

IZODOM 2000 POLSKA

98-220 Zduńska Wola, ul. Ceramiczna 2

tel. +48 43 823 41 88, +49 43 823 89 47, tel./fax +48 43 823 23 68

www.izodom2000polska.com e-mail: biuro@izodom2000polska.com



DESIGN AND CALCULATION GUIDELINES FOR FLOORS OF IZODOM 2000 POLSKA SYSTEM

Floors

IZODOM 2000 POLSKA /KJ

- I. Floor for habitable building
- II. Other floor applications
- III. Construction details

Authors:

M.Sc. Jacek Filipczak

M.Sc. Elżbieta Habiera

M.Sc. Ewelina Kołodziejczyk

Verification:

Prof. Maria Kamińska



Katedra Budownictwa Betonowego Politechniki Łódzkiej

Department of Concrete Structures Technical University of Lodz

93 - 590 Łódź, Al. Politechniki 6, tel. (0-42) 631-35-75, fax. (0-42) 631-35-84

Lodz, May 2012

General

IZODOM 2000 POLSKA system offers rib and block floors comprising in-situ concrete beams (KJ truss) and infill hollow core EPS (expanded polystyrene) blocks (Fig.1). The blocks are designed for the ribs spacing of 0,75m.

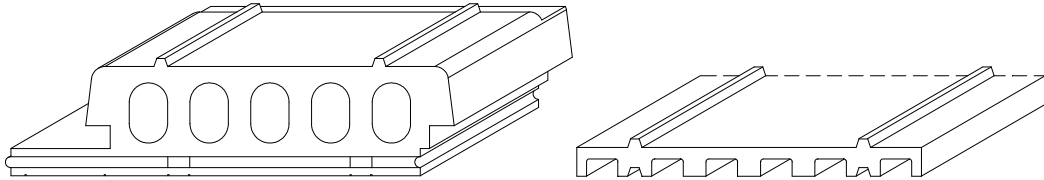


Fig. 1. EPS block and EPS filling plate of IZODOM 2000 POLSKA system

The shape of the blocks allows to achieve the good thermal insulating properties of the floor. It is important that we can design a floor above an unheated basement or below an attic without need of any additional insulation.

The overall heat transfer coefficients determined by Thermal Physics Laboratory of Building Research Institute (NF - 621/A/99 paper) are given in Table 1.

Table 1. The overall heat transfer coefficient $U_c^*)$ [W/(m²K)] according to PN-EN ISO 6946

Total floor depth	Direction of heat flux	
	from bottom to top	from top to bottom
0,25m	0,34	0,32
0,30m	0,29	0,28
0,35m	0,27	0,26
*) including thermal bridges		

The 50mm thickness of the topping concrete assures high stiffness of the floor and fire resistance R30 [4].

The 200mm height of the block and a 50mm topping concrete gives the total floor depth of 250mm and the design depth of 200mm. The system includes also 50mm flat cover plates with longitudinal hollows formed on the underside (Fig.1). The plates enable to increase the design depth to 250mm or 300mm (Fig.2).

The infill blocks and the cover plates are manufactured with special 'locks' to simplify the erection of the floor, stabilize their location and improve thermal properties of the insulating barrier as it gives an unbroken layer of insulation below. This way of EPS blocks combination guarantees stability during the casting.

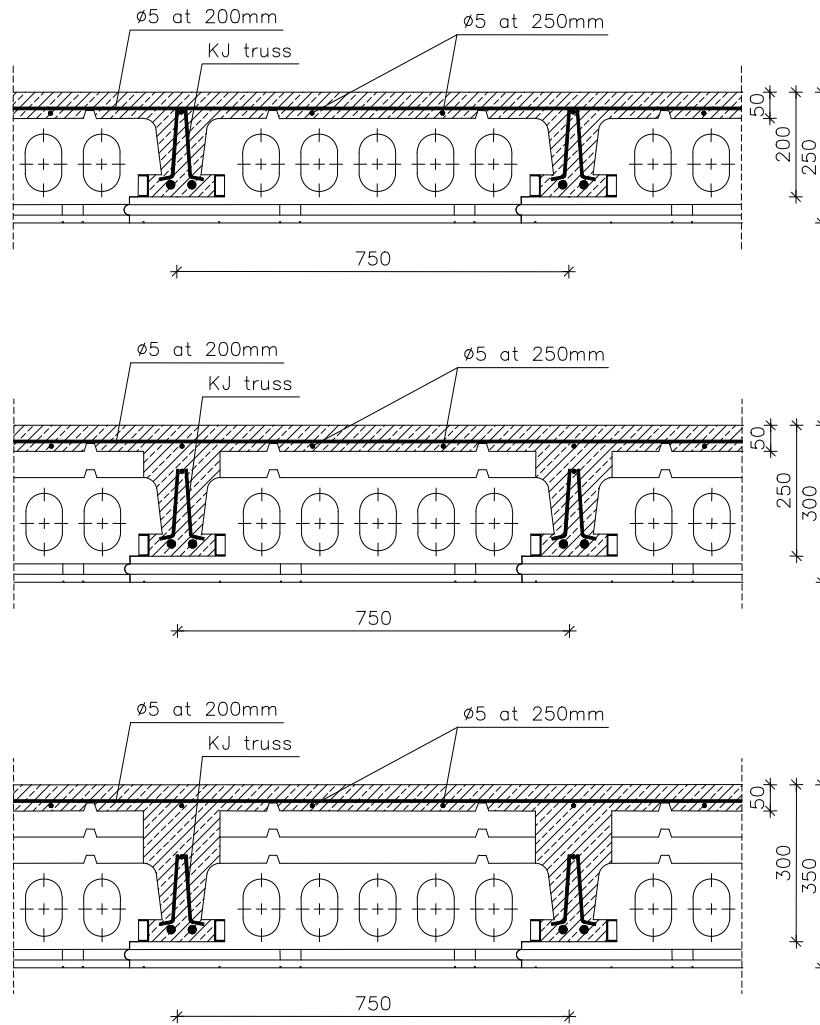


Fig. 2. IZODOM floor cross sections - different design depths

The main reinforcement of the rib is a KJ truss, manufactured as a welded reinforcing cage (Fig. 3) comprising RB500W steel bars with characteristic yield strength (f_{yk}) of 500MPa. Two different lengths of the bottom reinforcement (No.2 and No.3) of the truss are design according to a bending moment distribution.

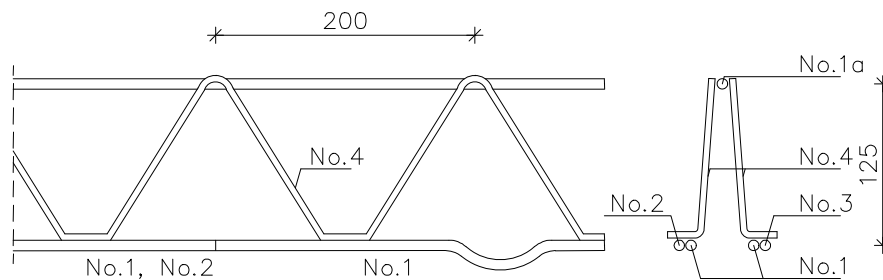


Fig. 3. Welded steel KJ truss

KJ trusses are delivered by the company together with infill EPS elements.

During concreting works, shuttering must be applied at joint of the hollow blocks along the in-situ concrete ribs (look at p. III.4).

The main advantage of the floor is the large ribs spacing, equal to 0,75m that leads to significant savings in time and cost. Furthermore, this type of the floor reduces much of the site work. The prepared floor has a flat and smooth bottom surface what makes it easy to finish. The ceiling can be finished with wallpapers, textured plaster, gypsum boards or other materials.

There are also other advantages of IZODOM 2000 POLSKA flooring system - the possibility of placing electrical wires or other elements of installation inside the floor, easy assembly of suspended ceilings and lighting. Installation pipes and wires can be put in the longitudinal hollows of the cover plates or inside steel galvanized cold-rolled profiles 40,5×18×1,50mm, placed in the undercuts of the blocks. The same profiles can be used to fasten other elements e.g. interior decorations. It is facilitated by the line nicks setting the location of the steel elements. The details are shown in the Figure 4.

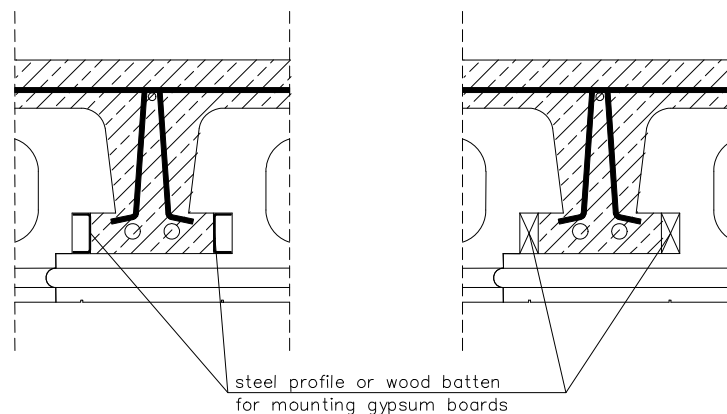


Fig. 4. The location of cold-rolled profiles and wood battens in the floor

The elements should be anchored in the rib concrete with self drilling steel screws. When there is no need to make the installation ducts, the 20×40mm wood battens can be used instead the steel profiles. The battens must be impregnated with the substance which is neutral for EPS (expanded polystyrene) and approved for use in rooms intended for human residence by National Institute of Hygiene.

The floor without steel profiles or wood battens also can be designed. In this case we obtain a wider flange of the concrete ribs.

Dimensions of the ribs assumed in load-bearing capacity and deflection calculations relevant to the three different design depths of the floor of 0,20, 0,25 and 0,30m are presented in Figure 5.

The values of bending moments and shear forces are determined for concrete class not lower than C20/25 and B or C class reinforcing (longitudinal and transverse) steel with characteristic yield strength $f_{yk} \geq 500\text{MPa}$. The calculations were conducted according to PN-EN 1992-1-1. The coefficients $\gamma_c = 1,5$ and $\cot(\theta)=2,0$ were assumed.

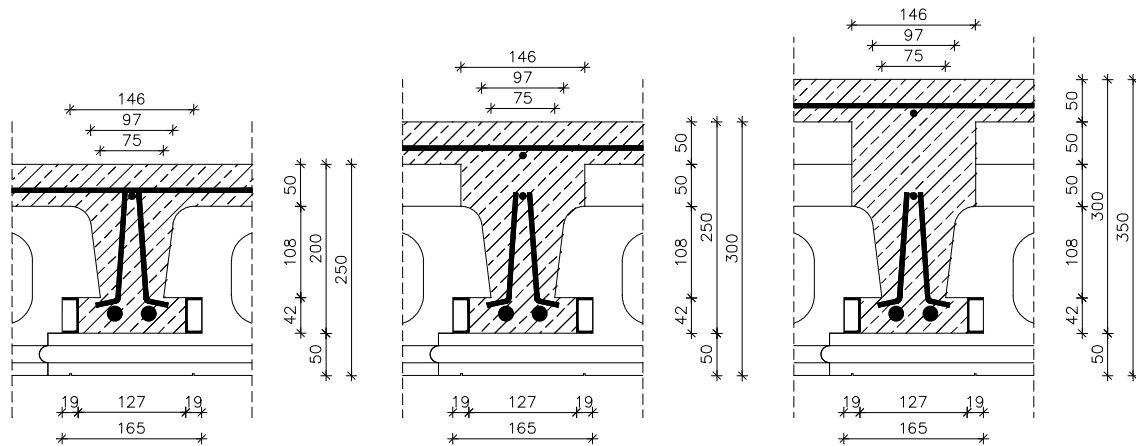


Fig. 5. The rib cross section at the three different design depth of the floor

The support zones of the ribs where the highest shear occurs were also included in calculations. As the KJ reinforcement trusses are the same height there was designed additional transverse reinforcement in form of a wiggly line - bar (Fig.1.1) fitted the design depth of the floor (compare Fig. 2).

Apart from the shear reinforcement, top reinforcement is required to be provided on the whole surface of the floor. There are parallel to the ribs $\varnothing 5\text{mm}$ bars spaced at 250mm and the perpendicular spaced at 200mm designed in the topping concrete (compare Fig. 2).

Relevant codes:

- [1] PN-EN 1990:2004 Eurocode 0: Basis of Structural Design
- [2] PN-EN 1991-1-1:2004 Eurocode 1: Actions on structures. Part 1-1: General actions - Densities, self-weight, imposed loads for buildings
- [3] PN-EN 1992-1-1:2008 Eurocode 2: Design of concrete structures Part 1-1: General rules and rules for buildings
- [4] PN-EN 1992-1-2:2008 Eurocode 2: Design of concrete structures Part 1-2: General rules - Structural fire design

I. Floor for habitable building

For habitable building floor the following loads were assumed:

- floor finish materials 1,50kN/m²
- equivalent uniformly distributed load of movable partitions 0,50kN/m²
- live load 2,00kN/m²

The self-weight load of the floor depends on its total depth and it is given in the index cards. It was assumed that each span length refers to a particular type of the reinforcement truss, described in Table A. The design depth of the floor should be determined on the basis of Table A for the design span length, defined as a length between axes of the bearing walls.

