BRNO UNIVERSITY OF TECHNOLOGY

VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ

FACULTY OF CIVIL ENGINEERING

FAKULTA STAVEBNÍ

INSTITUTE OF BUILDING STRUCTURES

ÚSTAV POZEMNÍHO STAVITELSTVÍ

MUNICIPAL CENTRE IN NIVNICE

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CALCULATIONS

MASTER'S THESIS

DIPLOMOVÁ PRÁCE

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BRNO 2025

1. STAIRCASE CALCULATION

For the building I have chosen U-shaped prefabricated concrete staircase.

My design was calculated as follows.

1.1. Staircase 1.S-1.NP

Clear height of the underground areas = 2,64m

Slab thickness = 0,2 m

Flooring 1NP = 0,16 m

Flooring 2NP = 0,16 m

Total rise of the stairs: **H = 3000 mm**

Used equation: 2h+ w = <600-650> mm, usually taken 630 mm

Where: **h……** recommended rise of step

w…… design width of step

It was supposed h' = 160 mm, value **<130-160>mm** – standard for public buildings

!! for barrier-free buildings is the rise of the step h = max 160mm

→ number of steps n = H/h'

n = 3000/160

n = 18,75 → chosen **19 steps**

! Max 16 steps in one flight (max 18 in family houses)!

We have 3 flights, 1 flight have 8 steps, 1 has 6 steps and 1 has 5 steps

→ real rise of the step h = H/n

h = 3000/19

h = 157,89mm < max 160 mm ✓

→ real width of the step, w = 630-2h

w = 630-2*157,89

w = 314,22 mm → Rounded to 10mm down

w = 310 mm > min 310 mm ✓

! **min 310mm in barrierless access buildings!**

→ slope of staircase, tg(α) =h/w

tg(α) = 157,89/310

tg(α) = *26,99*° < 28° ✓

!! **max 28° in barrierless access buildings!**

→ length of one flight, L = (n-1)*w

L1 = (8-1)*310 L 1= 2170mm

L2 = (6-1)*310 L2=1550mm

L3 = (5-1)*310 L 3= 1240mm

→ designed width of a staircase flight **B=1500mm** ✓

!! min. width 1500 mm in barrierless buildings

→ min. width of a landing Bp = 1600 mm > Bp,min ✓

Bp,min = B + 100 až 200 = 1500+100=1600 mm

→ clearance height of a staircase flight H1,min = 1500 + (750/ cos α)

H1,min = 1500 + (750/cos 26,99)

H1,min = 2342 mm

H1 = 2680 mm ✓

→ Passage height of a staircase flight H2,min = 750 + (1500 · cos α)

H2,min = 750 + (1500 · cos 26,99)

H2,min = 2087 mm

H2 = 2383mm ✓

1.2. Staircase 1.NP-2.NP

Clear height of the office = min 2,7 m taken: 2,9m

Installation cavity = 0,39 m

Slab thickness = 0,2 m

Flooring 1NP = 0,16 m

Flooring 2NP = 0,10 m

Total rise of the stairs: **H = 3590 mm**

Used equation: 2h+ w = <600-650> mm, usually taken 630 mm

Where: **h……** recommended rise of step

w…… design width of step

It was supposed h' = 160 mm, value **<130-160>mm –** standard for public buildings

!! for barrier-free buildings is the rise of the step h = max 160mm

→ number of steps n = H/h'

n = 3590/160

n = 22,44 → chosen **23 steps**

! Max 16 steps in one flight (max 18 in family houses)!

