CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF CIVIL ENGINEERING

DEPARTMENT OF ARCHITECTURAL ENGINEERING (K124)

Project documentation of a residential building – Chodov

Diploma Thesis

Author: Bc. Akbota Baibatyrova

Branch of study: Building structures

Supervisor: Ing. Malila Noori, Ph.D.

Prague, 2023

CZECH TECHNICAL UNIVERSITY IN PRAGUE
Faculty of Civil Engineering
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DIPLOMA THESIS ASSIGNMENT FORM

I. PERSONAL AND STUDY DATA

Surname: Baibatyrova   Name: Akbota   Personal number: 453341

Assigning Department: K124 Department of Architectural Engineering

Study programme: Civil Engineering

Study branch/spec.: Building Structures

II. DIPLOMA THESIS DATA

Diploma Thesis (DT) title: Project documentation of a residential building - Chodov

Diploma Thesis title in English: Project documentation of a residential building - Chodov

Instructions for writing the thesis:

The design of the residential building consists of technical solution of the structure and envelop of the building. Thermal evaluation and assessing the energy efficiency of a building. Elaboration of project documentation of building to obtain building permit included static, building services, fire safety evaluation in line with the current Czech standard norms.

List of recommended literature:

[1] Regulation No. 268/2009 Coll. (Regulation on technical requirements for constructions) of Act No. 183/2006 Coll.
[2] The construction of building - Barry R. BSP 1989
[3] Hanaor, A. : Principles of structures. Blackwell Science. 1998
[4] Faculty of Civil Engineering study materials - CTU in Prague
[5] Hollis M.: Surveying Buildings, RICS Books 2007
[6] Assessment of Traditional Housing, BRE Watford, 2001
[7] Whitlow R.: Materials and Structures, Longman 1992
[8] Foster J.S.: Structures and Fabric, Parts I - III, Longman 1994
[9] Schodek, D.: Structures- Pearson. New Yersay. 2004

Name of Diploma Thesis Supervisor: Ing. Malila Noori, Ph.D.

DT assignment date: 02.03.2023   DT submission date in IS KOS: 22.05.2023
see the schedule of the current acad. year

DT Supervisor's signature   Head of Department's signature

III. ASSIGNMENT RECEIPT

I declare that I am obliged to write the Diploma Thesis on my own, without anyone's assistance, except for provided consultations. The list of references, other sources and consultants' names must be stated in the Diploma Thesis and in referencing I must abide by the CTU methodological manual "How to Write University Final Theses" and the CTU methodological instruction "On the Observation of Ethical Principles in the Preparation of University Final Theses".

Assignment receipt date   Student's name

Acknowledgement

I would like to thank Ing. Malila Noori, Ph.D. for her support and help throughout the consultations. I would also like to express my profound thanks to colleagues and friends for motivating and inspiring me. And lastly, words are not sufficient to express my love and gratitude to my family in Kazakhstan.

Abstract

The purpose of this diploma thesis is to design a new residential building in Prague, in accordance with Czech standard norms to obtain a building permit. The documentation includes the architectural building part, the static design, the foundation structures, the building services, and the fire safety part. In the architectural building part, the technical solution, plan view, elevation view, section drawings, details of the building are solved. The static design part focuses on the structural behaviour of the load bearing elements of the building. The foundation structures part deals with the geological survey and its interaction with the building. The building services part concentrates on the rainwater drainage, wastewater drainage, water supply, heat supply solutions and ventilation of the building. The focus of the fire safety part is to reduce the damage caused by fire and limit its spread. The diploma thesis is solved in compliance with the Czech standard norms

Keywords: *new residential building, project documentation, flat roof, green roof, reinforced concrete structures, thermal evaluation, details*

DIPLOMA THESIS CONTENT	
I	Diploma thesis assignment
II	Technical report
III	Architectural building part
IV	Static design part
V	Foundation part
VI	Building services part
VII	Fire safety part

CZECH TECHNICAL UNIVERSITY IN PRAGUE

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DEPARTMENT OF ARCHITECTURAL ENGINEERING (K124)

DIPLOMA PROJECT

Project documentation of a residential building - Chodov

Technical report

Author: Bc. Akbota Baibatyrova

Supervisor: Ing. Malila Noori, Ph.D.