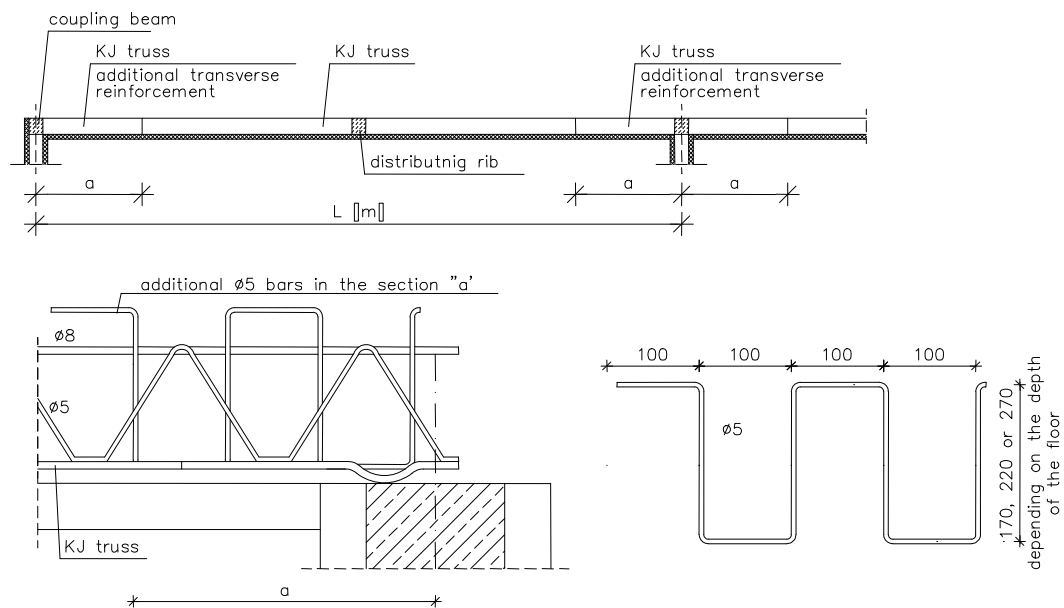


Fig. I.1. Additional transverse reinforcement $\varnothing 5$ of steel with $f_{yk} \geq 500\text{MPa}$

Apart from the main reinforcement KJ truss, additional transverse reinforcement should be provided in the ribs. In floors with the design depth of 0,20m this reinforcement is not required, what is presented in table B.

For floors with the design depth of 0,25m or 0,30m, the length 'a' (measured from the axis of the support) where the additional reinforcement should be applied is given in Table B. The reinforcement should be made of $\varnothing 5$ steel bars – which characteristic yield strength $f_{yk} \geq 500\text{MPa}$ and form into a wiggly line (Fig. I.1).

The design bending moments of the single rib in relation to the type of the KJ truss and the depth of the floor are given in Table B. It is meant to simplify verification of the ultimate limit state of the floor under different loads than they were assumed in the calculations (e.g. a partition wall parallel to the rib or a column of the roof structure). In these cases, the shear resistance of the ribs should be also verified. Design shear

force in a rib section can not exceed the value $V_{Rd,max}$ defined as the design value limited by crushing of the compression struts. In regions of the member where V_{Ed} is higher than $V_{Rd,c}$ (the design shear resistance of the member without shear reinforcement, Table I.1) calculated shear reinforcement is necessary. The cross-sectional area of the shear reinforcement and the spacing of the stirrups can be taken (to satisfy $V_{Ed} \leq V_{Rd,s}$ condition) according to Table I.1.

The range of transverse reinforcement (from the axis of the support) under constant lateral load $q' = 0,75q_{Ed}$ [kN/m] can be calculated from:

$$a = \frac{V_{Ed} - V_{Rd,c}}{V_{Ed}} \cdot \frac{L}{2}, \text{ where: } V_{Ed} = q' \cdot \frac{L}{2}$$

but for different kind of a load the distance should be determined according to a shear force graph.

Table I.1. The design values V_{Rd} for a single rib

V_{Rd}	Reinforcement	Design floor depth		
		0,20m	0,25m	0,30m
$V_{Rd,c}$ kN / rib	the main bottom bars of the truss (bars No. 1)			
	Ø6	6,56	7,46	8,12
	Ø8	7,96	9,05	9,85
	Ø10	9,25	10,52	11,45
$V_{Rd,s}$ kN / beam	the transverse reinforcement of the truss	30,82	-	-
	additional Ø5 at 100mm	-	35,30	42,97
$V_{Rd,max}$ kN / rib		35,77	45,70	55,64

If the load bearing capacity of the single rib is not sufficient for assumed loads, the floor with double rib or with double rib and additional reinforced between (Fig. I.2) can be also designed.

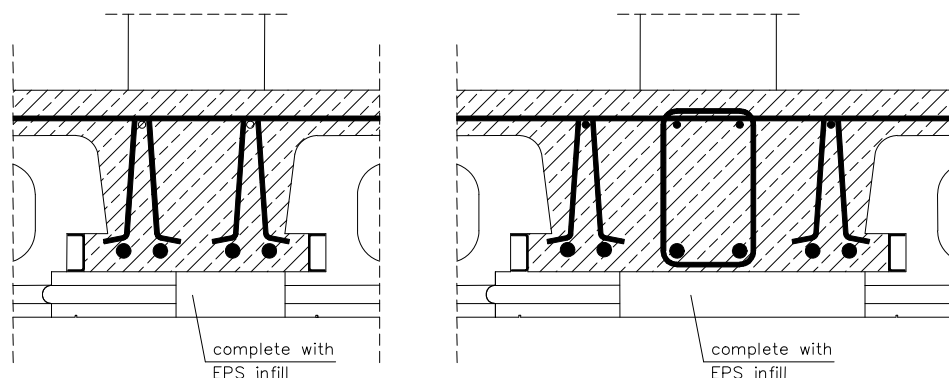


Fig. I.2. Construction details of the double ribs for high loads (e.g. loaded with a partition wall or a bearing column)

IZODOM 2000 POLSKA FLOOR / KJ for habitable building

The design depth 0,20m

Loads per 1m² of a floor area:

Load type	characteristic kN/m ²	γ_f	design kN/m ²		sustained kN/m ²
self-weight load	1,85	1,35	2,50	4,53	1,85
floor finish materials	1,50	1,35	2,03		1,50
movable partitions	0,50	1,50	0,75	3,75	0,50
live load	2,00	1,50	3,00		0,60 ^{*)}
				8,28	4,45

*) according to [1] $\Psi_2 = 0,3$.

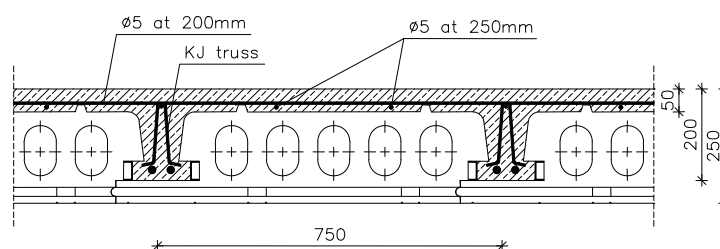
The reduced load according to [1]:

expression 6.10a $q_{Ed} = 0,85 \times 4,53 + 3,75 = 7,60 \text{ kN/m}^2$

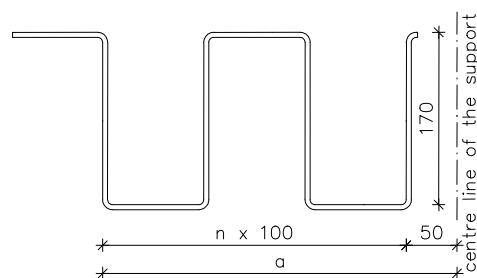
expression 6.10b $q_{Ed} = 4,53 + 0,70 \times 3,75 = 7,16 \text{ kN/m}^2$

assumed load $q_{Ed} = 7,60 \text{ kN/m}^2$

The reinforcement of the KJ truss should be determined for the assumed span length (between the wall axes) according to Table A.



The transverse reinforcement applied at the support zones („a” distance) should be made of $\varnothing 5$ mm steel bars with a yield strength $f_{yk} \geq 500 \text{ MPa}$ and shaped into a wiggly line like in the picture below.



Moreover, a reinforcement linking the floor with coupling beams of external and internal walls should be provided according to 4.2.

NOTE

For this depth of the floor, the span length should not exceed 5,50m.

If the load of the floor is different than it was assumed in the calculations, the nomograms given in part II should be used.

Material usage	concrete class min. C20/25	0,069m ³ /m ²
	$\varnothing 5$ mm bars in the topping	7,80mb/m ² (1,20kg/m ²)

IZODOM 2000 POLSKA FLOOR / KJ for habitable building

The design depth 0,25m

Loads per 1m² of a floor area:

Load type	characteristic kN/m ²	γ_f	design kN/m ²		sustained kN/m ²
self-weight load	2,04	1,35	2,75	4,78	2,04
floor finish materials	1,50	1,35	2,03		1,50
movable partitions	0,50	1,50	0,75	3,75	0,50
live load	2,00	1,50	3,00		0,60 ^{*)}
				8,53	4,64

*) according to [1] $\Psi_2 = 0,3$.

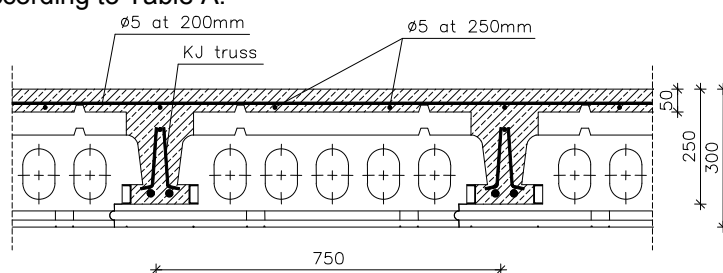
The reduced load according to [1]:

expression 6.10a $q_{Ed} = 0,85 \times 4,78 + 3,75 = 7,81 \text{ kN/m}^2$

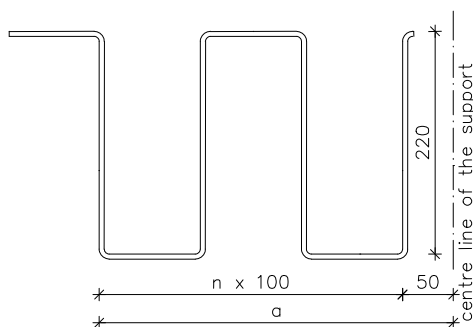
expression 6.10b $q_{Ed} = 4,78 + 0,70 \times 3,75 = 7,41 \text{ kN/m}^2$

assumed load $q_{Ed} = 7,81 \text{ kN/m}^2$

The reinforcement of the KJ truss should be determined for the assumed span length (between the wall axes) according to Table A.



The transverse reinforcement applied at the support zones („a” distance) should be made of Ø5mm steel bars with a yield strength $f_{yk} \geq 500 \text{ MPa}$ and shaped into a wiggly line like in the picture below.



Moreover, a reinforcement linking the floor with coupling beams of external and internal walls should be provided according to 4.2.

NOTE

For this depth of the floor, the span length should not exceed 6,60m.

If the load of the floor is different than it was assumed in the calculations, the nomograms given in part II should be used.

Material usage	concrete class min. C20/25	0,079m ³ /m ²
	Ø5mm bars in the topping	9,00mb/m ² (1,40kg/m ²)

IZODOM 2000 POLSKA FLOOR / KJ for habitable building

The design depth 0,30m

Loads per 1m² of a floor area:

Load type	characteristic kN/m ²	γ_f	design kN/m ²		sustained kN/m ²
self-weight load	2,29	1,35	3,09	5,12	2,29
floor finish materials	1,50	1,35	2,03		1,50
movable partitions	0,50	1,50	0,75	3,75	0,50
live load	2,00	1,50	3,00		0,60 ^{*)}
				8,87	4,89

*) according to [1] $\Psi_2 = 0,3$.

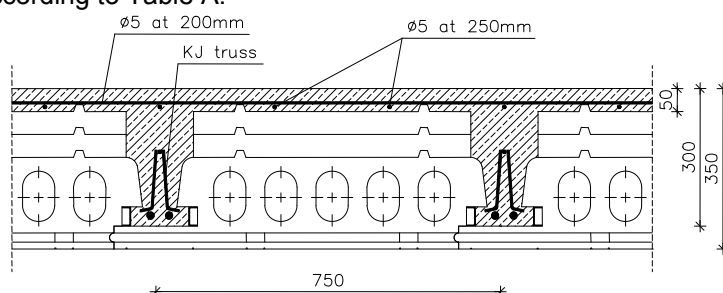
The reduced load according to [1]:

expression 6.10a $q_{Ed} = 0,85 \times 5,12 + 3,75 = 8,10 \text{ kN/m}^2$

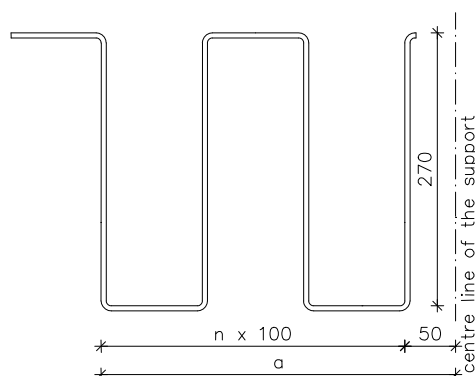
expression 6.10b $q_{Ed} = 5,12 + 0,70 \times 3,75 = 7,75 \text{ kN/m}^2$

assumed load $q_{Ed} = 8,10 \text{ kN/m}^2$

The reinforcement of the KJ truss should be determined for the assumed span length (between the wall axes) according to Table A.



The transverse reinforcement applied at the support zones („a” distance) should be made of Ø5mm steel bars with a yield strength $f_{yk} \geq 500 \text{ MPa}$ and shaped into a wiggly line like in the picture below.



Moreover, a reinforcement linking the floor with coupling beams of external and internal walls should be provided according to 4.2.

NOTE

For this depth of the floor, the span length should not exceed 7,80m.

If the load of the floor is different than it was assumed in the calculations, the nomograms given in part II should be used.

