \tag{2.2}$$

Brickwork shear strength

$$f_{vk} = f_{vko} + 0{,}4\sigma_d, \tag{2.3}$$

but not more than 0,065f_b or f_{vlt},

where f_{vko} – characteristic initial shear strength;

f_{vlt} – boundary value f_{vk};

σ_d – design value of a compressive effort;

f_b – stone strength.

Table 2.1 – K values to be used for building mortars of general purpose, thin-layered and light

Brickwork element		General purpose building mortar	Thin-layered building mortar (thickness of brickwork horizontal seams) ≥ 0,5 mm, but ≤ 3 mm	Light building mortar with density	
				$600 \leq \rho_d \leq 800$ kg/m³	$800 \leq \rho_d \leq 1{,}300$ kg/m³
Clay brick	Group 1	0,55	0,75	0,30	0,40
	Group 2	0,45	0,70	0,25	0,30
	Group 3	0,35	0,50	0,20	0,25
	Group 4	0,35	0,35	0,20	0,25
Silicate brick	Group 1	0,55	0,80	±	±
	Group 2	0,45	0,65	±	±
Concrete filling	Group 1	0,55	0,80	0,45	0,45
	Group 2	0,45	0,65	0,45	0,45
	Group 3	0,40	0,50	±	±
	Group 4	0,35	±	±	±
Porous concrete	Group 1	0,55	0,80	0,45	0,45
Precast concrete stones	Group 1	0,45	0,75	±	±
Machined natural stone	Group 1	0,45	±	±	±
±) The building mortar/brickwork element combination is usually not used, therefore data is not provided					

2.1 The calculation of the centrally compressed or noncentrally compressed walls strength

The resistance of brick walls to vertical load depends on the wall geometry, the influence of eccentricity and the brickwork properties.

When calculating the resistance of stone walls to a vertical load, following provisions can be assumed:

– flat areas remain flat;

– the tensile strength of the brickwork in vertical direction relative to the horizontal seams equals to zero.

Design value of the vertical load applied to the brickwork wall N_{Ed}, should be less, or equal to the carrying capacity N_{Rd}, according to the condition

$$N_{Ed} \leq N_{Rd}. \qquad (2.4)$$

Design value of carrying capacity N_{Rd} at vertical load is determined using the formula

$$N_{Rd} = \Phi \cdot t \cdot f_d \cdot b, \quad (2.5)$$

where Φ –coefficient of the cross-section carrying capacity reduction, which takes the value of Φ_i for the upper and lower sections and Φ_m for the middle cross section, depending on the flexibility and eccentricity;

t – thickness of the wall;

f_d – the design compressive strength of the brickwork;

b – the length of the wall design area.

The coefficient of the cross section carrying capacity reduction for the consideration of flexibility and eccentricity:

– above or below the walls of the Φ_i:

$$\Phi_i = 1 - 2\frac{e_i}{t}, \quad (2.6)$$

where e_i – an eccentricity from above or, correspondingly, from the bottom of the wall, determined by the formula:

$$e_i = \frac{M_{id}}{N_{id}} + e_{he} + e_{init} \geq 0{,}05t, \quad (2.7)$$

where M_{id} – design value of the bending moment of the top or bottom of the wall caused by the eccentricity of the load in the resting area;

N_{id} – the design value of the vertical load above or below the wall;

e_{he} – an eccentricity from the top or bottom of the wall, caused by the horizontal loads;

e_{init} – random eccentricity;

t – the thickness of the wall.

– in the middle of the Φ_m *wall height*

The coefficient of the carrying capacity within the mid part of the height of Φ_m wall can be determined from the attachment K [1] when applying e_{mk}, where e_{mk} – eccentricity in the middle of the wall height

$$e_{mk} = e_m + e_k \geq 0{,}05t, \quad (2.8)$$

$$e_m = \frac{M_{md}}{N_{md}} + e_{hm} \pm e_{init}, \quad (2.9)$$

where e_m – eccentricity caused by the load;

M_{md} – the design value of the greatest moment in the middle of the wall height while taking into account the moments affecting from above and below the wall, as well as moments from all loads applied to the wall with eccentricity;

N_{md} – the design value of the vertical load at the middle of the wall height while taking into account all loads applied to the wall with eccentricity;

e_{hm} – an eccentricity at the middle of the height, caused by the effect of the horizontal loads.

