CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF CIVIL ENGINEERING

DEPARTMENT OF CONCRETE AND MASONRY STRUCTURES

TECHNICAL REPORT

CONCRETE

Created by

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Name of project	Office building in Prague
Investor:	CTU
Created by :	Ahmed Alkhateeb
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1. General information

Residential building outside of Prague is designed. The building is located on the corner of Bovarikova and Novakova Streets. Investor is CTU. The residential building is design economically and utilizing modern ways of design and construction. The project emphasize in good quality. The project utilized orthogonal architecture to blend in with the surrounding of nice and efficient buildings. Czech and euro codes were used during design.

2. Basic information

The residential building has 1 underground floor and 4 upper ground floors. The Length is 28.58 m. Width is 19.6 m. Height above the ground is 16.48 m. Height under the ground is 3m. Total height is 19.48 m. The underground floor is equipped with a technical room and ten parking spaces. 13 more parking spaces are located outside the building. Drive in to the building is from Bovarikova street. Drive in is than separated into a way to outside parking spaces and to the way to the underground floor. Entrance to the underground floor is via ramp with slope of 14%.

2.1. Software

- AutoCAD 2015
- MS Office

3. Structural system

The structural system of underground floor is a one-way slab with girders in one direction. Girders are supported by reinforced concrete columns. Column dimension is 300x550mm.Underground perimeter reinforced concrete wall is 300 mm thick. Floor structure is created by a one way slab by thickness of 180 mm. Communication areas around stairs well and elevator is created by reinforced concrete wall of thickness 300 mm. There are light shafts located in the underground walls. The shafts are thermally separated with use of isobeams.

Structural system of the upper floors is one way reinforced concrete slab sitting on load bearing masonry walls. Perimeter load bearing masonry wall is 440 mm thick, inner load bearing masonry wall is 300 mm thick. Load bearing walls around communication area are from reinforced concrete and are 300 mm thick. Elevator shaft walls is created by reinforced concrete walls of thickness of 200 mm and are separated from the load bearing structure of the building due to acoustic reasons.

4. Materials

Concrete :

Reinforced concrete columns underground level

C30/37 - XC2, XF1 - dmax=22mm - Cl<0.2% - S4

Reinforced concrete perimeter walls underground level

C25/30 - XC3, XF2, XA1 - dmax=22mm - Cl<0.2% - S4

Reinforced concrete walls (communication areas) underground level

C25/30 - XC2, XF1 - dmax=22mm - Cl<0.2% - S4

Reinforced concrete walls (communication areas) upper levels

C25/30 – XC1 - dmax=22mm - Cl<0.2% - S4

Reinforced concrete slabs

C30/37 – XC1 - dmax=22mm - Cl<0.2% - S4

Reinforced concrete foundations

C25/30 - XC3, XF2, XA1 - dmax=22mm - Cl<0.2% - S4

Reinforced concrete of the elevator shaft

C25/30 – XC1 - dmax=22mm - Cl<0.2% - S4

Reinforced concrete of precast staircase elements

C30/37 – XC1 - dmax=22mm - Cl<0.2% - S4

Reinforced concrete ramp

C25/30 - XC3, XF2, XA1 - dmax=22mm - Cl<0.2% - S4

Reinforcement bars

B500B

5. **Loads**

The load generated from one way slab underground - first floor composition is 13KN/m2

The load generated from one way slab underground - general floor composition is 12.69KN/m2

The load generated from one way slab roof composition is 8.982KN/m2

Live load for floor for residential building is 2.0 KN/m2

Live load for roof for residential buildings (maintenance) is 0.75 KN/m2

Snow load =0.7 KN/m2

6. Preliminary design

6.1. Input data

Input data	Concrete Class	fcd				
Reinforced concrete column :	C35/45	23.33	Mpa	Cmin	20	mm
Reinforced concrete wall :	C30/37	20	Mpa	Ø =	10	mm
Reinforced slab :	C30/37	20	Mpa	fyd	435	Mpa
Reinforced beam :	C30/37	20	Mpa			

6.2. Preliminary design of slab

pilimiry desgin of slab						
countinouas fixed						
L/33 -L/30 =		5830/33	5830/30 =	177	-	194
hs =	180	mm				
d =hs-c-Ø/2	155	mm				

6.3. Load table of the slab

Load table for slab [between Underground & ground floor]				
Type	Name	Fk [KN/m²]	ɤ	Fd [KN/m²]
Dead Load	Surface layer	0.05	1.35	0.068
	Glue layer	0.011	1.35	0.015
	Concrete layer	1.25	1.35	1.688
	Sapparation foil	0.01	1.35	0.014
	Acustic insulation	0.048	1.35	0.065
	RC	4.5	1.35	6.075
	Thermal insulation	0.072	1.35	0.097
	Gupsum board	0.4	1.35	0.540
	Partition	1.1	1.35	1.485
Life Load		2	1.5	3
∑				13.045