Material usage	concrete class min. C20/25	0,089m ³ /m ²
	Ø5mm bars In the topping	9,00mb/m ² (1,40kg/m ²)

TYPICAL FLOOR FOR HABITABLE BUILDING

Table A

Bars sections and their lengths in the truss IZODOM 2000 POLSKA / KJ

Length of the truss L [m]	Number and diameter of bars with the length equal to the length of the truss			Number of welded bars, their diameter and length				Design depth of the floor		
	No. 1	No. 1a	No. 4	No. 2		No. 3		[m]		
	Ø [mm]	Ø [mm]	Ø [mm]	Ø [mm]	L ₂ [m]	Ø [mm]	L ₃ [m]			
1	2	3	4	5	6	7	8	9	10	11
≤ 3,00	2Ø6	1Ø8	2Ø5	1Ø6	3,00	1Ø6	2,24	0,20	0,25	0,30
3,10	2Ø6	1Ø8	2Ø5	1Ø6	3,10	1Ø6	2,44			
3,20	2Ø6	1Ø8	2Ø5	1Ø6	3,20	1Ø6	2,44			
3,30	2Ø6	1Ø8	2Ø5	1Ø6	3,30	1Ø6	2,64			
3,40	2Ø6	1Ø8	2Ø5	1Ø6	3,40	1Ø6	2,64			
3,50	2Ø6	1Ø8	2Ø5	1Ø6	3,50	1Ø6	2,84			
3,60	2Ø8	1Ø8	2Ø5	1Ø6	2,44					
3,70	2Ø8	1Ø8	2Ø5	1Ø6	2,64					
3,80	2Ø8	1Ø8	2Ø5	1Ø6	2,64					
3,90	2Ø8	1Ø8	2Ø5	1Ø6	3,24	1Ø6	2,44			
4,00	2Ø8	1Ø8	2Ø5	1Ø6	3,24	1Ø6	2,44			
4,10	2Ø8	1Ø8	2Ø5	1Ø6	3,44	1Ø6	2,64			
4,20	2Ø8	1Ø8	2Ø5	1Ø6	3,44	1Ø6	2,64			
4,30	2Ø8	1Ø8	2Ø5	1Ø8	4,04	1Ø6	2,84			
4,40	2Ø8	1Ø8	2Ø5	1Ø8	4,04	1Ø6	2,84			
4,50	2Ø8	1Ø8	2Ø5	1Ø8	4,24	1Ø6	2,64			
4,60	2Ø8	1Ø8	2Ø5	1Ø8	3,44	1Ø8	2,64			
4,70	2Ø8	1Ø8	2Ø5	1Ø8	3,64	1Ø8	2,84			
4,80	2Ø8	1Ø8	2Ø5	1Ø10	4,80	1Ø8	3,24			
4,90	2Ø8	1Ø8	2Ø5	1Ø10	4,90	1Ø8	3,44			
5,00	2Ø8	1Ø8	2Ø5	1Ø10	5,00	1Ø10	3,84			
5,10	2Ø8	1Ø8	2Ø5	1Ø10	5,10	1Ø10	4,04			
5,20	2Ø10	1Ø8	2Ø5	1Ø10	4,84	1Ø8	3,64			
5,30	2Ø10	1Ø8	2Ø5	1Ø10	5,04	1Ø10	3,84			
5,40	2Ø10	1Ø8	2Ø5	1Ø12	5,04	1Ø10	3,84			
5,50	2Ø10	1Ø8	2Ø5	1Ø12	5,24	1Ø12	4,44			
5,60	2Ø8	1Ø8	2Ø5	1Ø10	5,24	1Ø8	3,64			
5,70	2Ø8	1Ø8	2Ø5	1Ø10	5,70	1Ø10	4,24			
5,80	2Ø8	1Ø8	2Ø5	1Ø10	5,80	1Ø10	4,24			
5,90	2Ø8	1Ø8	2Ø5	1Ø10	5,90	1Ø10	4,44			
6,00	2Ø10	1Ø8	2Ø5	1Ø10	5,24	1Ø8	4,04			
6,10	2Ø10	1Ø8	2Ø5	1Ø10	5,44	1Ø8	4,24			
6,20	2Ø10	1Ø8	2Ø5	1Ø10	5,44	1Ø10	4,24			
6,30	2Ø10	1Ø8	2Ø5	1Ø10	5,64	1Ø10	4,44			
6,40	2Ø10	1Ø8	2Ø5	1Ø12	6,04	1Ø10	4,04			
6,50	2Ø10	1Ø8	2Ø5	1Ø12	6,24	1Ø10	4,24			
6,60	2Ø10	1Ø8	2Ø5	1Ø12	6,24	1Ø12	5,04			
6,70	2Ø10	1Ø8	2Ø5	1Ø10	5,64	1Ø8	4,44			
6,80	2Ø10	1Ø8	2Ø5	1Ø10	6,04	1Ø10	4,44			
6,90	2Ø10	1Ø8	2Ø5	1Ø10	6,24	1Ø10	4,64			
7,00	2Ø10	1Ø8	2Ø5	1Ø10	6,24	1Ø10	4,64			
7,10	2Ø10	1Ø8	2Ø5	1Ø10	6,04	1Ø10	4,84			
7,20	2Ø10	1Ø8	2Ø5	1Ø12	6,44	1Ø10	4,44			
7,30	2Ø10	1Ø8	2Ø5	1Ø12	6,64	1Ø10	4,64			
7,40	2Ø10	1Ø8	2Ø5	1Ø12	6,64	1Ø10	4,64			
7,50	2Ø10	1Ø8	2Ø5	1Ø12	7,24	1Ø12	5,24			
7,60	2Ø10	1Ø8	2Ø5	1Ø12	7,24	1Ø12	5,24			
7,70	2Ø10	1Ø8	2Ø5	1Ø12	7,44	1Ø12	5,44			
7,80	2Ø10	1Ø8	2Ø5	1Ø12	7,44	1Ø12	5,44			

TYPICAL FLOOR FOR HABITABLE BUILDING

Table B

Ultimate bending and shear capacity for rib IZODOM 2000 POLSKA / KJ

Length of the truss L [m]	Truss bars			Bending moment carried by one rib [kNm] at the depth of the floor			Length of "a" distance at the support zones [m] with additional reinforcement for shear at the depth of the floor			
	No. 1	No. 2	No. 3	0,20m	0,25m	0,30m	0,20m	0,25m	0,30m	
	∅ [mm]	∅ [mm]	∅ [mm]							
1	2	6	7	8	3	4	6	7	8	
≤ 3.00	2∅6	1∅6	1∅6	8,81	11,25	13,68	-	0,55	0,65	
3.10	2∅6	1∅6	1∅6				-	0,55	0,65	
3.20	2∅6	1∅6	1∅6				-	0,55	0,65	
3.30	2∅6	1∅6	1∅6				-	0,55	0,65	
3.40	2∅6	1∅6	1∅6				-	0,55	0,65	
3.50	2∅6	1∅6	1∅6	10,10	12,90	15,71	-	0,55	0,65	
3.60	2∅8	1∅6					-	0,55	0,65	
3.70	2∅8	1∅6					-	0,55	0,65	
3.80	2∅8	1∅6		12,28	15,70	19,11	-	0,55	0,65	
3.90	2∅8	1∅6	1∅6				-	0,55	0,65	
4.00	2∅8	1∅6	1∅6				-	0,55	0,65	
4.10	2∅8	1∅6	1∅6				-	0,55	0,65	
4.20	2∅8	1∅6	1∅6				-	0,55	0,65	
4.30	2∅8	1∅8	1∅6	13,97	17,86	21,76	-	0,65	0,65	
4.40	2∅8	1∅8	1∅6				-	0,65	0,65	
4.50	2∅8	1∅8	1∅6				-	0,75	0,65	
4.60	2∅8	1∅8	1∅8				-	0,75	0,75	
4.70	2∅8	1∅8	1∅8	15,66	20,03	24,40	-	0,85	0,75	
4.80	2∅8	1∅10	1∅8				-	0,85	0,85	
4.90	2∅8	1∅10	1∅8				-	0,95	0,85	
5.00	2∅8	1∅10	1∅10	17,81	22,81	27,80	-	0,85	0,85	
5.10	2∅8	1∅10	1∅10				-	0,95	0,95	
5.20	2∅10	1∅10	1∅8	19,97	25,58	31,19	-	1,05	0,95	
5.30	2∅10	1∅10	1∅10	22,03	28,24	34,45	-	0,85	0,75	
5.40	2∅10	1∅10	1∅10	24,17	31,00	37,83	-	0,85	0,85	
5.50	2∅10	1∅12	1∅10	26,73	34,31	41,89	-	0,95	0,85	
5.60	2∅10	1∅12	1∅12	29,27	37,60	45,93	-	0,95	0,95	
5.70	2∅8	1∅10	1∅8		22,81	27,80		1,25	1,25	
5.80	2∅8	1∅10	1∅10		25,58	31,19		1,35	1,25	
5.90	2∅8	1∅10	1∅10				-	1,35	1,35	
6.00	2∅8	1∅10	1∅10				-	1,45	1,35	
6.10	2∅10	1∅10	1∅8		28,24	34,45		1,25	1,15	
6.20	2∅10	1∅10	1∅8				-	1,25	1,25	
6.30	2∅10	1∅10	1∅10		31,00	37,83		1,35	1,25	
6.40	2∅10	1∅10	1∅10				-	1,35	1,35	
6.50	2∅10	1∅12	1∅10				-	1,45	1,35	
6.60	2∅10	1∅12	1∅10		34,31	41,89		1,45	1,45	
6.70	2∅10	1∅12	1∅10				-	1,45	1,45	
6.80	2∅10	1∅12	1∅12		37,60	45,93		1,55	1,45	
6.90	2∅10	1∅10	1∅8			34,62			1,55	
7.00	2∅10	1∅10	1∅10			37,83			1,55	
7.10	2∅10	1∅10	1∅10				-			1,65
7.20	2∅10	1∅10	1∅10				-			1,65
7.30	2∅10	1∅12	1∅10			41,89			1,75	
7.40	2∅10	1∅12	1∅10				-			1,75
7.50	2∅10	1∅12	1∅10				-			1,85
7.60	2∅10	1∅12	1∅12			45,93			1,85	
7.70	2∅10	1∅12	1∅12				-			1,95
7.80	2∅10	1∅12	1∅12				-			1,95
7.90	2∅10	1∅12	1∅12				-			2,05
8.00	2∅10	1∅12	1∅12			-			2,05	

II. Other floor applications

The design depth of the floor and the main reinforcement should be determined pursuant to appropriate nomograms.

Nomograms were prepared assuming:

- KJ truss as a ribs reinforcement,
- concrete class C20/25,
- the span of the floor between the wall axes from 3,0 to 7,8m.

Nomograms concern the two issues – load capacity and deflections. Nomograms allow to determine required main reinforcement, i.e. choose an appropriate KJ truss with a fixed longitudinal reinforcement. Permissible deflection of the floor is taken as $L/250$ or $L/500$, selectable by the designer and investor, and depends on the objects function.

After selecting the depth of the floor, the expected total design load and characteristic sustained load of the floor must be specified. Then on the basis of the appropriate nomograms the required main reinforcement of the ribs must be selected.

If the floor has two or more spans, additional $\varnothing 12$ ribbed steel bars should be used over the support, one for each floor beam. This top reinforcement should extend at least $1/3$ the length of the span, measured from the face of the support.

The range of the additional transverse ribs reinforcement and diameter of the bars should be set using the values specified in the Table II.1 and the relationships as in point I.

Table II.1. The design values V_{Rd} transmitted by the band of the floor with a width of 1m

V_{Rd}	Reinforcement	Design floor depth		
		0,20m	0,25m	0,30m
$V_{Rd,c}$ kN / m	the main bottom bars of the truss (bars No. 1)			
	$\varnothing 6$	8,75	9,95	10,82
	$\varnothing 8$	10,61	12,06	13,13
	$\varnothing 10$	12,33	14,02	15,26
$V_{Rd,s}$ kN / m	the transverse reinforcement of the truss	41,09	-	-
	additional $\varnothing 5$ at 100mm	-	47,06	57,29
$V_{Rd,max}$ kN / m		47,69	60,93	74,18

Example

Design a simply supported floor with a span $L=5,9\text{m}$ made of the concrete class C20/25.

Due to the span, assumed the floor with the design depth $0,25\text{m}$.