The random eccentricity e_{init} is equal to

$$e_{init} = h_{ef}/450, \quad (2.10)$$

where h_{ef} – the free wall height of which is calculated using the formula:

$$h_{ef} = \rho_n h, \quad (2.11)$$

where h – height of one floor in the light;

ρ_n – the reduction coefficient where n = 2, 3 or 4 depending on the shear wall mounting:

– for walls fixed with reinforced concrete slabs at the bottom, or on both sides of the roof which covers the bay and has a support on one side only to the depth not less than 2/3 of the wall's thickness

$$\rho_2 = 0{,}75; \quad (2.12)$$

– for walls that are unfastened from above and below with wooden beams or roof, and have supports on both sides at the same level

$$\rho_2 = 1{,}0; \quad (2.13)$$

– for walls fastened from above and below with fixing of one vertical edge, when $h \le 3{,}5l$

$$\rho_3 = \frac{1}{1 + \left[\frac{\rho_2 h}{3l}\right]^2} \rho_2, \quad (2.14)$$

$h > 3{,}5l$

$$\rho_3 = \frac{1{,}5l}{h} \geq 0{,}3, \tag{2.15}$$

where l – the length of the wall;

– for walls fastened from above and below with increased stiffness along two vertical edges when h < 1,15l, from ρ_2, taken from (2.12) or (2.13), depending on which value is applied in a particular case:

$$\rho_4 = \frac{1}{1 + \left[\frac{\rho_2 h}{l}\right]^2} \rho_2 . \tag{2. 16}$$

For walls with applied columns, the effective thickness t_{ef} is calculated using the formula:

$$t_{ef} = \rho_t t, \tag{2.17}$$

where ρ_t – stiffness ratio for walls reinforced with applied columns (fig. 2.1, tabl. 2.2).

Table 2.2 – Stiffness ratio ρ_t t of walls reinforced with applied columns

Ratio of distance between the applied columns (center to center) to the applied column width	The ratio of the applied column thickness to the actual thickness of the wall with which it is connected		
	1	2	3
6	1,0	1,4	2,0
10	1,0	1,2	1,4
20	1,0	1,0	1,0

3 AN EXAMPLE OF STONE PARTITION CALCULATION

The designed multi-storey building consists of the bearing walls, internal reinforced concrete columns, floor slabs and coverings, which are interconnected into a single whole, and is called the spatial system. The building has transverse walls, located at a distance of l_w = 36 m.

Considering the above, a building with an incomplete reinforced concrete framework can be referred to a rigid structural scheme.

It is necessary to provide the strength of a five-storey building partition wall with the floor height H = 4,2 m. The building cross section has three bays l_1 = 7,0 m. Longitudinal step of reinforced concrete columns l_2 = 6,0m. Two windows with dimensions of $b_в$ = 1,6 m; $h_в$ = 2,0 m are located in each bay. The distance from the bottom of the windows to the floor level of the first floor is 0,75 m. The house is built in Kharkov city from clay brick of ordinary pressing with a volumetric weight of 18 kN/m^3. Taking into account the construction area, the thickness of the walls is assumed as 640 mm.

The determination of loads and forces is performed in the following sequence. First, determine the size of the gird:

$$h = 1/10 l_1 = 0,1 \cdot 700 = 70 \text{ cm}. \quad b = 0,4h = 0,4 \cdot 70 = 28 \text{ cm}.$$

Accepted separately 50 mm: b = 30 cm.

Load from the gird own weight divided by the area, is expressed as

$\frac{b \cdot h \cdot \rho}{l_2} = \frac{0.3 \cdot 0.7 \cdot 25}{6.0} =$ 0,875 kN/m, where ρ= 25 kN/m^3 – the concrete density.