CONTENT:

1 General information

1.1 Building description

New residential building

Prague 11 – Chodov

Parcel No. 174, 176

2 underground floors + 4 upper floors

Fig.1 Vizualization of a building

The new residential buildings is build in Prague, Chodov. There will be two buidlings “A” and “B” with shared two underground floors. Each building has its own main entrance from the East side. The buidling is located in parcels n.174 and 176. Existing family house with two apartments and garages in parcel n.176 will be demolished.

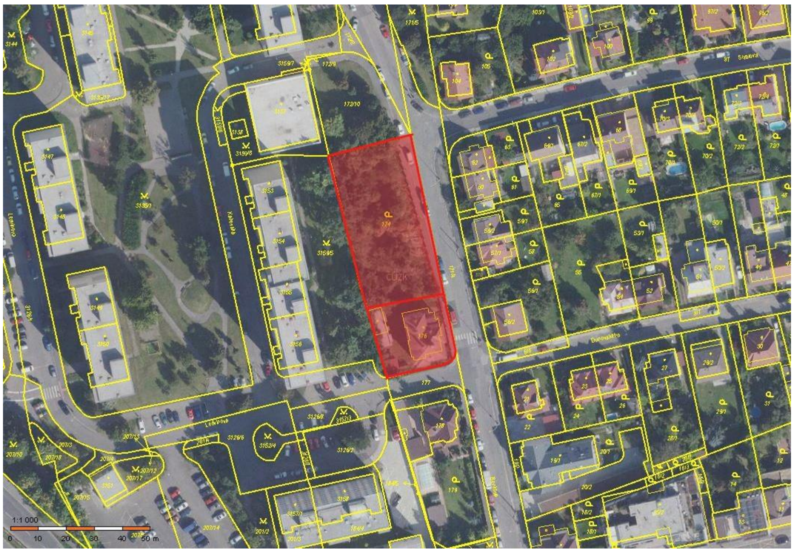


Fig. 2 Boundaries of land parcels n.174 and n.176 in cadastral map [1]