The load of the floor $[\text{kN}/\text{m}^2]$ amount to:

	total design			characteristic sustained	
		γ_f		γ_f	
▪ flooring	0,80	1,35	1,08	1,0	0,80
▪ self-weight load	2,04	1,35	2,75	1,0	2,04
▪ gypsum boards					
under the floor	0,20	1,35	0,27	1,0	0,20
▪ equivalent load of					
movable partitions	0,25	1,50	0,38	1,0	0,25
▪ live load	5,00	1,50	<u>7,50</u>	0,5	<u>2,50</u>
			11,98		5,79

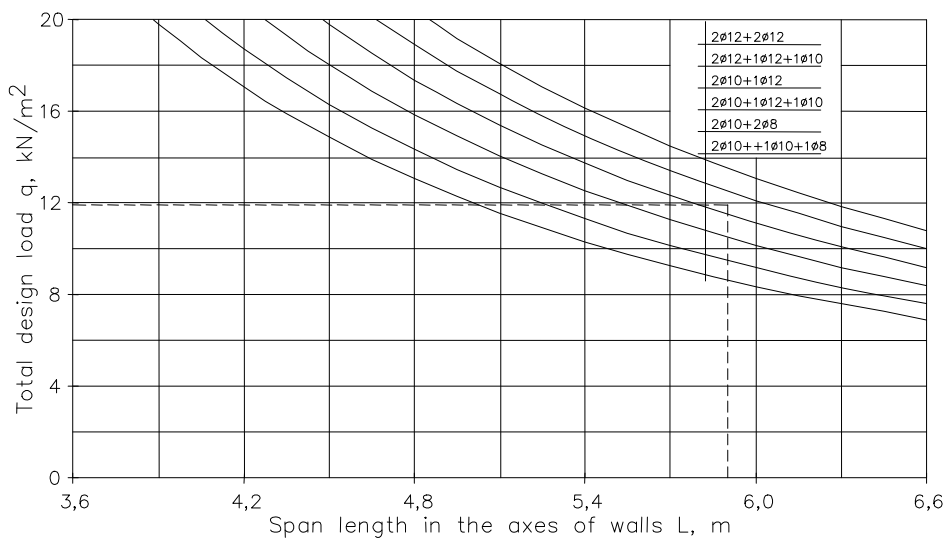


Fig. II.1a. Establishment of the main reinforcement of the floor required due to capacity

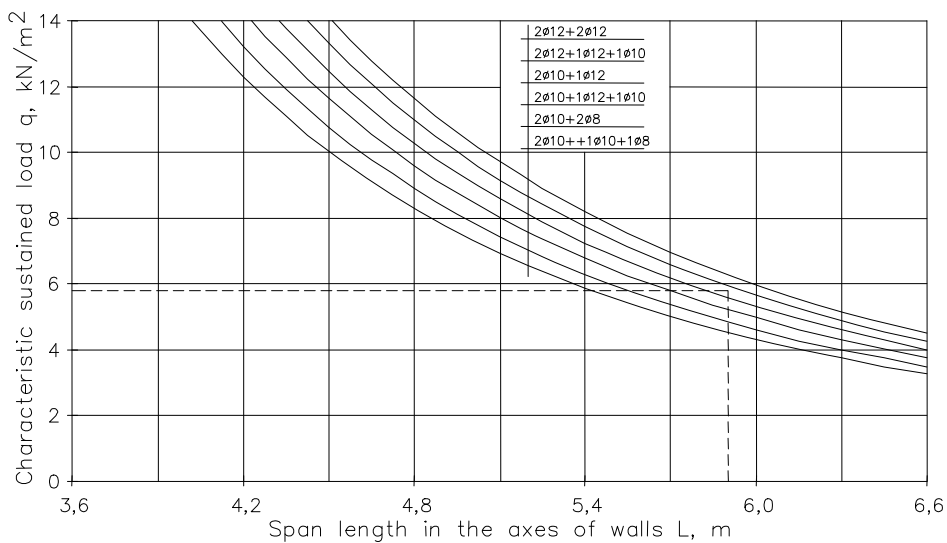


Fig. II.1b. Establishment of the main reinforcement of the floor required due to deflection; $a_{dop} = L/250$

From the nomogram for the floor with the design depth $h=0,25\text{m}$ (Fig. II.1a) can be read that due to the load capacity is needed $2\varnothing12 + 1\varnothing12 + 1\varnothing10$ reinforcement, with a total cross-sectional area $\Sigma A_s=4,17\text{cm}^2$.

Due to the deflection, at the allowable deflection $L/250$ (Fig. II.1b), the same bottom truss reinforcement $2\varnothing12 + 1\varnothing12 + 1\varnothing10$ ($A_s=4,17\text{cm}^2$) is required.

The floor with a design depth $h = 0,25\text{m}$ can not satisfy a condition of permissible deflection equal to $L/500$.

The design transverse force follow from:

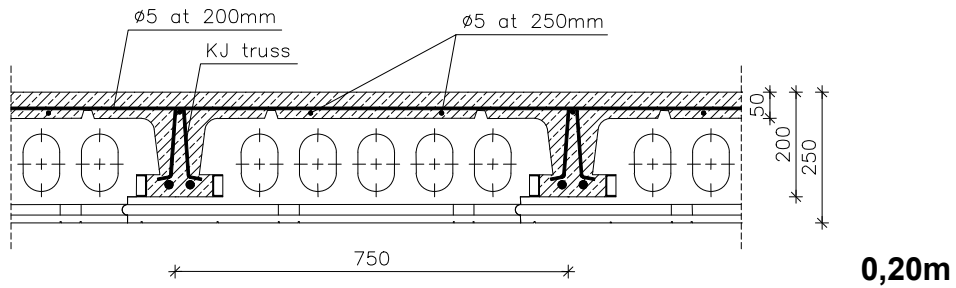
$$V_{Ed} = \frac{qL}{2} = \frac{11,98 \cdot 5,9}{2} = 35,34\text{kN/m}$$

and does not exceed $V_{Rd,max}=60,93\text{kN/m}$ (Table II.1), therefore for $V_{Rd,c}=14,02\text{kN/m}$ (table II.1, $h=0,25\text{m}$, bottom main reinforcement $\varnothing10\text{mm}$), the transverse reinforcement is required in sections of length:

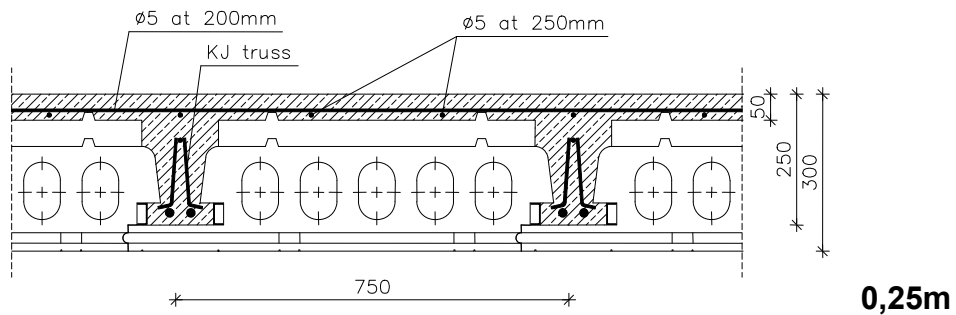
$$a = \frac{35,34 - 14,02}{35,34} \cdot \frac{5,9}{2} = 1,78\text{m}$$

In these sections on both supports the transverse reinforcement of the truss should be completed as it shown in the Fig. I.1. On the basis of the table II.1 we assume the transverse reinforcement $\varnothing5$ at 100mm , for which $V_{Rd,s}=47,06\text{kN/m} > V_{Ed}=35,34\text{kN/m}$.

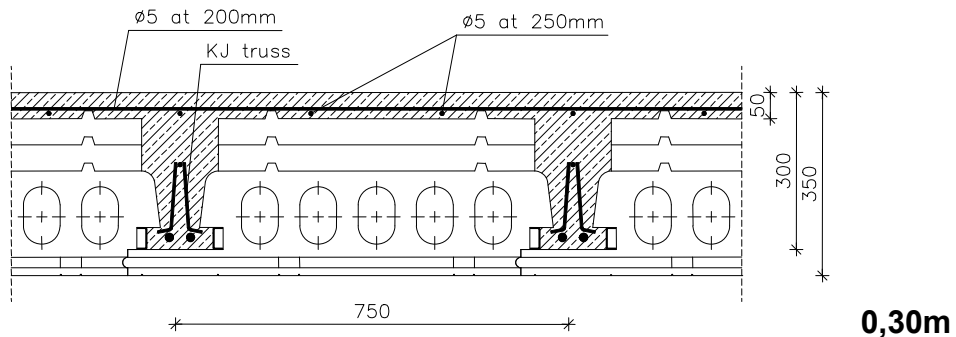
Floor cross section at the design depth



0,20m



0,25m



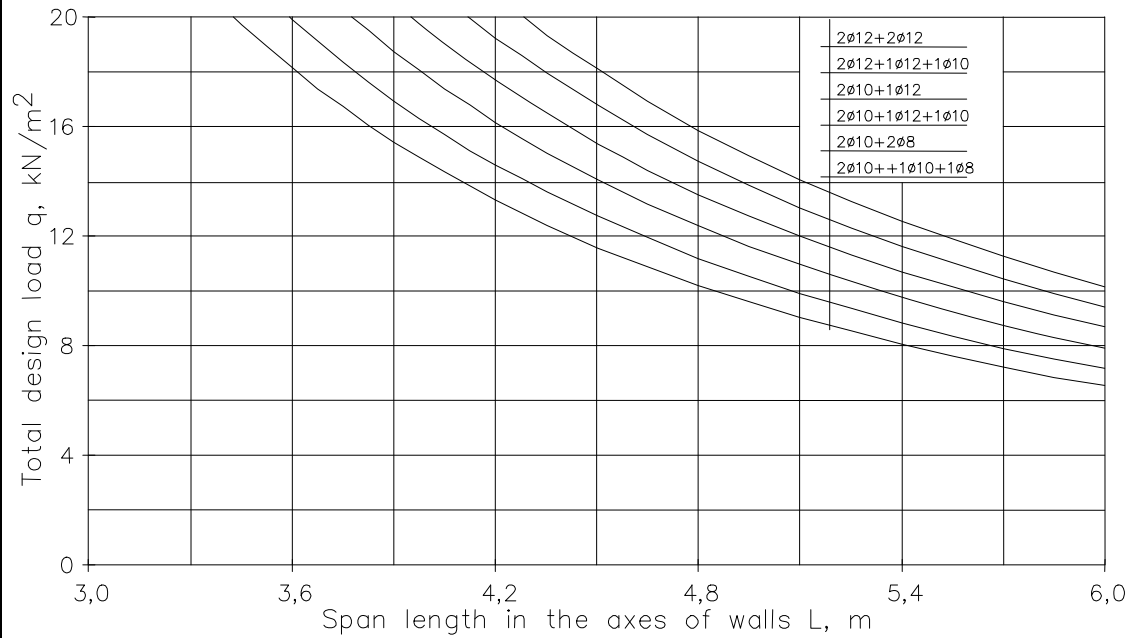
0,30m

The floor depth and longitudinal reinforcement determined on the basis of nomograms.
The range of transverse reinforcement determined by calculations on the basis of Table II.1.

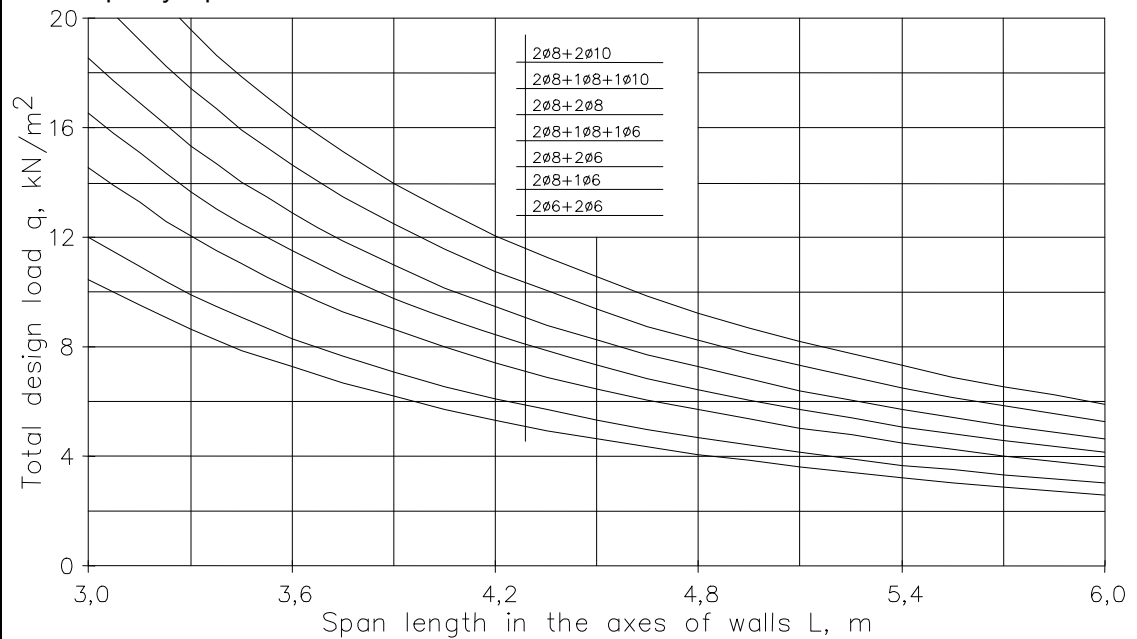
Material usage	Design depth of the floor [m]		
	0,20	0,25	0,30
Concrete, m ³ /m ²	0,069	0,079	0,089
Ø5 bars in the topping mb/m ²	7,80	7,80	7,80
kg/m ²	1,20	1,20	1,20
Self-weight load, kN/m ²	1,85	2,04	2,29