The loads calculation is represented in tabular form (table 3.1).

Table 3.1 – Different loads

Load type	Characteristic load kN/m^2	Reliability index γ_f	Design load value, kN/m^2
1	2	3	4
Covering type **Constant (g)** 1. Three-layered reinforced bitumen felt (3 · 0,04)	0,12	1,2	0,14
2. Cement mortar screed δ=2,2 cm; ρ=20kNm^3 (0,02·20)	0,44	1,3	0,57
3. Heat insulation material - foam concrete δ =12 cm; ρ =4 N/m^2 (0.12x4)	0,48	1,2	0,58
4. Covering ribbed slab	1,6	1,1	1,76
5. The gird's own weight	0,875	1,1	0,96

Continuation of Table 3.1

1	2	3	4
Total (**g**)			**4,01**
Temporary (*V*) Snow load	1,6	1,04	**1,67**
Total *(g + V)*			**5,68**
Floor slab type **Constant (g)** 1 Parquet flooring δ = 3 cm; ρ = 7 kN/m^3 (0,03 × 7)	0,21	1,2	0,25
2 Asphalt cement	0,05	1,3	0,07
3 Sound insulation — slag concrete δ = 6 cm; ρ = 15 kN/m^3 (0,06 × 15)	0,9	1,3	1,17
4 Floor slab with round voids	3,0	1,1	3,3
5 The gird's own weight	0,875	1,1	0,96
Total *(g)*			**5,75**
Temporary (v= 1,5 kN/m^2)	1,5	1,3	**1,95**
Total *(g + V)*			**7,70**

The windows are located along the facade of the building within the two adjacent bays (fig. 3.1). The cross section *a–a* is a design one which passes on the top of the first floor windows, because at this level, three factors are manifested together:

a) the largest longitudinal force;

b) the greatest bending moment;

c) the smallest cross-sectional area.

Determination of design forces

Loading on the walls from the coverings and floor slabs is calculated based on the loading area:

$$A_{\text{sup.}} = \frac{l_1 - 0{,}2}{2} \cdot l_2 = \frac{7{,}0 - 0{,}2}{2} \cdot 6{,}0 = 20{,}4 \ \text{m}^2.$$

Design loads:

– from the covering

$$N_1 = (g + V)\, A_{sup.} = 5{,}8 \cdot 20{,}4 = 115{,}9 \text{ kN};$$

– from 4 inter-floor slabs

$$4N_2 = 4(g + v)\, A_{sup.} = 4 \cdot 7{,}7 \cdot 20{,}4 = 630 \text{ kN};$$

– from the wall's own weight that is transmitted to the design section (the weight of the bearing partition wall and the weight of the wall between the windows mid part, which is transmitted to the separation wall through the flat arches or bands). The surface of the crosshatched wall part of the facade

$$A_w = 1{,}4 \cdot 2{,}0 \cdot 4 + 3{,}0 \cdot 2{,}2 \cdot 4 + 3{,}0 \cdot 2{,}4 = 44{,}8 \text{ m}^2.$$

$$N_w = 44{,}8 \cdot 0{,}64 \cdot 18 \cdot 1{,}1 = 567{,}7 \text{ kN}.$$

Full vertical load affecting the design section *a-a:*

$$N = N_1 + 4\, N_2 + N_w = 115{,}9 + 630 + 567{,}7 = 1313{,}6 \text{ kN}.$$

Calculation of a partition wall

The distance from the bearing reaction application point of the gird above the first floor to the inner face of the wall in case of the gird embedding c = 250 mm;

$e_3 = c/3 = 250/3 = 83$ mm > 70 mm; assume as $e_3 = 70$ mm.