We have 3 flights, 2 flights have 8 steps, 1 has 7 steps

→ real rise of the step h = H/n

h = 3590/23

h = 156,09 mm < max 160 mm ✓

→ real width of the step, w = 630-2h

w = 630-2*156,09

w = 317,82 mm → Rounded to 10mm down

w = 310 mm > min 310 mm ✓

! **min 310mm in barrierless access buildings!**

→ slope of staircase, tg(α) =h/w

tg(α) = 156,09/310

tg(α) = *26,73*° < 28° ✓

!! **max 28° in barrierless access buildings!**

→ length of one flight, L = (n-1)*w

L1 = (8-1)*310 L2 = (7-1)*310

L 1= 2170mm L2=1860mm

→ min. width of a staircase flight **B=1500mm** ✓

!! min. width 1500 mm in barrierless buildings

→ min. width of a landing **B_p = 1600 mm > $B_{p,min}$ ✓**

$B_{p,min}$ = B + 100 až 200 = 1500+100=1600 mm

→ clearance height of a staircase flight $H_{1,min} = 1500 + (750/ \cos \alpha)$

$H_{1,min} = 1500 + (750/\cos 26{,}73)$

$H_{1,min}$ = 2340 mm

H1 = Will be satisfied, there is no flight above, just roof structure, see section A-A

→ Passage height of a staircase flight $H_{2,min} = 750 + 1500 \cdot \cos \alpha$

$H_{2,min} = 750 + 1500 \cdot \cos 26{,}73$

$H_{2,min}$ = 2090 mm

H2 = Will be satisfied, there is no flight above, just roof structure, see section A-A

2. ROOF OUTLET CALCULATION

2.1 Roof outlet

Used equation: Qr = A * I * C (l/s)

Where:

A (m²)	Effective roof Area	Acc. to ČSN EN 12 056-3
i (l/s*m²)	Rainfall intensity	Acc. to tab.10 ČSN 75 6760:2003
C (-)	Water flow factor	Acc.to tab.11 ČSN 75 6760:2003

Effective roof area

→The effective area of the roof is determined by the footprint area of the building's roof, to which 50% of the parapet wall areas are added.

Roof footprint area	A1 = 289,92 m²
Parapet wall area	A2 = 49,65/2 = 24,825 m²
Effective roof area	A3 = 289,92+24,825 = 314,745 m²

Rainfall intensity

i = 0,03 l/s*m2

Water flow factor

C = 1

Type of surface	Water flow factor C [-]		
	< 1 %	1 % - 5 %	> 5 %
roofs with a non-permeable top layer	1.00	1.00	1.00
roof with gravel on top of an impermeable layer	0.90	0.90	0.90
vegetation roof (up to 100 mm)	0.70	0.70	0.90
vegetation roof (100 - 250 mm)	0.40	0.40	0.50
vegetation roof (250 mm and more)	0.30	0.30	0.30
asphalt and concrete surfaces	0.70	0.80	0.90
floor tiles with sand joints	0.50	0.60	0.70
modified gravel surface	0.30	0.40	0.50
unadjusted and open spaces	0.20	0.25	3.00
playground	0.10	0.15	0.20
grass areas	0.05	0.10	0.15

→ even though there are coefficients smaller than 1, it is recommended to use C=1, in case the owner decides to change the type of the roof surface eg. exchange substrate layer for non-permeable top layer, and when constructing the roof, the inlet may be insufficient.

Calculation:

Qr = A * I * C (l/s)

Qr = 314,745 * 0,03 * 1

Qr = 9,44 l/s

Střešní vpusti TW

Název výrobku TOPWET	Typ odvodnění	Rozměr (DN)	Doporučená návrhová kapacita průtoku naměřena dle ČSN 1253-1:2016)*	Přepočet doporučené návrhové kapacity na plochu střechy)**	Naměřený průtok TOPWET dle ČSN 1253-1:2016)***	Dovolený průtok dešťového odpadního potrubí dle ČSN 75 6760 již přepočtený na plochu střechy	
						vnitřní	vnější
TW(E) 75 S	svislé	DN 70	**5.1 l/s (35 mm)**	**170 m²**	5.1 l/s (35 mm)	106 m²	66 m²
TW(E) 110 S	svislé	DN 100	**8.5 l/s (45 mm)**	**283 m²**	5.6 l/s (35 mm)	270 m²	100 m²
TW(E) 125 S	svislé	DN 125	**11.2 l/s (55 mm)**	**373 m²**	7.9 l/s (45 mm)	420 m²	200 m²
TW(E) 160 S XL	svislé	DN 150	**12.2 l/s (55 mm)**	**406 m²**	8.9 l/s (45 mm)	833 m²	300 m²
TW(E) 75 V	vodorovné	DN 70	**4.0 l/s (35 mm)**	**133 m²**	4.0 l/s (35 mm)	106 m²	66 m²
TW(E) 110 V	vodorovné	DN 100	**7.5 l/s (45 mm)**	**250 m²**	5.4 l/s (35 mm)	270 m²	100 m²
TW(E) 125 V	vodorovné	DN 125	**9.1 l/s (55 mm)**	**303 m²**	7.5 l/s (45 mm)	420 m²	200 m²