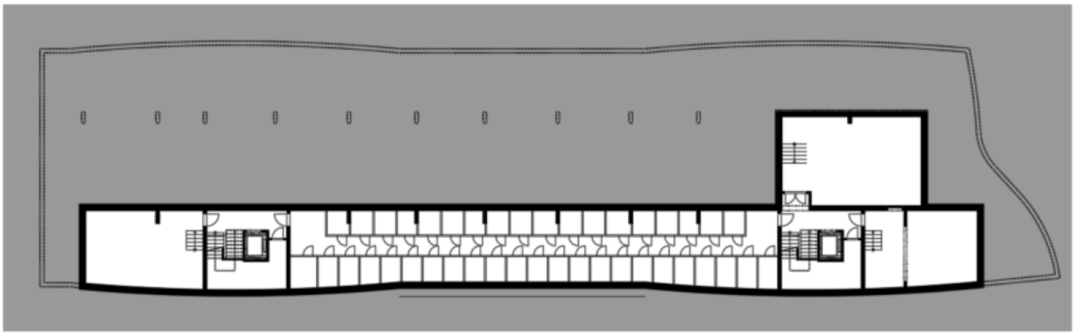


Fig.3 Architectural study of the 2nd underground floor

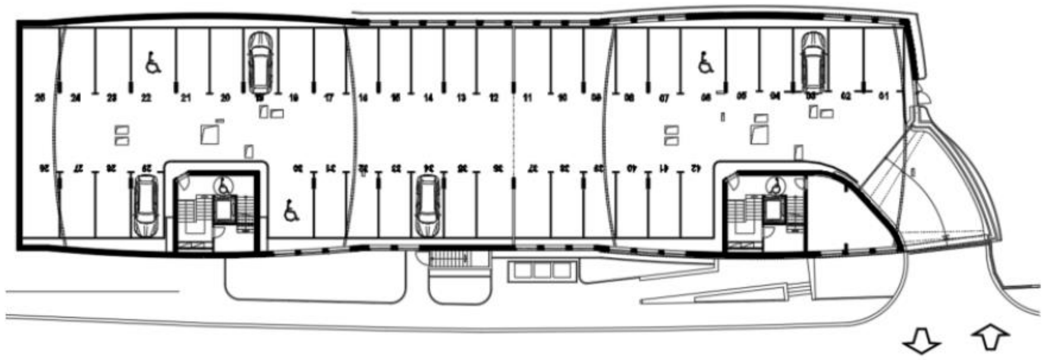


Fig.4 Architectural study of the 1st underground floor

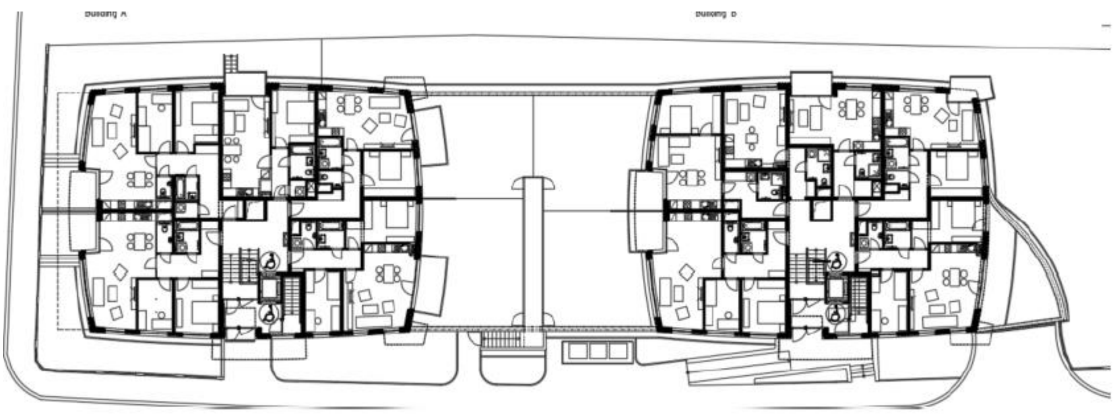


Fig.5 Architectural study of the 1st ground floor

Building A has 2 underground floors, 4 upper ground floors. There are 5 apartments on the 1-3rd floors and 3 apartments on the 4th floor. In total there are 18 apartments in each building (A,B). Apartments range from 1+KK to 4+KK. On the 1st underground floor there are 40 parking spaces, 2 janitorial rooms and 2 stroller rooms. On the 2nd underground floor 40 storage rooms, UPS rooms, 2 air handling unit rooms and technical room. The 4th floor roof is designed as green roof.

The long-side length of the building A is 25,34m, short-side length is 19,10m. The 1 ground floor level ±0,000 is 296,300 m a.s.l. Height of the floor is 3m, total height of the building is 15,40m. A barrier-free solution is ensured by a walk-through lift and access to the building is designed in accordance with the Decree No. 398/2009 Coll.[2]. There are 2 disabled parking spaces available on 1st underground floor (in total 40 parking spaces).

2 Geological survey and foundation

2.1 Earthwork

The topsoil approximately 0,4m will be removed from the job site. After the end of construction, the excavated topsoil will be reused for landscaping the area. The demolished structures will be taken to landfill or recycled and crushed for use in backfill. For stability of a foundation pit from the East and South of the building there are pile walls. The anchors are temporary with a lifespan of up to 2 years and will not be removed.