Loading eccentricity N_2 *relative to* the weight center of partition wall e_1 cross section (fig. 3.1)

$e_1 = h/2 - 70 = 640/2 - 70 = 250$ mm = 25 cm,

the bending moment affecting the cross section under the gird support

$M = N_2 \cdot e_1 = 157{,}5 \cdot 25 = 3937{,}5$ kN·cm. The bending moment in *a-a* cross section

$$M_x = \frac{M \cdot 3{,}0}{3{,}4} = \frac{3937{,}5 \cdot 2{,}75}{3{,}4} = 3184{,}7 \text{ kN·cm},$$

relative eccentricity of the longitudinal force

$$e_0 = \frac{M_x}{N} = \frac{3184{,}7}{1313{,}6} = 2{,}42 \text{ cm}.$$

Full eccentricity $e_i = e_0 + e_{init}$.

Random eccentricity $e_{init} = 1/450\ h_{ef}$,

Free height of the wall $h_{ef} = \rho_n h$,

The height of one floor in the light h = 3,4 m;

Reduction coefficient $\rho_n = \rho_4 = \dfrac{1}{1+\left[\dfrac{\rho_2 h}{l}\right]^2}\rho_2$; $\rho_2 = 1{,}0$; $l = 6$ m,

$$\rho_4 = \frac{1}{1+\left[\dfrac{1\cdot 3{,}4}{6}\right]^2}1 = 0{,}76.$$

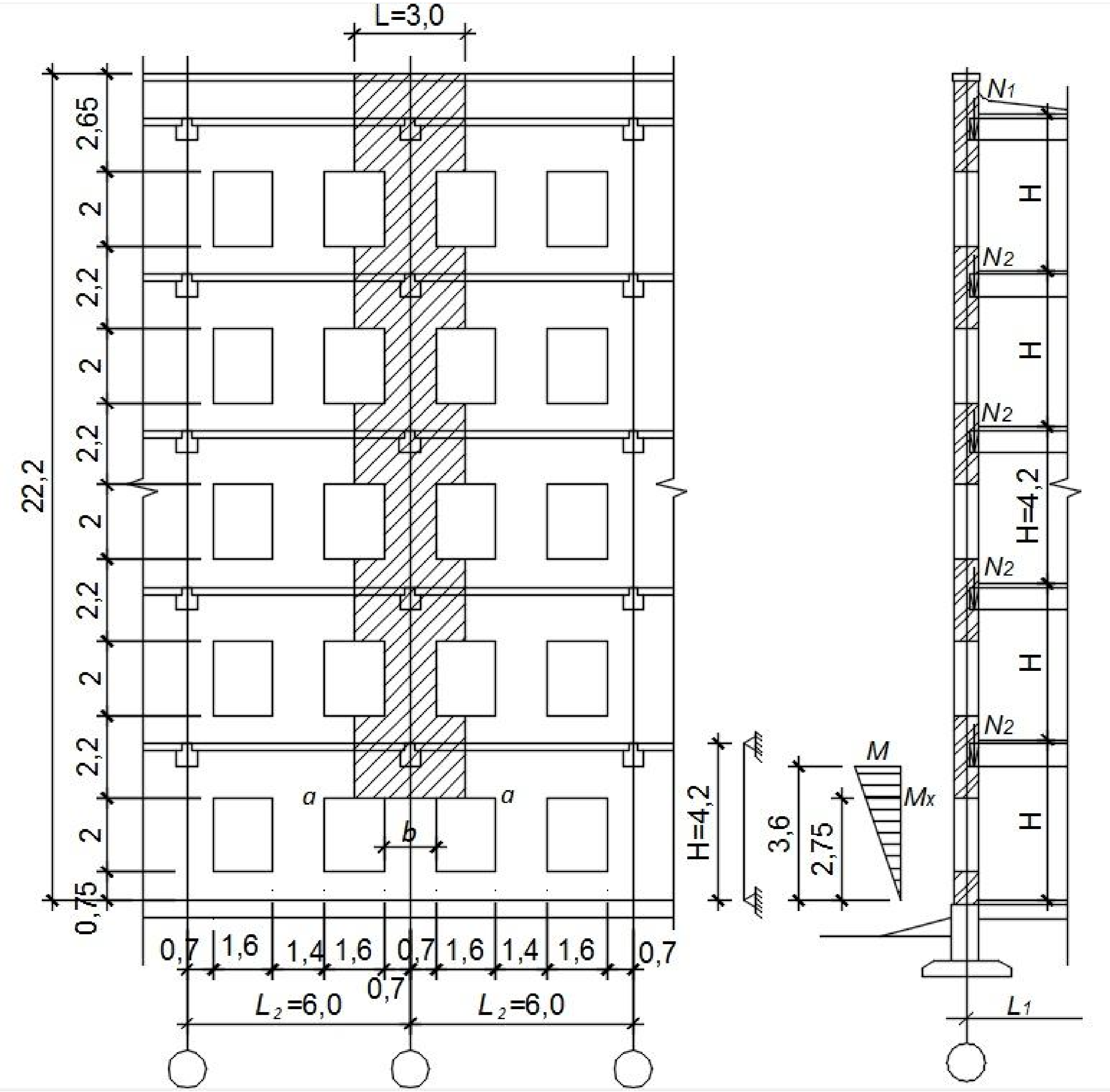

Figure 3.1 – Schemes to determine forces affecting the partition wall