→ Chosen: **3x vertical inlet TW 125 S BIT, DN 125 , flow rate 8,5 l/s**

2.2 Safety overflow

Used equation: **Qnot = (0,07-0,03*C) · A**

→ since we have more than 2 outlets

Where:

A (m²) Effective roof Area Acc. to ČSN EN 12 056-3

C (-) Water flow factor Acc.to tab.11 ČSN 75 6760:2003

Calculation:

Qnot = (0,07-0,03 * C) * A

Qnot = (0,07 – 0,03 * 1)* 314,745

Qnot = **12,59 l/s**

Pojistné přepady

Název výrobku TOPWET	Typ odvodnění	Rozměr (DN)	Doporučená návrhová kapacita průtoku naměřena dle ČSN 1253-1:2016)*	Přepočet doporučené návrhové kapacity na plochu střechy)**	Naměřený průtok TOPWET dle ČSN 1253-1:2016)***
TWPP 50	vodorovné	DN 50	**0.9 l/s (50 mm)**	**12 m²**	0.5 l/s (35 mm)
TWPP 75	vodorovné	DN 70	**1.9 l/s (75 mm)**	**27 m²**	0.6 l/s (35 mm)
TWPP 110	vodorovné	DN 100	**5.5 l/s (110 mm)**	**78 m²**	0.9 l/s (35 mm)
TWPP 125	vodorovné	DN 125	**7.6 l/s (125 mm)**	**108 m²**	1.1 l/s (45 mm)
TWPP 50X100	vodorovné	50X100	**1.5 l/s (50 mm)**	**21 m²**	0.9 l/s (35 mm)
TWPP 50X150	vodorovné	50X150	**2.2 l/s (50 mm)**	**31 m²**	1.3 l/s (35 mm)
TWPP 100X100	vodorovné	100X100	**4.2 l/s (100 mm)**	**60 m²**	0.9 l/s (35 mm)
TWPP 150X150	vodorovné	150X150	**11.5 l/s (150 mm)**	**164 m²**	1.9 l/s (45 mm)
TWPP 100X300	vodorovné	100X300	**12.5 l/s (100 mm)**	**178 m²**	2.6 l/s (35 mm)