The upper layer of the site backfill is 1,4m. Below the upper layer is clayey gravel G5 to the 1,8m depth, to the 2,4m depth there is a slate with grade R4, from 2,4m slate R2. The groundwater level is below the foundation structure.

2.2 Plain concrete

Plain concrete C12/15 with the thickness of 100 mm.

2.3 Foundation of the building

Slab foundation is 350mm with strengthening of the foundation thickness to 600mm (2d from the face of the columns) in the basement. The foundation is designed according to the engineering and geological survey. All the loads from upper floors will be transferred by slab/beams and columns to the slab foundation. Waterproofing of the underground structures is solved by using Xypex crystallization admixture.

3 Structural design

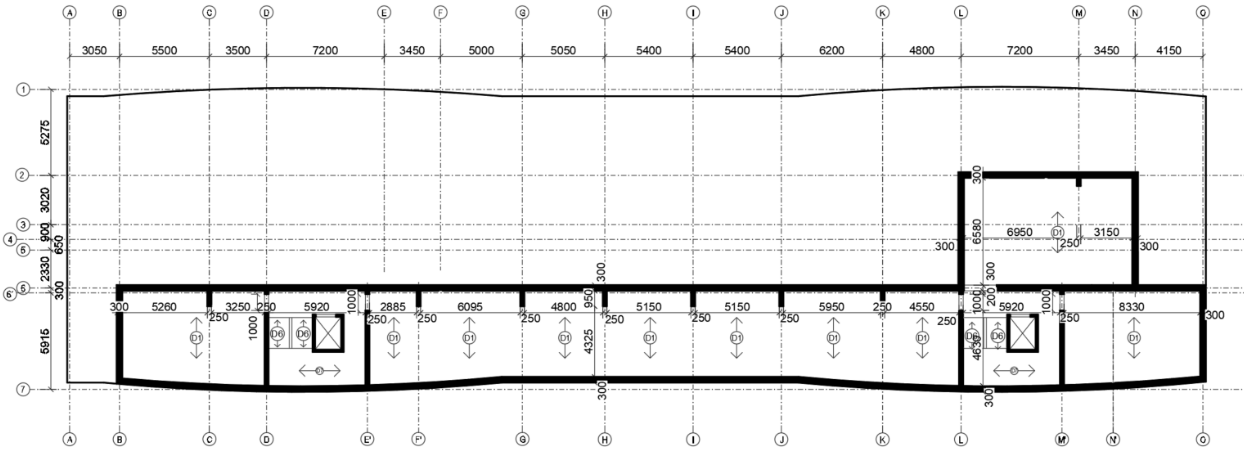


Fig.6 Structural system of the 2nd underground floor

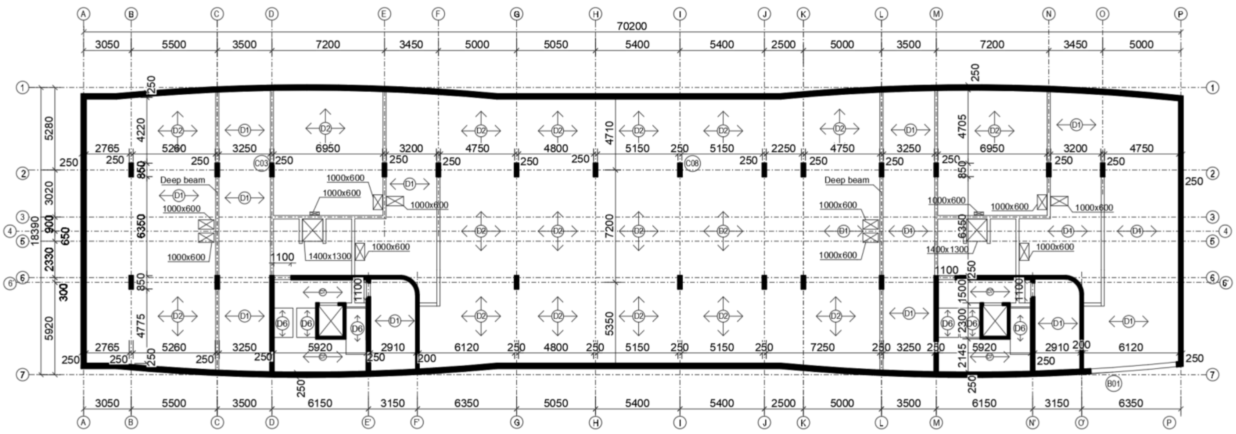


Fig.7 Structural system of the 1st underground floor

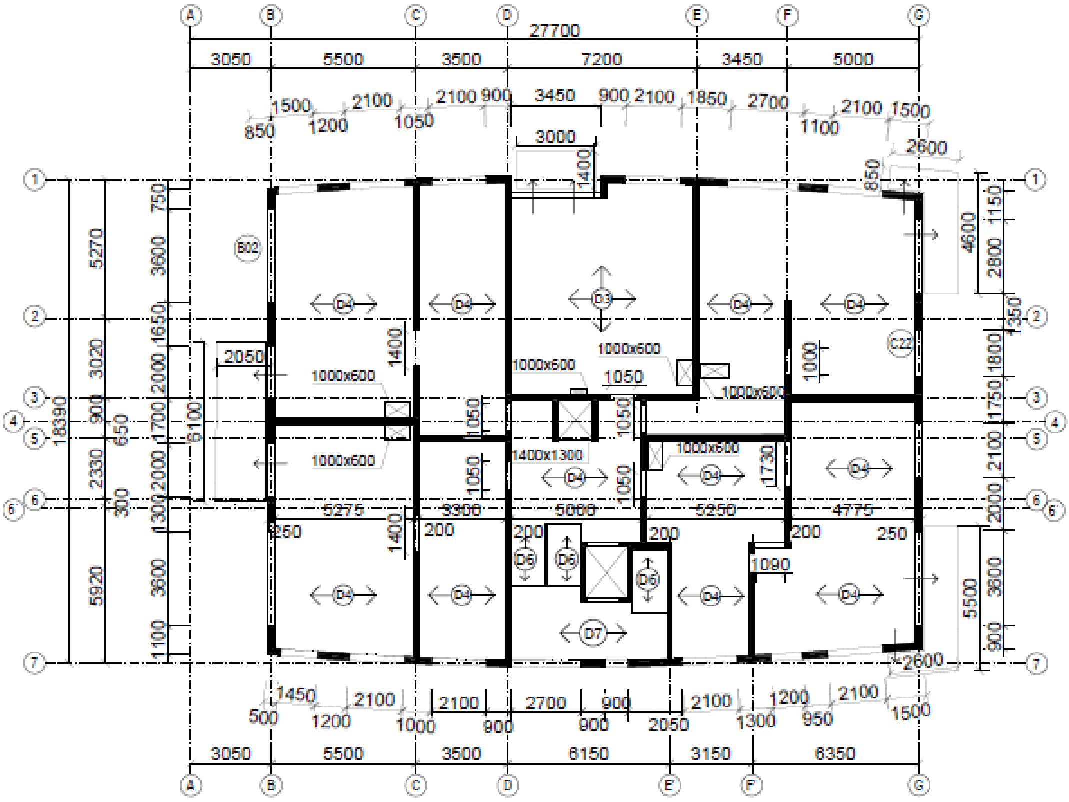


Fig.8 Structural system of the 1st floor

3.1 Vertical load bearing structures

The vertical load bearing structures of the underground floors are made of reinforced concrete. The perimeter wall of the 2nd underground floor is 300mm, inner load bearing wall is 250mm. The 1st underground floor perimeter wall is 250mm thick, inner vertical load bearing wall 200-250mm and load bearing columns 250x850mm. The reinforced concrete perimeter wall of the 1st -4th floors is 250mm thick, 5th floor is 200mm. Load bearing inner walls of the upper ground floors are 200-250mm thick.