$h_{ef} = 0{,}76\cdot 3{,}4 = 2{,}584$; $e_{init} = (1/450)\cdot 2{,}584 = 0{,}00574$ m $= 0{,}57$ cm;

$$e_i = 2{,}42 + 0{,}57 = 2{,}99 \text{ cm}.$$

$$\Phi_i = 1 - 2\frac{e_i}{t} = 1 - 2\frac{2{,}99}{64} = 0{,}907.$$

Using the formula $N_{Rd} = \Phi \cdot t \cdot f_d \cdot b$;

$$f_d = \frac{N_{Rd}}{\Phi \cdot t \cdot b} = \frac{1313{,}6}{0{,}907 \cdot 64 \cdot 140} = 0{,}162 \text{ kN/cm}^2 = 1{,}62 \text{ MPa}.$$

The length of the design area of *b* wall is determined from figure 3.2.

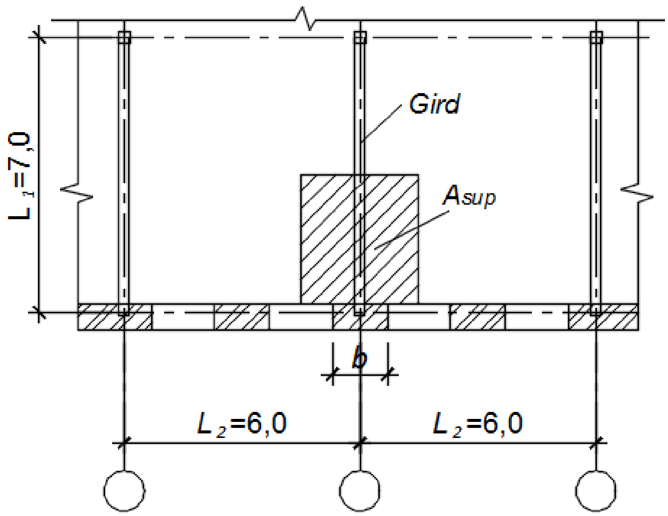

Figure 3.2 – To determine *b* – the length the wall design area

Assume the brickwork from clay bricks of plastic pressing with strength f_d = 12,5 MPa on the building mortar with strength f_d = 5 MPa (according to table 1 of Attachment).

In this case, the design resistance to pressure f_d = 1,7 MPa > 1,62 MPa.

Thus, the strength of the partition wall is assured.

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APPENDIX A

Table A.1 – Design supports for compressive strengths of brickwork from bricks of all types and ceramic stones with slit-like vertical voids in heavy building mortars.