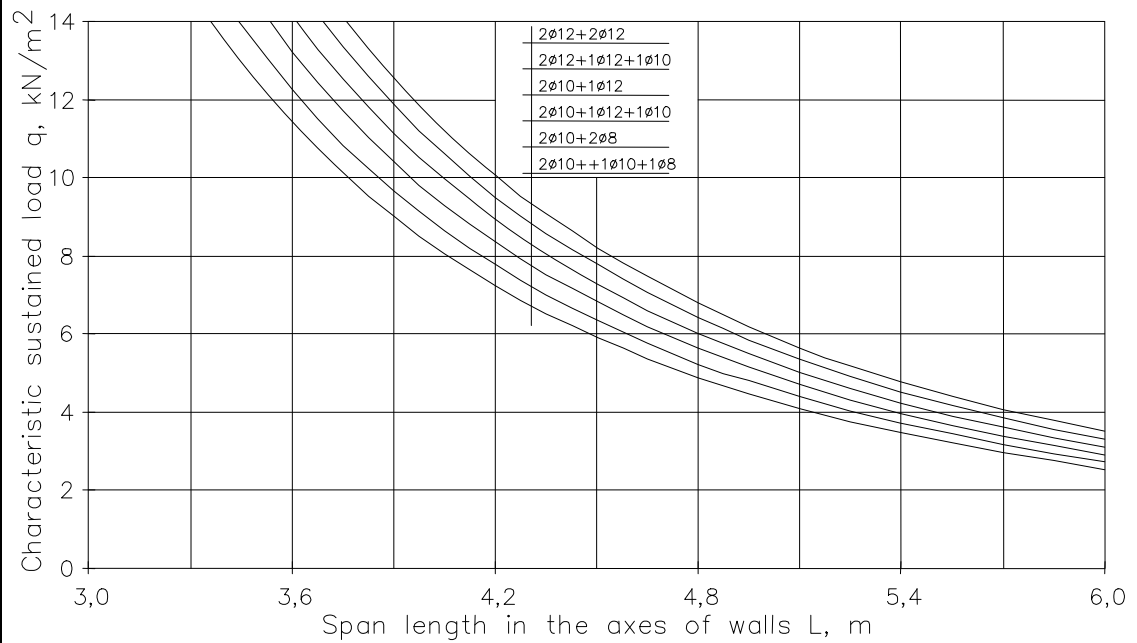
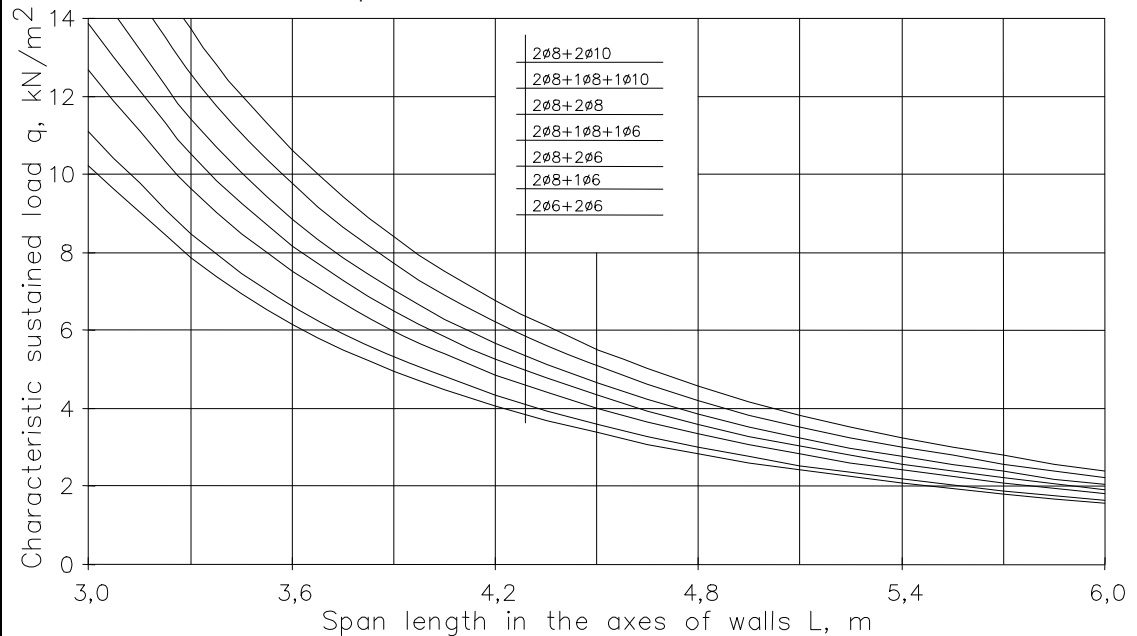
IZODOM 2000 POLSKA FLOORdesign depth **0,20m**total depth **0,25m****CONCRETE C20/25****TRUSS KJ****(steel with $f_{yk} \geq 500$ MPa)**

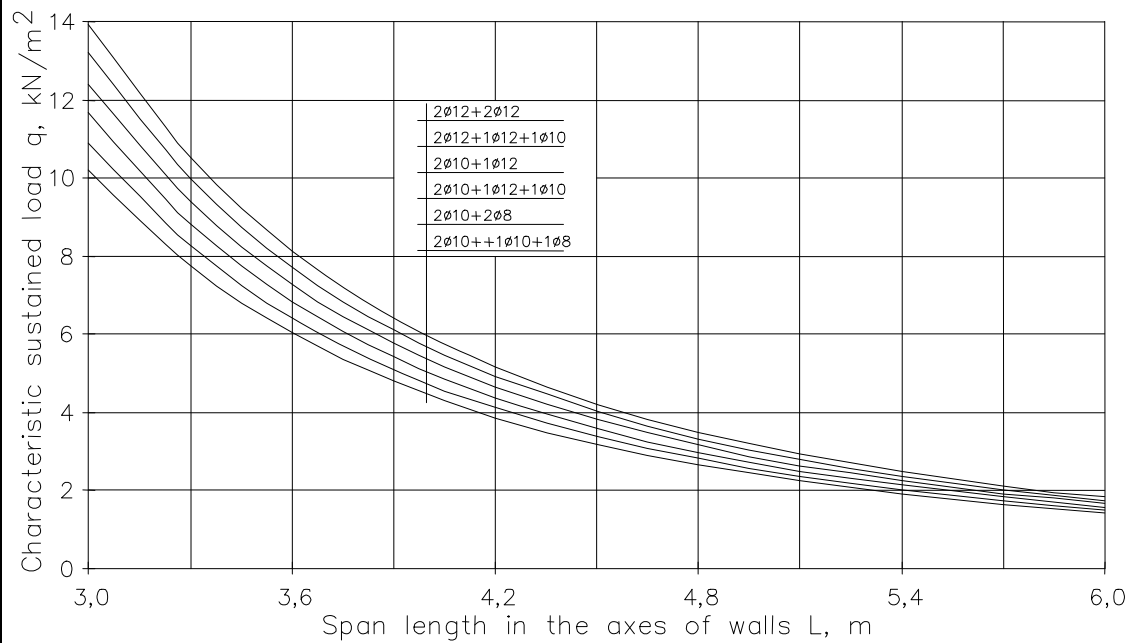
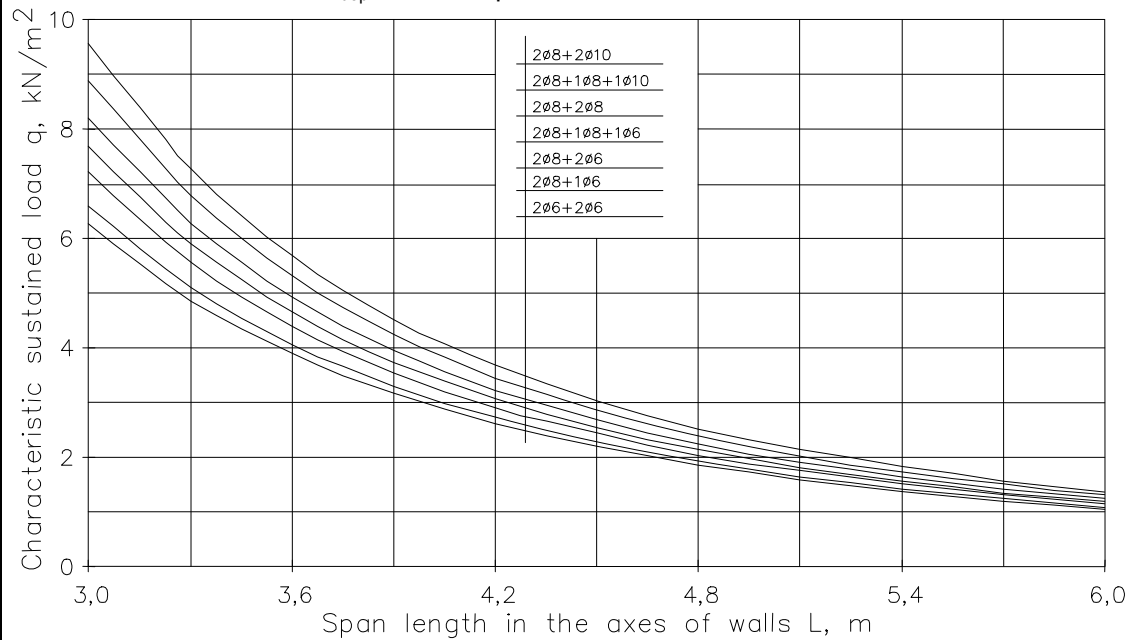
Load capacity – part II



Load capacity – part I

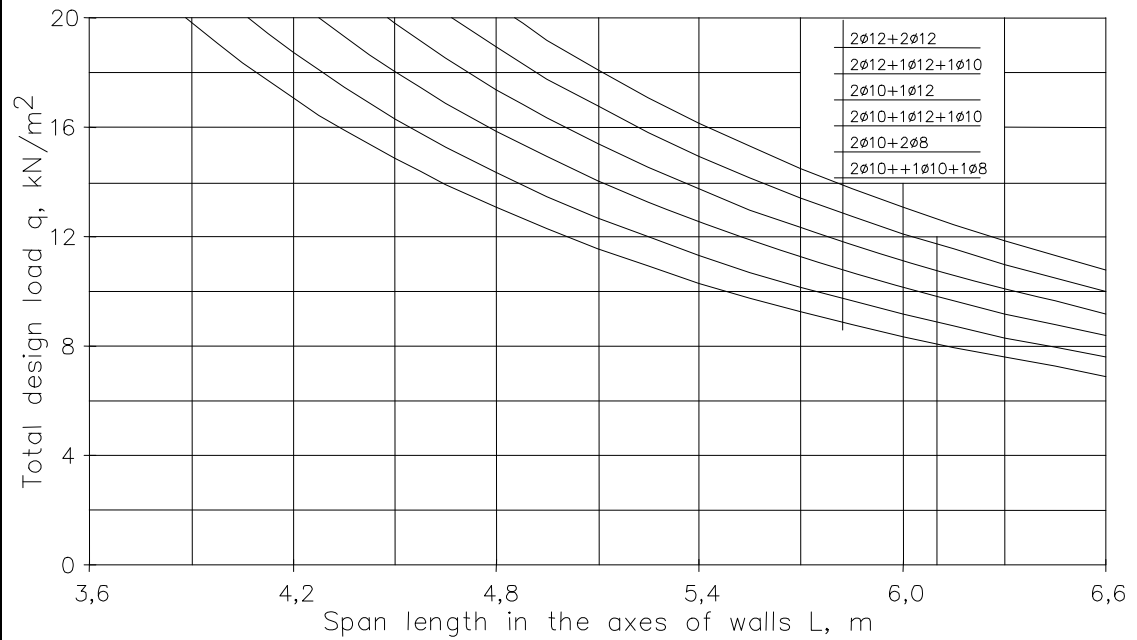


IZODOM 2000 POLSKA FLOORdesign depth **0,20m**total depth **0,25m****CONCRETE C20/25****TRUSS KJ****(steel with $f_{yk} \geq 500$ MPa)**Deflection at the condition $a_{dop} < L/250$ – part IIDeflection at the condition $a_{dop} < L/250$ – part I

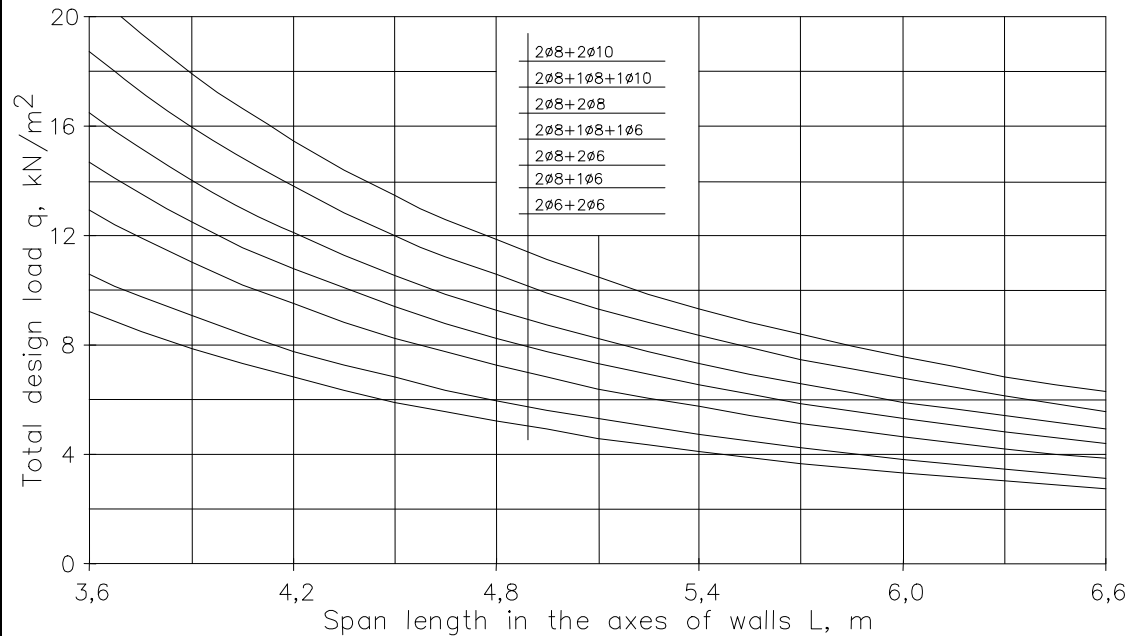
IZODOM 2000 POLSKA FLOORdesign depth **0,20m**total depth **0,25m****CONCRETE C20/25****TRUSS KJ****(steel with $f_{yk} \geq 500$ MPa)**Deflection at the condition $a_{dop} < L/500$ – part IIDeflection at the condition $a_{dop} < L/500$ – part I