→ Chosen: **2x safety overflow TWPP 125, DN125, flow rate 7,6 l/s**

3. MONOLITHIC REINFORCED CONCRETE LINTEL

RF concrete lintel L2

Opening: L0 = 5500mm

Overlap: u = L0/10+100 = 5500/10+100 = 650mm

min overlap on each side is 325mm → DESIGN u=500mm

Total length: L= 5500+2*500 = 6500mm

Height: h = L/12~L/10 = 6500/12 ~ 6500/10 = 541 ~ 650mm → DESIG

h=500mm

Width: b = (0,4~ 0,5)*h = (0,4~ 0,5)*500 = 200 ~ 250mm → DESIGN b=300mm

4. FOUNDATION STRIP CALCULATION

4.1. Permanent load

PERMANENT						
Structure	Composition	Thickness	Length	Width	Density	Loading Gk
		(m)	(m)	(m)	(kN/m3)	kN
ROOF						
	plants	0,03	4,95	1	0,16	0,02376
	turf and sand	0,06	4,95	1	15	4,455
	drainage layer	0,03	4,95	1	1	0,1485
	ISOVER EPS100	0,2	4,95	1	0,2	0,198
	ISOVER EPS 100	0,34	4,95	1	0,2	0,3366
	SPIROLL panel	0,2	4,95	1	-	0,99
	plaster	0,015	4,95	1	20	1,485
					TOTAL Gk	**7,63686**
					Gd	**10,309761**
2.NP						
FLOOR + CEILING	Flooring	0,008	4,65	1	5	0,186
	Cement based glue	0,003	4,65	1	18	0,2511
	cement screed	0,05	4,65	1	20	4,65
	ISOVER EPS 100	0,1	4,65	1	0,2	0,093
	SPIROLL panel	0,2	4,95	1	-	0,99
	plaster	0,015	4,65	1	20	1,395
					TOTAL Gk	**7,5651**
					Gd	**10,212885**
1.NP						
FLOOR + CEILING	Flooring	0,08	4,65	1	5	1,86
	cement based glue	0,003	4,65	1	18	0,2511
	cement screed	0,05	4,65	1	20	4,65
	Isover EPS 100	0,15	4,65	1	0,2	0,1395
	SPIROLL panel	0,2	4,95	1	-	0,99
	paint	-	4,65	1	-	-
					TOTAL Gk	**7,8906**
					Gd	**10,65231**
0.B						
FOUNDATION SLAB	not part of calculation					
FOUNDATION PAD	approximately	1	0,5	1	24	12
					TOTAL Gk	**12**
					Gd	**16,2**

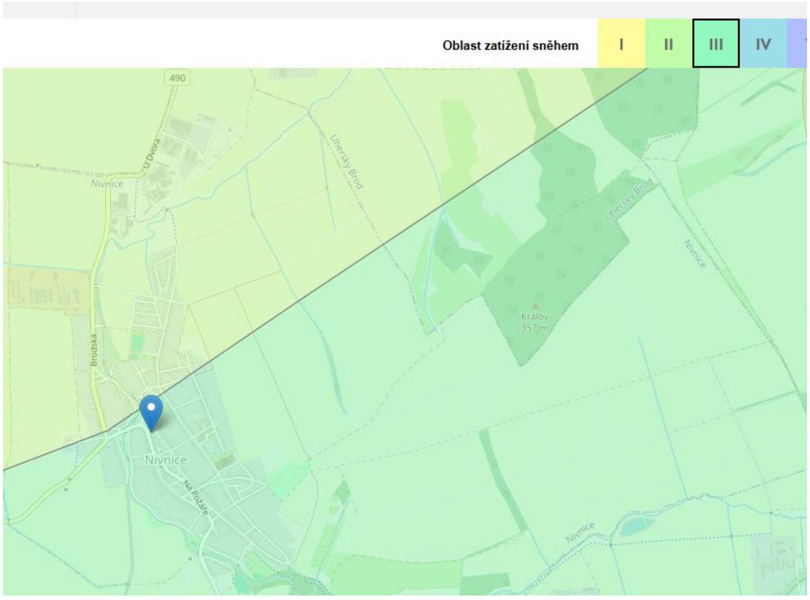
Structure	Surface density	Height	Length	Width	Density	Loading Gk
	(kg/m3)	(m)	(m)	(m)	(kN/m3)	kN
2.NP						
WALL						
masonry + plaster	800	3,25	0,3	1	8	7,8
RF ring	-	0,2	0,3	1	25	1,5
					TOTAL Gk	**9,3**
					Gd	**12,555**
1.NP						
WALL						
masonry + plaster	800	3,25	0,3	1	8	7,8
RF ring	-	0,2	0,3	1	25	1,5
					TOTAL Gk	**9,3**
					Gd	**12,555**
0.B						
WALL						
formwork block		2,8	0,3	1	25	21
Rf ring	-	0,3	0,3	1	25	2,25
					TOTAL Gk	**23,25**
					Gd	**31,3875**

TOTAl Gd	103,872	
Partitions+fake ceilings 15% form total Gd	15,5809	
Overall Gd	**119,453**	**kN**

4.2. Snow load

SNOW			
Sk=	1,5		
Sd=	1,5*1,5=	2,25kN/m	
span	4,95		
TOTAL	4,95*2,25=	**11,1375**	**kN**