Strength of brick or stone f_b, MPa	Design supports f_d, MPa (kgf/cm²) for brickwork compression from bricks of all types and ceramic stones with slit-like vertical voids with width up to 12 mm with height of the brickwork row 50 ... 150 mm on heavy building mortars for strength f_m of the mortar								With the strength of the solution	
	20,0	15,0	10,0	7,5	5,0	2,5	1,0	0,4	0,2	zero
30,0	3,9 (39)	3,6 (36)	3,3 (33)	3,0 (30)	2,8 (28)	2,5 (25)	2,2 (22)	1,8 (18)	1,7 (17)	1,5 (15)
25,0	3,6 (36)	3,3 (33)	3,0 (30)	2,8 (28)	2,5 (25)	2,2 (22)	1,9 (19)	1,6 (16)	1,5 (15)	1,3 (13)
20,0	3,2 (32)	3,0 (30)	2,7 (27)	2,5 (25)	2,2 (22)	1,8 (18)	1,6 (16)	1,4 (14)	1,3 (13)	1,0 (10)
15,0	2,6 (26)	2,4 (24)	2,2 (22)	2,0 (20)	1,8 (18)	1,5 (15)	1,3 (13)	1,2 (12)	1,0 (10)	0,8 (8)
12,5	–	2,2 (22)	2,0 (20)	1,9 (19)	1,7 (17)	1,4 (14)	1,2 (12)	1,1 (11)	0,9 (9)	0,7 (7)
10,0	–	2,0 (20)	1,8 (18)	1,7 (17)	1,5 (15)	1,3 (13)	1,0 (10)	0,9 (9)	0,8 (8)	0,6 (6)
7,5	–	–	1,5 (15)	1,4 (14)	1,3 (13)	1,1 (11)	0,9 (9)	0,7 (7)	0,6 (6)	0,5 (5)
5,0	–	–	–	1,1 (11)	1,0 (10)	0,9 (9)	0,7 (7)	0,6 (6)	0,5 (5)	0,35 (3,5)
3,5	–	–	–	0,9 (9)	0,8 (8)	0,7 (7)	0,6 (6)	0,45 (4,5)	0,4 (4)	0,25 (2,5)

Note. Design supports of the brickwork on building mortars of strength grade from 4 to 50 should be reduced using reduction factors: 0,85 – for brickwork on stiff cement mortars (without addition of lime or clay), light and lime solutions up tp 3 months of age; 0,9 – for cement mortars brickwork (without lime or clay) with organic softening agents.

It is not required to reduce design resistance for enhanced quality brickwork – the mortar seal is performed using the frame with leveling and compacting the mortar with the scraping straight edge. The mortar grade is specified in the project for commonplace brickwork and the brickwork of enhanced quality.

Table A.2 – Boundary relations of walls height to their thickness ($\beta=H/h$), when wind loads is not considered for walls design

Wind pressure, N/m^2	Walls impairment by apertures		
	0,7	0,5	0,3
393	12	16	19
687	9	12	14
981	8	10	12

Table A.3 – Coefficients of longitudinal bending of brickwork ***φ***

Flexibility		***φ*** for Elastic characteristics of brickwork **α**						
λ_h	λ_i	1,500	1,000	750	500	350	200	100
4	14	1,00	1,00	1,00	0,98	0,97	0,90	0,82
6	21	0,98	0,96	0,95	0,91	0,88	0,81	0,68
8	28	0,95	0,92	0,90	0,85	0,80	0,70	0,54
10	35	0,92	0,88	0,84	0,79	0,72	0,60	0,43
12	42	0,88	0,84	0,79	0,72	0,64	0,51	0,34
14	49	0,85	0,79	0,73	0,66	0,57	0,43	0,28
16	56	0,81	0,74	0,68	0,59	0,50	0,37	0,23
18	63	0,77	0,70	0,63	0,53	0,45	0,32	–
20	76	0,69	0,61	0,53	0,43	0,35	0,24	–
26	90	0,61	0,52	0,45	0,36	0,29	0,20	–
30	104	0,53	0,45	0,39	0,32	0,25	0,17	–
34	118	0,44	0,38	0,32	0,26	0,21	0,14	–
38	132	0,36	0,31	0,26	0,21	0,17	0,12	–
42	146	0,29	0,25	0,21	0,17	0,14	0,09	–
46	160	0,21	0,18	0,16	0,13	0,10	0,07	–
50	173	0,17	0,15	0,13	0,10	0,08	0,05	–
54	187	0,13	0,12	0,10	0,08	0,06	0,04	–