Load table for slab [general floor]				
Type	Name	Fk [KN/m²]	ɤ	Fd [KN/m²]
Dead Load	Surface layer	0.2	1.35	0.270
	Glue layer	0.01	1.35	0.014
	Concrete layer	1.25	1.35	1.688
	Sapparation foil	0.01	1.35	0.014
	Acustic insulation	0.048	1.35	0.065
	RC	4.5	1.35	6.075
	Inner plaster	0.06	1.35	0.081
	Partition	1.1	1.35	1.485
Life Load		2	1.5	3
∑				12.690

Load table for slab [roof]				
Type	Name	Fk [KN/m²]	Ɣ	Fd [KN/m²]
Dead Load	Gravel	0.84	1.35	1.134
	Geotextile	0.01	1.35	0.014
	Water proofing	0.025	1.35	0.034
	Water proofing	0.025	1.35	0.034
	thermal insulation	0.36	1.35	0.486
	RC	4.5	1.35	6.075
	Inner plaster	0.06	1.35	0.081
Life Load		0.75	1.5	1.125
∑				8.982

6.4. Design of Mrd of slab

Bending moment on slab [between Underground & ground floor]									
Bottom Renforcment									
Med = 1/12*Fd*L²	36.570	KN.m							
μ= Med/b*d²*fcd	0.076	-->	ζ	0.964					
As,req =	Med/ζ*d*fyd	563	mm²						
from table									
desgin Ø12-170mm	-->	As,prov	=	665	mm²				
Fs=	As,prov*fyd	289275	N						
x=	Fs/0.8b*fcd	18.08	mm						
z=	d-0.4*x	147.77	mm						
Mrd=	Fs*z	42745624	N.mm	-->	42.746	KN.m	>	36.570	KN.m
top Renforcment									
Med = 1/10*Fd*L²	43.885	KN.m							
μ= Med/b*d²*fcd	0.091	-->	ζ	0.953					
As,req =	Med/ζ*d*fyd	683	mm²						
from table									
design Ø12-140mm	-->	As,prov	=	808	mm²				
Fs=	As,prov*fyd	351480	N						
x=	Fs/0.8b*fcd	21.97	mm						
z=	d-0.4*x	146.21	mm						
Mrd=	Fs*z	51390945	N.mm	-->	51.391	KN.m	>	43.885	KN.m

Bending moment on slab [general floor]									
Bottom Renforcment									
Med = 1/12*Fd*L²	35.575	KN.m							
μ= Med/b*d²*fcd	0.074	-->	ζ	0.964					
As,req =	Med/ζ*d*fyd	547	mm²						
from table									
desgin Ø12-170mm	-->	As,prov	=	665	mm²				
Fs=	As,prov*fyd	289275	N						
x=	Fs/0.8b*fcd	18.08	mm						
z=	d-0.4*x	147.77	mm						
Mrd=	Fs*z	42745624	N.mm	-->	42.746	KN.m	>	36.570	KN.m
top Renforcment									
Med = 1/10*Fd*L²	42.690	KN.m							
μ= Med/b*d²*fcd	0.089	-->	ζ	0.945					
As,req =	Med/ζ*d*fyd	670	mm²						
from table									
design Ø12-160mm	-->	As,prov	=	707	mm²				
Fs=	As,prov*fyd	307545	N						
x=	Fs/0.8b*fcd	19.22	mm						
z=	d-0.4*x	147.31	mm						
Mrd=	Fs*z	45304877	N.mm	-->	45.305	KN.m	>	42.690	KN.m

Bending moment on slab [roof]									
Bottom Renforcment									
Med = 1/12*Fd*L²	25.180	KN.m							
μ= Med/b*d²*fcd	0.052	-->	ζ	0.974					
As,req =	Med/ζ*d*fyd	383	mm²						
from table									
desgin Ø8-125mm	-->	As,prov	=	403	mm²				
Fs=	As,prov*fyd	175305	N						
x=	Fs/0.8b*fcd	10.96	mm						
z=	d-0.4*x	150.62	mm						
Mrd=	Fs*z	26403979	N.mm	-->	26.404	KN.m	>	25.180	KN.m
top Renforcment									
Med = 1/10*Fd*L²	30.215	KN.m							
μ= Med/b*d²*fcd	0.063	-->	ζ	0.969					
As,req =	Med/ζ*d*fyd	462	mm²						
from table									
design Ø10-155mm	-->	As,prov	=	507	mm²				
Fs=	As,prov*fyd	220545	N						
x=	Fs/0.8b*fcd	13.78	mm						
z=	d-0.4*x	149.49	mm						
Mrd=	Fs*z	32968473	N.mm	-->	32.968	KN.m	>	30.215	KN.m

6.5. Preliminary design of beam

pilimary desgin of beam						
hB=	(1/12-1/10)*L	=(5830/12-5830/10)		486	-	583
hB=	500	mm				
dB= hB-c-Ø/2	475	mm				
bB=	(1/3-2/3)hB	= (500/3-1000/3)	167	-	333	
bB=	300	mm				