Sněhová oblast	Objemová hmotnost sněhu (kg/m³)	I	II	III	IV
Charakteristická hodnota zatížení sněhem na zemi (kPa)		0,7	1	1,5	2
hmotnost sněhu na střeše určená z charakteristické hodnoty (kg/m²)		56	80	120	160
Čerstvý	**100**	**56 cm**	**80 cm**	**120 cm**	**160 cm**
Ulehlý (několik hodin nebo dnů po napadnutí)	**200**	**28 cm**	**40 cm**	**60 cm**	**80 cm**
Starý (několik týdnů nebo měsíců po napadnutí)	**300**	**19 cm**	**27 cm**	**40 cm**	**53 cm**
Mokrý	**400**	**14 cm**	**20 cm**	**30 cm**	**40 cm**



4.3. Variable load

VARIABLE			
Office qk=	3kN/m		
Qd=	1,5*3=	4,5 kN	
span 1NP	4,95m		
span21NP	4,95m		
TOTAl	2*4,95*4,5	**44,55**	**kN**

4.4. Total loading

SUM OF ALL LOADS	**175,1408244**	**kN**

4.5. Foundation strip design

FOUNDATION PAD							
Soil resistance Rdt	250	kPa					
Force Ned	175,1408244	kN					
Aeff = Ned/Rdt	175,14/250=	0,700563298	m		**DESIGN**	**0,8**	**m**
Aeff=l*b	0,8=1*b	**l=1m**		**b=0,8m**			
a=(b-d)/2	(0,8-0,3)/2=	0,25	m				
h= a*tg(60)	0,25*tg(60)	0,43	m		**DESIGN**	**0,5m**	min is 0,5m
Ned/A ≤ Rdt	175,14/(0,8*1)=	**218,93**	**≤250** ✓				

Parking spaces calculation

Calculation of the required parking and standing spaces:

$$N = O0 \cdot ka + P0 \cdot ka \cdot kp$$

Where:

N – total number of parking spaces

O0 – base number of long-term parking spaces

P0 – base number of short-term parking spaces

ka – coefficient reflecting the degree of automobilization

kp – coefficient of parking reduction based on the type of area

Nivnice municipality:

Number of inhabitants: 3333

Number of registered vehicles: 1312

Degree of automobilization: 394 vehicles per 1000 inhabitants

Coefficient of automobilization influence: ka=0,99

Coefficient of parking reduction based on the area type: kp=1

(we will not apply reduction of parking spaces based on public transport)

LONG-TERM PARKING SPACES:

O0 = 7

We will not assume there will be any long-term parking spaces for visitors, since it is municipality hall with post office and ceremony hall. The building is used just for public and administrative matters, not for permanent living. Since there are 7 permanent employees, we will design 7 permanent parking spaces.

SHORT-TERM PARKING SPACES:

POST OFFICE

- 1 space / 20 m² of office space (office)
  S = 18,8m² / 20 m² = 0,94 spaces

- 1 space per counter
  S = 1 / 1 = 1 space

MUNICIPALITY HALL (local significance institution)

- 1 space / 30 m² of office space (offices)
- S =92,07 m² / 30 m² = 3,07 spaces

CEREMONY HALL

- 1 space / 25 m² of public area
- S = 68,16 m² / 25 m² = 2,73 spaces

TOTAL: P0=0,94+1+3,07+2,73= 7,43 spaces

OVERALL CALCULATION

$N = O0 \cdot ka + P0 \cdot ka \cdot kp$

$N = 7 \cdot 0{,}99 + 7{,}43 \cdot 0{,}99 \cdot 1$

$N = 14{,}29$ → **min 15 spaces**

CONCLUSION

There has to be designed min. 15 parking spaces. In close proximity, there are already 62 parking spaces constructed, see attachment. The ceremony hall will use the parking spaces that serve the administration during the day. The hall will be mostly utilized in the afternoon and on weekends, so the operating hours of the hall and the administrative section of municipal centre will not overlap. Since there are 62 parking spaces already, there is no need to create more. We will just design 2 parking spaces right in front of the entrance to the building. One for disabled and one for parents with children.

5.6. Attachment