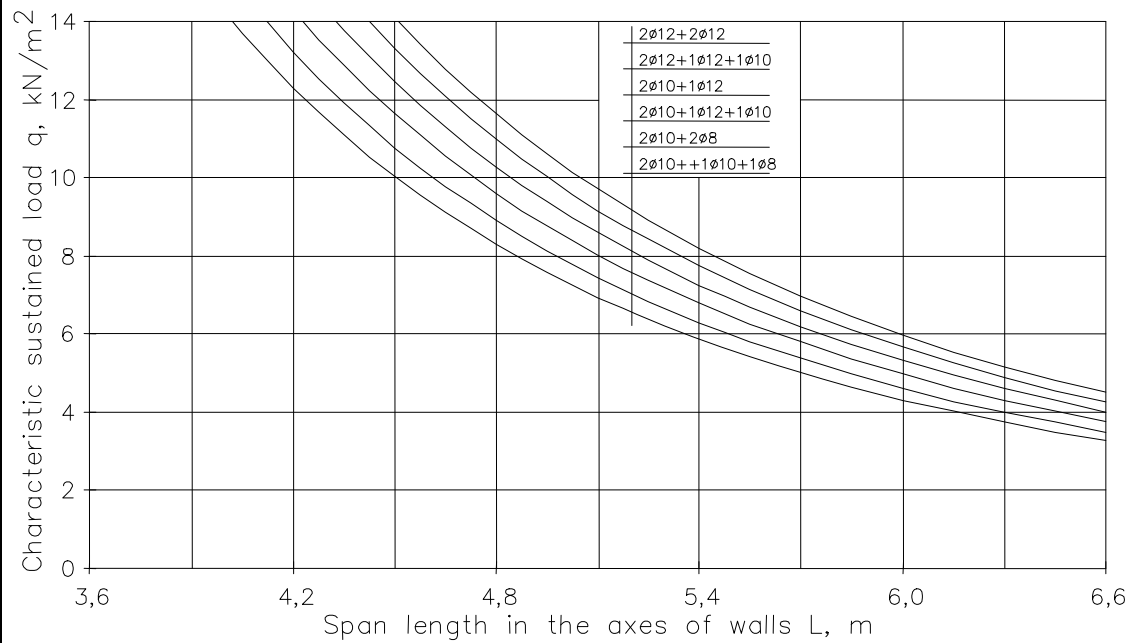
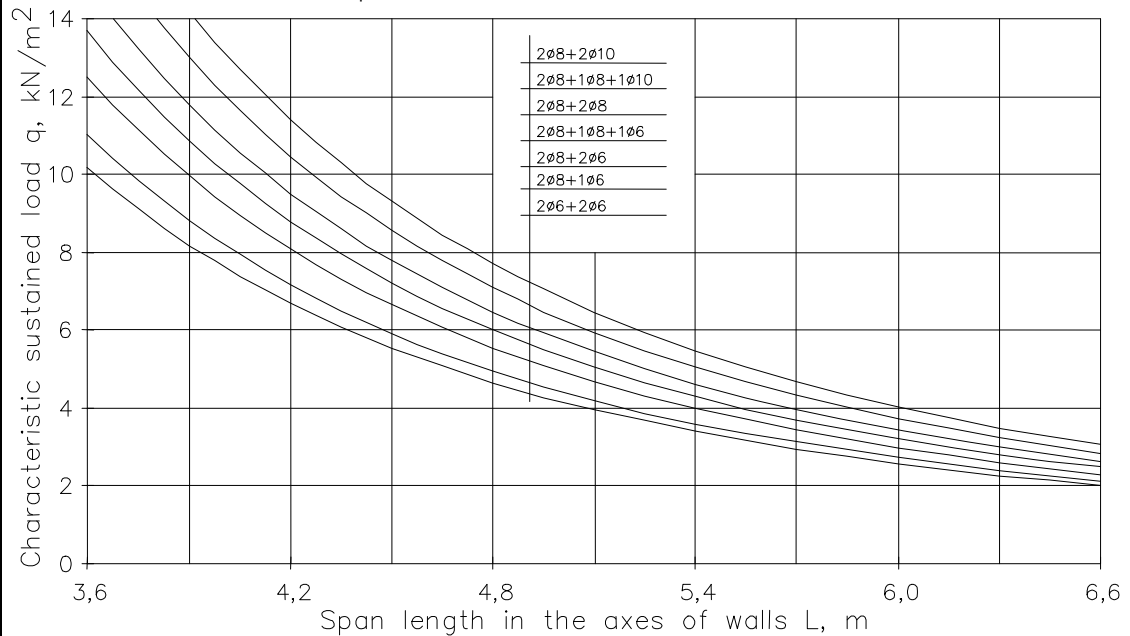
IZODOM 2000 POLSKA FLOORdesign depth **0,25m**total depth **0,30m****CONCRETE C20/25****TRUSS KJ****(steel with $f_{yk} \geq 500$ MPa)**

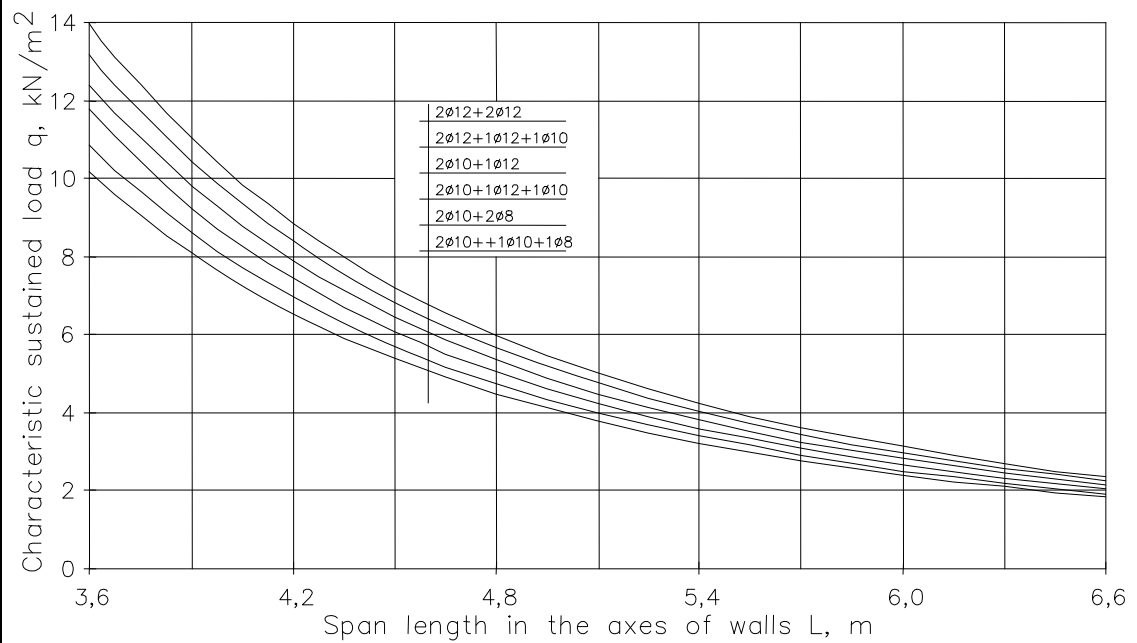
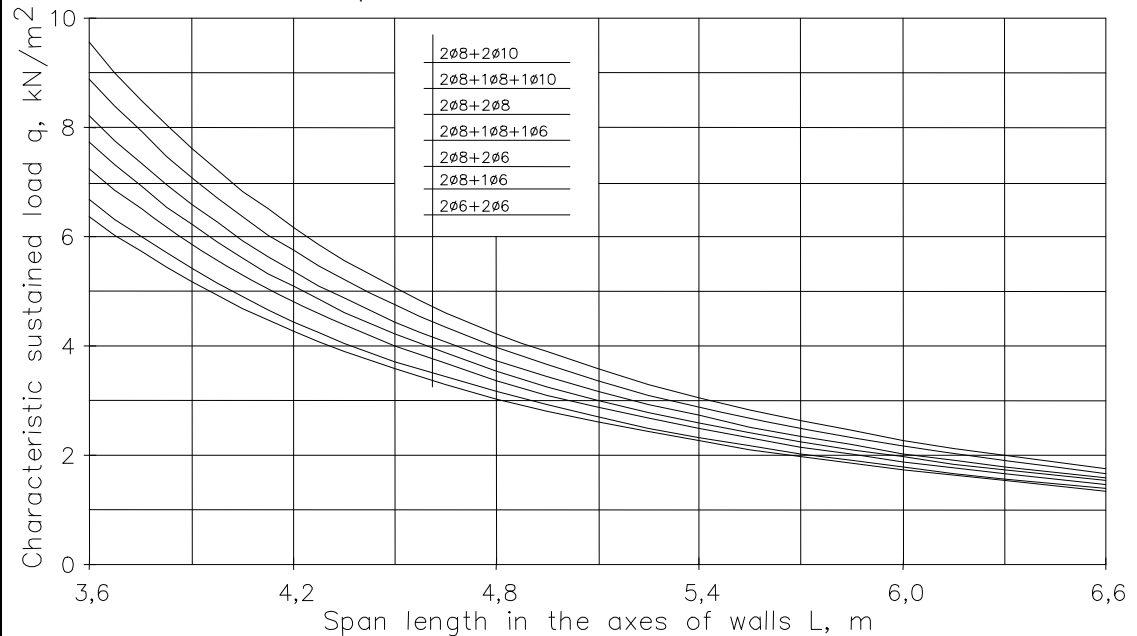
Load capacity – part II



Load capacity – part I

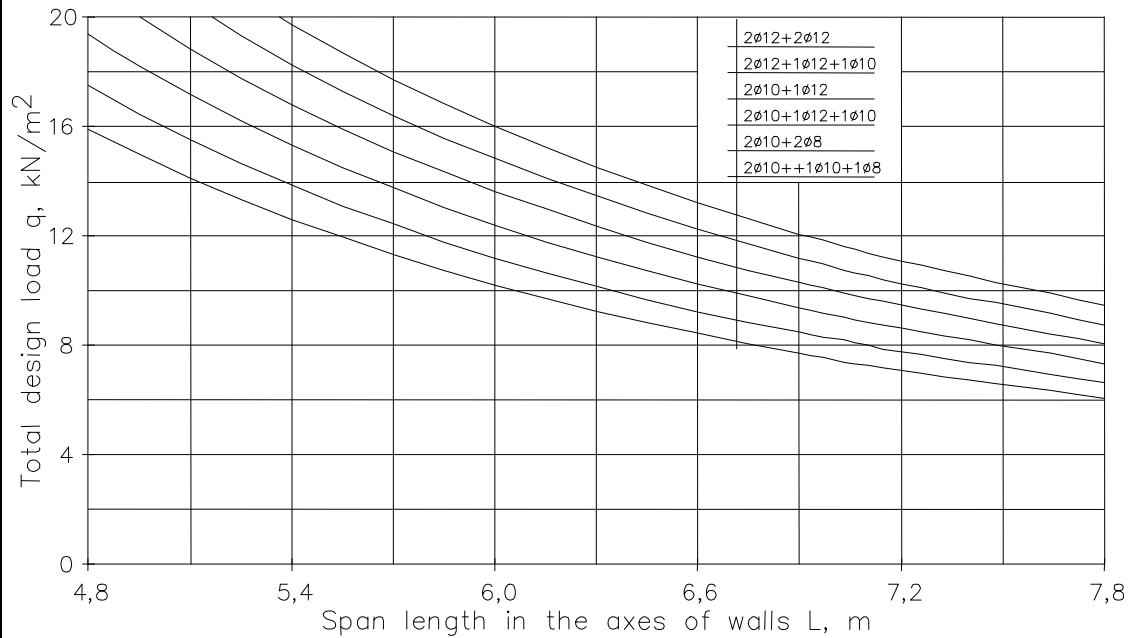


IZODOM 2000 POLSKA FLOORdesign depth **0,25m**total depth **0,30m****CONCRETE C20/25****TRUSS KJ****(steel with $f_{yk} \geq 500$ MPa)**Deflection at the condition $a_{dop} < L/250$ – part IIDeflection at the condition $a_{dop} < L/250$ – part I

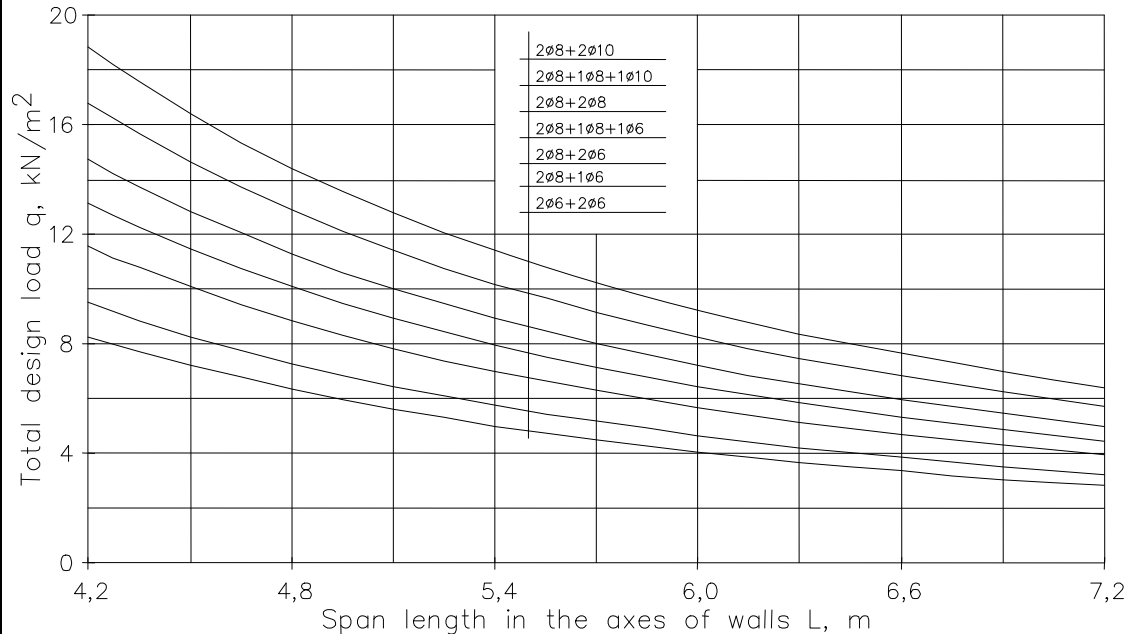
IZODOM 2000 POLSKA FLOORdesign depth **0,25m**total depth **0,30m****CONCRETE C20/25****TRUSS KJ****(steel with $f_{yk} \geq 500$ MPa)**Deflection at the condition $a_{dop} < L/500$ – part IIDeflection at the condition $a_{dop} < L/500$ – part I