6.6. Load table for beam

Load table for beam				
Type	Name	Fk [KN/m²]	ɣ	Fd [KN/m²]
Dead Load	Slab	-	-	67
	Beam	3.75	1.35	5.063
	Wall	7.68	1.35	10.368
Life Load		2	1.5	3
∑	-	-	-	85.431

6.7. Design for Mrd of beam

Med =	1/8*Fd*L²	359.235	KN.m						
b1=	(4.5/2)-(0.3/2)	2.1	m	-->	2100	mm			
b2=	(5.8/2)-(0.3/2)	2.75	m	-->	2750	mm			
Leff =	0.85*7.4 =	6.29	m	-->	6290	mm			
Beff1 =	0.2*b1+0.1*Leff	1049	mm						
Beff2 =	0.2*b2+0.1*Leff	1179	mm						
Beff =	Beff1+ Beff1	2228	mm						
As,req =	Med/0.8*dB*fyd	2173	mm						
design 5-25Ø	-->	As,prov	=	2454	mm²				
Fs=	As,prov*fyd	1067490	N						
x=	Fs/0.8Beff*fcd	29.95	mm						
z=	d-0.4*x	463.02	mm						
Mrd=	Fs*z	494271227	N.mm	-->	494.271	KN.m	>	359.235	KN.m
x/d < or = ξbal	29.95/475 =	0.063	<	0.636					
spaceing in bars	300-2*20-5*25-2*8 =	24	>	24					
ρmin < ρ < ρmax =									
ρ =	As,prov/Ac	0.016							
0.0015 < 0.016 < 0.04									

6.8. Shear design of beam

shear force desgin of a beam									
Ved=	5/8*fd*L	309.686	KN						
v =	0.7 -Fck/200	0.55	>	0.5					
Vrd max =	v * Fcd *b*z*(cotΘ/1+cotΘ²)	705217.941	N	-->	705.218	KN	>	309.686	KN
Ast=	n*π*(d²/4)	157	mm²						
S =	(Ast*fyd*z*cotΘ)/Ved	153	mm	-->	S =	150	mm		
Vrd,real =	(Ast *fyd*z*cotΘ)/S	316220.793	N	-->	316.221	KN	>	309.686	KN
50mm <S < 075*d	-->	50mm < 150 mm <356mm							

6.9. Design of column

desgin of column									
tribitary area =	20	m²							
type	Name	Fk [KN]	γ	Fd[KN]					
Dead Load	Slab	-	-	1303.883					
	Beam	-	-	444.239					
	Column	4.1	1.35	5.535					
	Wall	383.88	1.35	518.238					
	Partition	48	1.35	64.8					
Life Load		2	1.5	3					
∑				2339.694					
Ned =	2339.694	KN							
Nrd =	Ac*fcd+0.02Ac*fyd	4735500	N	-->	4735.50	KN	>	2339.694	KN

6.10. Design of wall

Load table of wall							
Load length	5.2	m					
Type	Name	Fk [KN/m]	γ	Fd[KN/m]			
Dead Load	Slab 1	67.836	1.35	91.578357			
	Slab 2	263.958	1.35	356.343624			
	Slab 3	46.7064	1.35	63.05364			
	Wall	27.25	1.35	36.7875			
	Partition	28.6	1.35	38.61			
Life load	People	2	1.5	2.7			
	Snow	3.64	1.5	4.914			
	Maintinance	3.9	1.5	5.265			
∑				599.252			
Ned=	599.252						
Nrd =	Ac*fcd+0.02Ac*fyd	7435500	N/m	7435.5	KN/m	>	599.252

6.11. Stair case design

desgin of stair cases			
SH=	3040	mm	
ho=	160	mm	
b=	630-'2ho	310	mm
n=	SH/ho	19	steps
design of of angle :			
α =	30		
h1=	1500+750/cos(α)		2366
h2=	750+1500*cos(α)		2049

Load table for stairs [Landing]				
Type	Name	Fk [KN/m²]	γ	Fd [KN/m²]
Dead Load	Slab	4.5	1.35	6.075
	Floor	1	1.35	1.35
Life Load		3.5	1.5	5.25
∑				12.675
Load table for stairs [flight]				
Type	Name	Fk [KN/m²]	γ	Fd [KN/m²]
Dead Load	Slab	7.794	1.35	10.523
	Cladding	0.758	1.35	1.023
	Steps	2	1.35	2.700
Life Load		3.5	1.5	5.250
∑				19.496

$Med1 = 1/12*Fd*L^2$	19.902								
$Med2 = 1/12*fd*L^2$	5.264								
$\mu = Med/b*d^2*fcd$	0.01	-->	ζ	0.995					
As,req =	Med/ζ*d*fyd	170	mm^2						
from table									
desgin Ø5.5-125mm	-->	As,prov	=	190	mm^2				
Fs=	As,prov*fyd	82650	N						
x=	Fs/0.8b*fcd	5.17	mm						
z=	d-0.4*x	267.93	mm						
Mrd=	Fs*z	22144724	N.mm	-->	22.145	KN.m	>	19.902	KN.m

According to the calculations above all the load-bearing structures is designable and it will carry the load successful.