Note. For intermediate values of λ coefficient φ is determined according to interpolation

Table A.4 – Elastic characteristics α for some types of brickwork

Brickwork type	Mortar grade			Strength of mortar, MPa	
	200 - 25	10	4	0.2	0
From large precast concrete stones on porous fill materials, silicate, popcorn concrete on light fill materials and light natural stone	1,000	750	500	500	350
From ceramic stone	1,200	1,000	750	500	350
From commonplace clay of plastic pressing and hollow, concrete brick on porous fill materials and light natural stone	1,000	750	500	350	200
From silicate bricks	750	500	350	350	200
From clay bricks of semidry pressing	500	500	350	350	200

Table A.5 – Maximal length l_{cm} between transversal structures

Covering type	Length between transversal structures (m) for brickwork type			
	1	2	3	4
Reinforced concrete and reinforced stone prefabricated embedded and monolithic	54	42	30	–
From prefabricated reinforced concrete decking and reinforced concrete or steel beams with decking made of slabs or stones	42	36	24	–
Wooden	30	24	18	12

Table A.6 – Design and regulatory rebar supports in reinforced brickwork

Type of structures reinforcement	Rebar resistance, MPa		
	Steel of A240C grade, strip and angular	Steel of A300C grade	Commonplace reinforcing wire of B500 grade
1 Grid reinforcement	155/175*	_	220/240*
2 Longitudinal reinforcement: – tensile reinforcement – compressed reinforcement	210 180	270,19 0	250 200

Note. * The denominator specifies the standard resistance of steel

Table A.7 – Requirements for geometrical characteristics of stone brickwork elements groups

Materials and boundary values								
	Group 1 (all materials)	Elements	Group 2		Group 3		Group 4	
			Vertical voids				Horizontal voids	
Volume of all voids (% from the overall volume)	≤25	Clay brick	> 25; ≤ 55		≥ 25; ≤ 70		> 25; ≤ 70	
		Silicate brick	> 25; ≤ 55		Not used		Not used	
		Precast concrete stones[б)]	> 25; ≤ 60		≥ 25; ≤ 70		> 25; ≤ 70	
Volume of all voids (% from the overall volume)	≤12.5	Clay brick	Each of the multiple voids ≤ 2 or 12,5		Each of the multiple voids ≤ 2 or 12,5		Each of the multiple voids ≤ 30	
		Silicate brick	Each of the multiple voids ≤ 15		Not used		Not used	
		Precast concrete stones[б)]	Each of the multiple voids ≤ 30		Each of the multiple voids ≤ 30		Each of the multiple voids ≤ 25	
Stated values for brick internal and external partition, mm	No requirements		Brick internal partition	Brick external partition	Brick internal partition	Brick external partition	Brick internal partition	Brick external partition
		Clay brick	≥ 5	≥ 8	≥ 3	≥ 6	≥ 5	≥ 6
		Silicate brick	≥ 5	≥ 10	Not used		Not used	
		Precast concrete stones[б)]	≥ 15	≥ 18	≥ 15	≥ 15	≥ 20	≥ 20
Stated value for total thickness of brick's internal and external partition[a)] (% from dimensional width)	No requirements	Clay brick	≥ 16		≥ 12		≥ 12	
		Silicate brick	≥ 20		Not used		Not used	
		Precast concrete stones[б)]	≥ 18		≥ 15		≥ 45	

Note. Total thickness of brick internal and external partition, measured horizontally in the relevant direction. For testing, qualification tests shall be conducted, which should be repeated only if fundamental changes are introduced in the elements structural dimensions.

In the case of conical voids or honeycombs, the average value of brick's internal and external partition thickness is used.

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