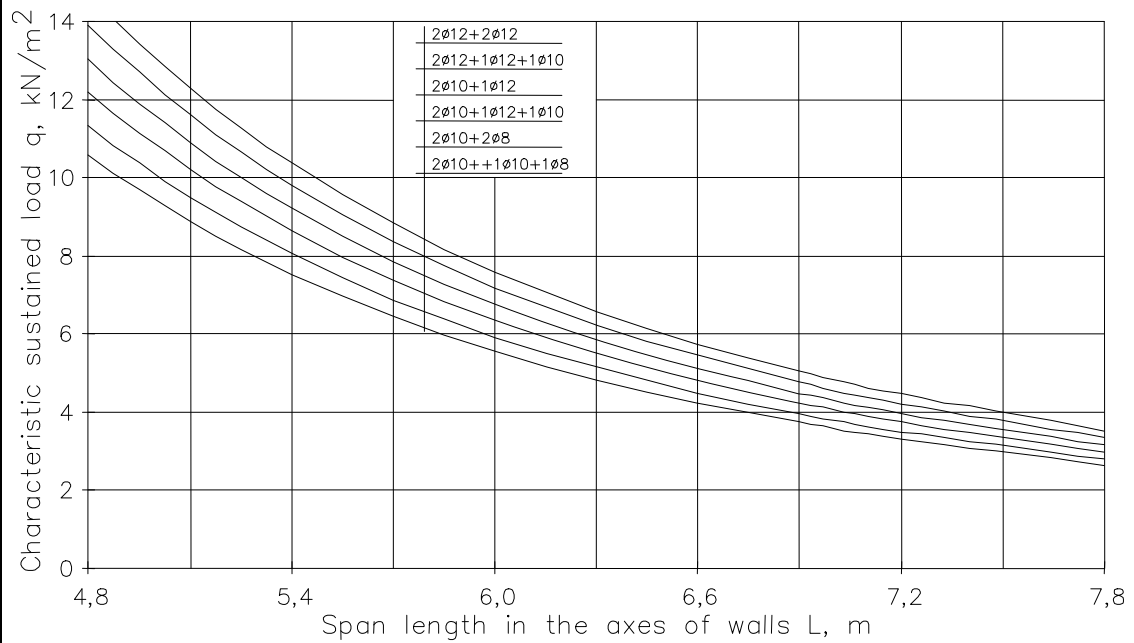
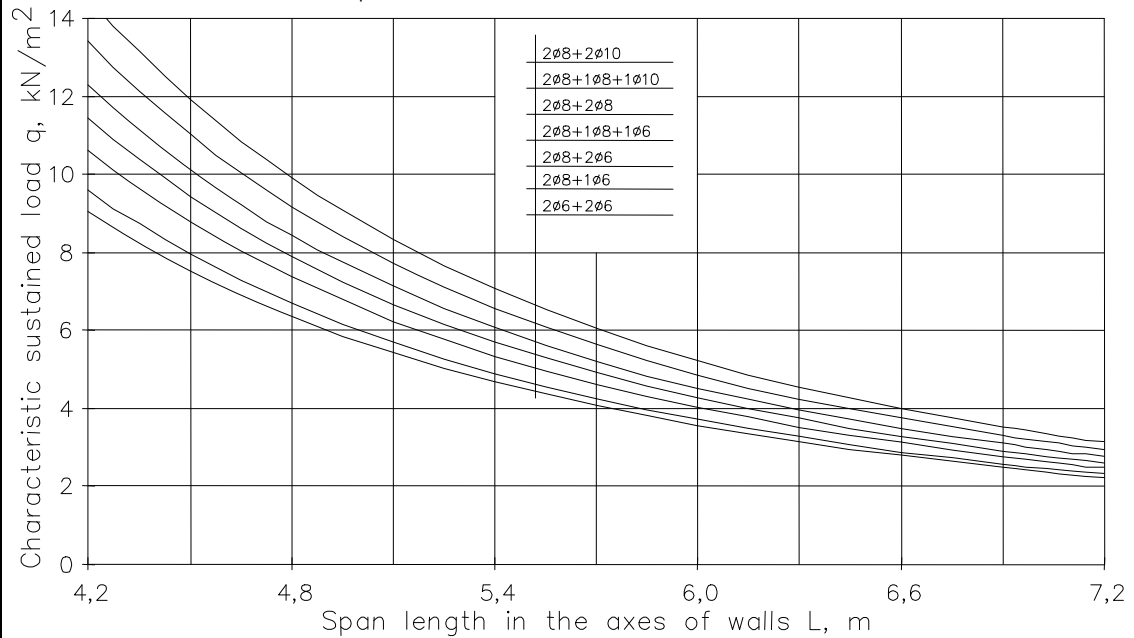
IZODOM 2000 POLSKA FLOORdesign depth **0,30m**total depth **0,35m****CONCRETE C20/25****TRUSS KJ****(steel with $f_{yk} \geq 500$ MPa)**

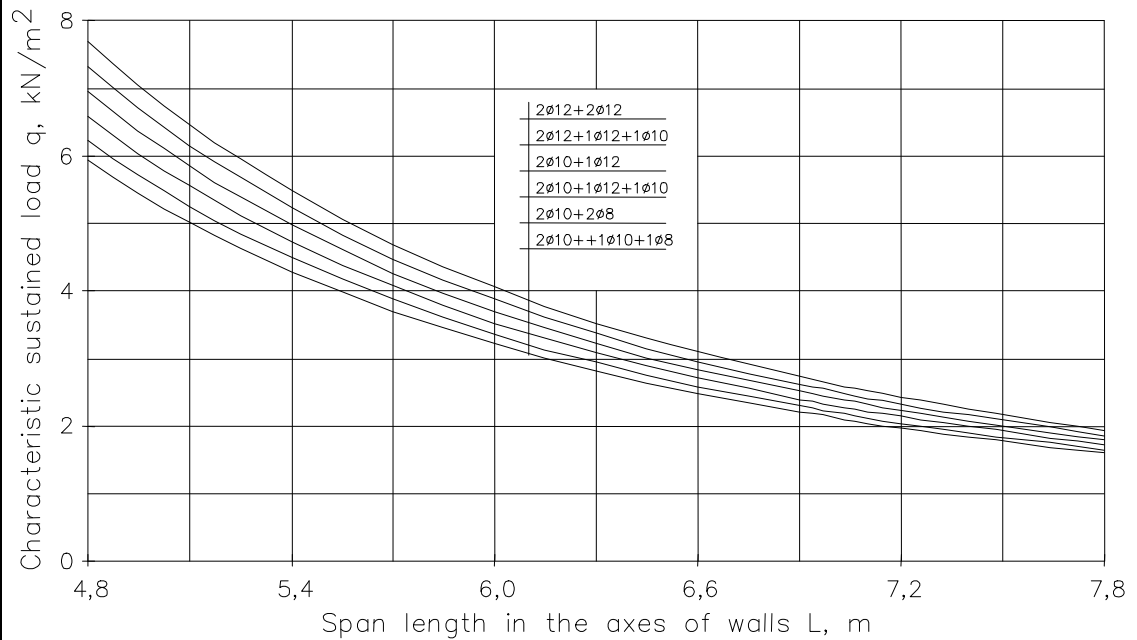
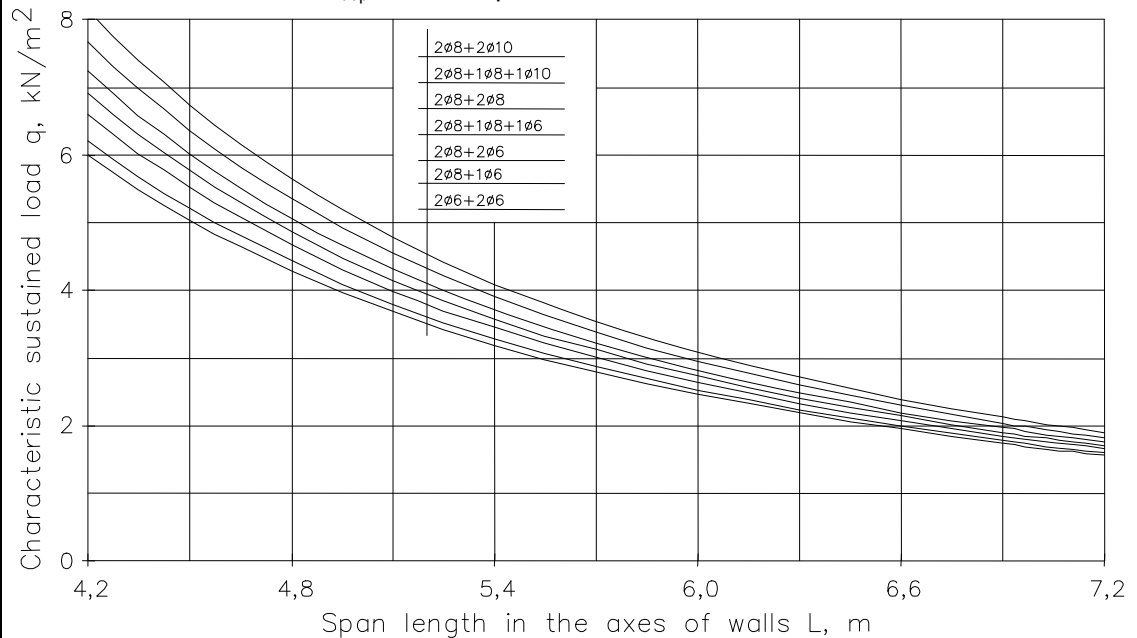
Load capacity – part II



Load capacity – part I



IZODOM 2000 POLSKA FLOORdesign depth **0,30m**total depth **0,35m****CONCRETE C20/25****TRUSS KJ****(steel with $f_{yk} \geq 500$ MPa)**Deflection at the condition $a_{dop} < L/250$ – part IIDeflection at the condition $a_{dop} < L/250$ – part I

IZODOM 2000 POLSKA FLOORdesign depth **0,30m**total depth **0,35m****CONCRETE C20/25****TRUSS KJ****(steel with $f_{yk} \geq 500$ MPa)**Deflection at the condition $a_{dop} < L/500$ – part IIDeflection at the condition $a_{dop} < L/500$ – part I

III. Construction details

III.1. Coupling beams and header beams

Coupling beams are shaped in the special Styrofoam blocks, named MP. If the floor with 0,25m or 0,30m design depth is used, the wall blocks should be overbuilt using MH height correctors (Fig. III.1).

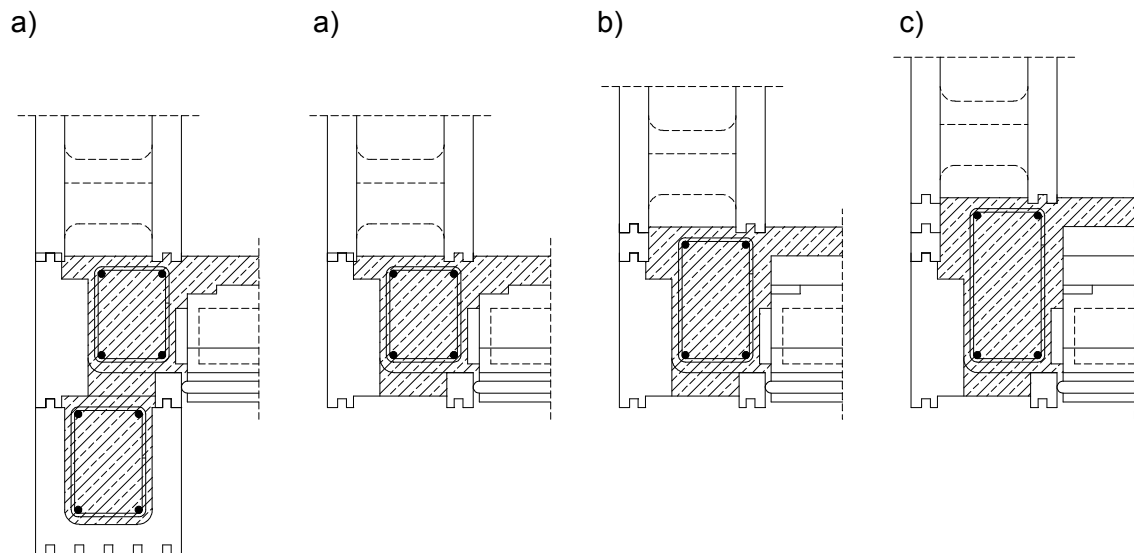


Fig. III.1. Forming the coupling- and header beams at different design depth of the floor: a) 0,20m, b) 0,25m, c) 0,30m

The reinforcement of the coupling beams should be performed with $4\varnothing 12$ longitudinal bars and $\varnothing 5$ stirrups, arranged in spaced not more than 300mm. The longitudinal reinforcement must be continuous along the entire length of the beams.

In some sections – over the window and door openings – the coupling beam can be used as a header beam. Then the necessary longitudinal and transverse reinforcement should be determined individually on the basis of the tables W1 or W2, according to the thickness of the concrete core of the load-bearing walls.

The transverse reinforcement was taken as $\varnothing 5$ mm or $\varnothing 6$ mm two legged stirrups of ribbed steel with characteristic yield strength $f_{yk} \geq 500$ MPa.

The tables, apart from the condition of the transverse reinforcement load capacity, also includes the requirements of standardizations for spacing of the stirrups and degree of the transverse reinforcement.

III.2. Distributive ribs and anchoring ribs in the coupling beams

If the floor span exceeds 4,0 m, it is necessary to make one distributive rib, and with a span greater than 6,0 m two ribs should be made. Rib should be reinforced with $3\varnothing 12$ bars and stirrups $\varnothing 5$ with spacing 150mm. Particular attention should be paid to the proper anchorage of the longitudinal bars of the distributive rib in the coupling beam, which is needed to limit the extent of the damage from possible accidental actions.

From the same reason, longitudinal reinforcement should be well anchored in the **bond** beam. In the extreme supports it is necessary to use $\varnothing 12$ anchoring bars (fig. III.2), placed in all floor ribs.

Over intermediate supports continuity of the longitudinal reinforcement should be provided by additional $\varnothing 12$ bars. This additional reinforcement should be placed in the bottom and top of the section in all floor ribs. The top reinforcement should be extend to $1/3$ of the span length and the bottom reinforcement to 0,6m on each side of the support. If in the adjacent fields of the floor ribs are shifted in the plane, then reinforcement loops should be used as for external walls (Fig. III.2).

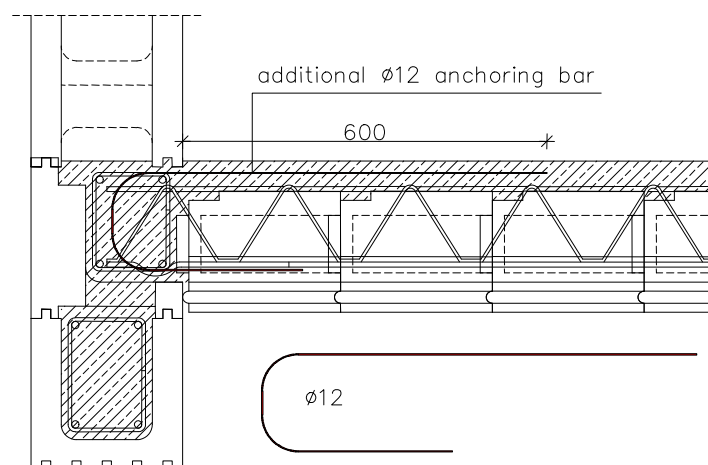


Fig. III.2. Ribs reinforcement anchored with additional bars in the coupling beams in external walls

III.3. Balcony slab

Balcony can be made as a complete monolithic cantilever slab, which is an integral part of the floor. The depth of the balcony slab can be taken approximately, depending on the balcony overhang (to the surface of the wall):

- 0,12m for $L=0,9$ m,
- 0,14m for $L=1,2$ m.

The overhang of the balcony slab should not exceed $1/4$ span of the floor in the consider direction.

For this solution of balcony slab, thermal bridges cannot be avoided (if both sides of the balcony slab will be not insulated for difficulty reasons). In order to minimize the surface of the thermal bridges, the balcony slab was connected with the floor in a point with a width of 130mm, where the concrete core of the ring beam tile is. Details of this solution are shown in Fig. III.3 and III.4.

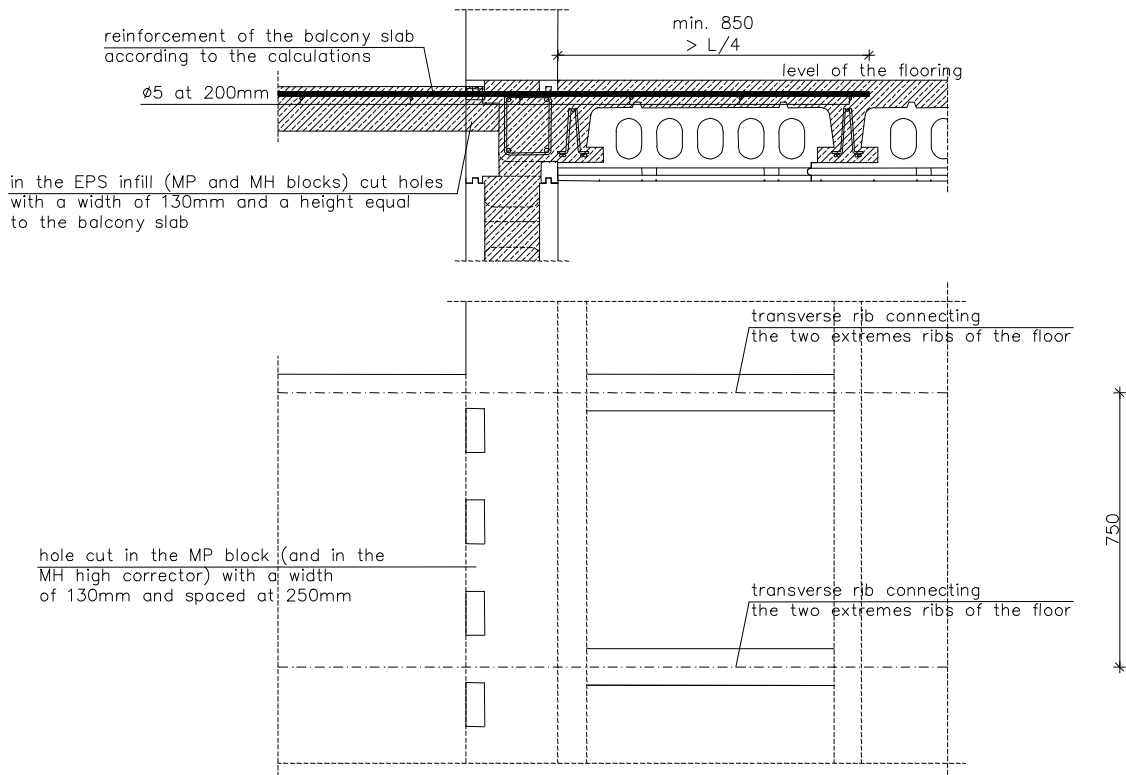


Fig. III.3. Conjunction of the balcony slab and the floor – main reinforcement of the slab perpendicular to the ribs

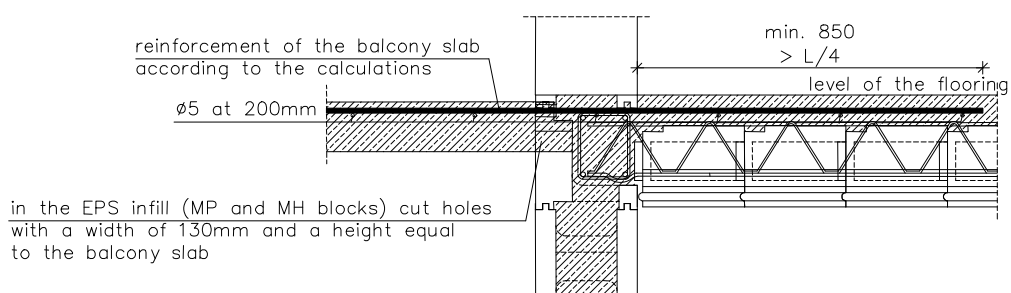


Fig. III.4. Conjunction of the balcony slab and the floor – main reinforcement of the slab parallel to the ribs

If the main reinforcement of the balcony slab is perpendicular to the ribs (Fig. III.3), the two extreme ribs should be connected by transverse ribs at 750mm spacing. This transverse ribs should be reinforced with $\phi 12$ bars bottom and top. The reinforcement should be so formed that included the reinforcement of the floor ribs. The transverse reinforcement should be formed as in the distributive ribs – with $\phi 5$ stirrups at 150mm.

Note: It is allowed to use the special fittings to connect the balcony slab and the floor that eliminate thermal bridges.

III.4. Performance of the floor

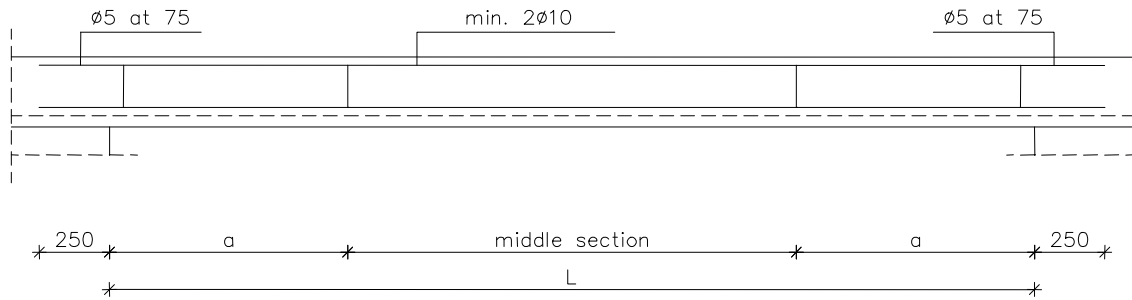
The ribs of the floor are made as monolithic, reinforced by KJ trusses, so the shuttering is necessary, supporting the hollow blocks in places where the ribs are located, across the all width of the ribs. Blocks supported by shuttering meet the strength requirements of the standard.

If the span of the floor exceed 6,0m, it is recommended to form the shutterings in such a way as to obtain a negative deflection, not exceeding 20mm.

It is recommended to use concrete with consistency, which is characterized by the slump equal to about 80mm. However, established consistency should be achieved by the use of plasticizing or streamlining admixture and not by increasing the amount of water in the mixture.

IZODOM 2000 POLSKA / KJ

Coupling and header beams. Load-bearing walls with a thickness of the core 0,15m



$$V_{Ed} = \frac{1}{2} qL$$

$$V_{Ed} \begin{cases} \leq V_{Rd,max} \\ \leq V_{Rd,s} \end{cases}$$

$$a = \frac{V_{Ed} - V_{Rd,c}}{V_{Ed}} \frac{L}{2}$$

V_{Ed} - design shear force, kN/m

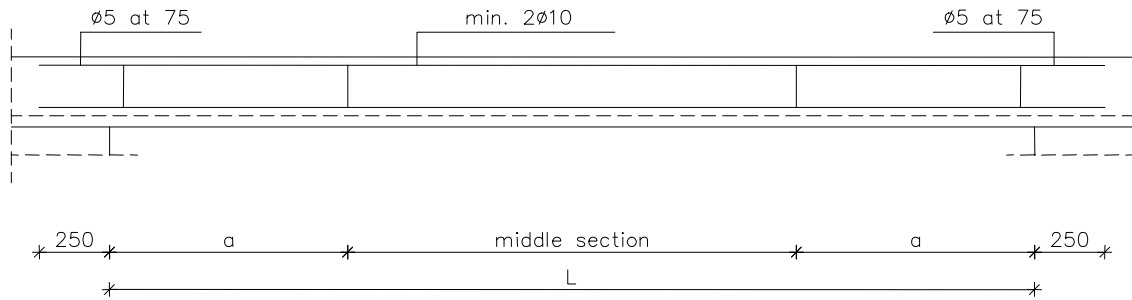
q - design total load of the coupling beam, kN/m

Table W1

Design value for the concrete C20/25		Coupling beam h=0,20m	Coupling beam – header beam with a depth		
			0,20m	0,25m	0,30m
Bending moment [kNm] at the bottom longitudinal reinforcement	2Ø8	7,16	7,16	-	-
	2Ø10	10,84	10,84	14,24	17,66
	2Ø12	15,29	15,29	20,21	25,12
	3Ø12	22,30	22,30	29,67	37,04
	2Ø16	25,85	25,85	34,60	43,34
	3Ø16	32,05	32,05	47,23	60,34
Transverse force $V_{Rd,c}$ [kN] at the bottom longitudinal reinforcement	2Ø8	12,10	12,10	13,77	14,99
	2Ø10	14,02	14,02	15,95	17,37
	2Ø12	15,83	15,83	18,01	19,61
	3Ø12	18,12	18,12	20,62	22,45
	2Ø16	19,18	19,18	21,83	23,76
	3Ø16	20,68	20,68	24,98	27,20
Transverse force $V_{Rd,s}$ [kN] carried by two legged stirrups diameter/spacing	Ø5/200	27,62	27,62	35,30	42,97
	Ø5/150	36,83	36,83	47,06	57,29
	Ø5/100	55,24	55,24	70,60	85,94
	Ø5/75	73,66	73,66	94,12	114,59
	Ø6/200	39,46	39,46	50,42	61,39
	Ø6/150	52,62	52,62	67,23	81,85
	Ø6/100	78,92	78,92	100,85	122,77
	Ø6/75	105,24	105,24	134,47	163,70
$V_{Rd,max}$ [kN]		66,77	66,77	85,32	103,86
Stirrups on the middle section		Ø5 co 200	Ø5 co 200	Ø5 co 200	Ø5 co 200

IZODOM 2000 POLSKA / KJ

Coupling and header beams. Load-bearing walls with a thickness of the core 0,20m



$$V_{Ed} = \frac{1}{2} qL$$

$$V_{Ed} \begin{cases} \leq V_{Rd,max} \\ \leq V_{Rd,s} \end{cases}$$

$$a = \frac{V_{Ed} - V_{Rd,c}}{V_{Ed}} \frac{L}{2}$$

V_{Ed} - design shear force, kN/m

q - design total load of the ring beam, kN/m

Table W2

		Coupling beam h=0,20m	Coupling beam – header beam with a depth		
			0,20m	0,25m	0,30m
Design value for the concrete C20/25					
Bending moment [kNm] at the bottom longitudinal reinforcement	2Ø10	11,03	11,03	-	-
	2Ø12	15,53	15,53	20,45	25,36
	3Ø12	22,70	22,70	30,08	37,45
	2Ø16	26,52	26,52	35,26	44,00
	3Ø16	36,77	36,77	49,88	63,00
	4Ø16	40,17	40,17	61,16	78,84
Transverse force $V_{Rd,c}$ [kN] at the bottom longitudinal reinforcement	2Ø10	17,19	17,19	19,56	21,29
	2Ø12	19,41	19,41	22,08	24,04
	3Ø12	22,21	22,21	25,28	27,51
	2Ø16	23,51	23,51	26,75	29,12
	3Ø16	26,92	26,92	30,62	33,34
	4Ø16	28,07	28,07	33,71	36,69
Transverse force $V_{Rd,s}$ [kN] carried by two legged stirrups diameter/spacing	Ø5/200	27,62	27,62	35,30	42,97
	Ø5/150	36,83	36,83	47,06	57,29
	Ø5/100	55,24	55,24	70,60	85,94
	Ø5/75	73,66	73,66	94,12	114,59
	Ø6/200	39,46	39,46	50,42	61,39
	Ø6/150	52,62	52,62	67,23	81,85
	Ø6/100	78,92	78,92	100,85	122,77
	Ø6/75	105,24	105,24	134,47	163,70
$V_{Rd,max}$ [kN]		90,48	90,48	115,79	140,95
Stirrups on the middle section		Ø5 co 200	Ø5 co 200	Ø5 co 200	Ø5 co 200