The preliminary design is provided in “static” part of the documentation.

3.1.1 Elevator shaft

The monolithic reinforced concrete elevator shaft with wall thickness 200mm is separated from the other structures with 20mm thick flexible rubber insulation boards. The KONE Monospace 300 DX (Fig. 4) with car size 1100x1400mm is designed as a passenger elevator for the building. An elevator has the capacity of 630kg, speed 1.0 m/s. The elevator is used for evacuation and the emergency energy source is located on the 2nd underground floor.

BB - car width 1100mm
DD – car depth 1400mm
CH – car clear height 2200mm
FW - side wall machine side 370mm
FW1 - side wall opposite machine 30mm
FW2 - side wall right - frame door application only
HH - door clear opening height 2100mm
HR - door raw opening height 2100mm
LL - door clear opening width 900mm
LR - door raw opening width 1600mm
LA - front panel width, left 490mm
LB - front panel width, right 150mm
WW - shaft width 1570mm
WD - shaft dept 2000mm

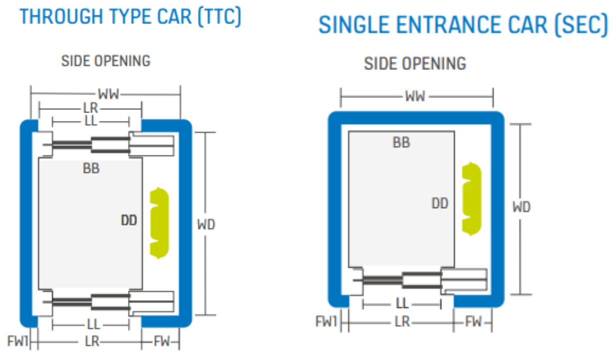


Fig. 9 KONE Monospace 300 DX

3.2 Horizontal load bearing structures

The monolithic one/two-way reinforced concrete slab of the 2nd underground floor supported on the reinforced concrete walls is designed with the thickness of 250mm. The reinforced concrete monolithic flat slab of the 1st underground floor with the thickness of 250mm is locally supported on the inner columns 250x850mm and perimeter walls. The reinforced concrete slab of the 1st-3rd floors and roof have a thickness of 220mm. The 4th floor with the green roof has the 250mm reinforced concrete slab. The structural design is in the “static” part.

3.2.1 Balconies

The designed 200mm high reinforced concrete cantilever balconies are connected using a load bearing thermal insulating element Shock Isokorb XT type K (Fig.10) with 120mm insulation. The concrete is frost resistant. The surface of the balconies will be from anti-slip, frost resistant ceramic tiles placed on adjustable pedestals. The surface water from the balconies is collected with 2,0% slope in the rainwater drainage outlet.

Fig10 Schöck Isokorb XT [3]

3.2.2 Staircase

The reinforced concrete prefabricated two flight staircase C30/37 are bedded on landings by using Schöck Tronsole® type F (Fig.11) which enables the acoustic separation of the structures. Shock Tronsole type L (Fig.12) acts as an impact sound insulation at the joint between stairs and wall. The landing with the 200mm thickness is connected using shock Tronsole type Z (Fig. 13) to eliminate the impact sound propagation. The ceramic tiles are anti-slip. The stainless steel railing will be to the height 1,1m from the floor surface.

The structural design of the staircase is in the part “static”.

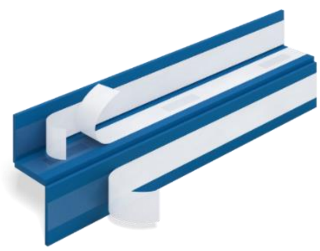


Fig. 11 Impact sound insulation Schöck Tronsole type F [3]

Fig. 12 Impact sound insulation Schöck Shock Tronsole type L [3]

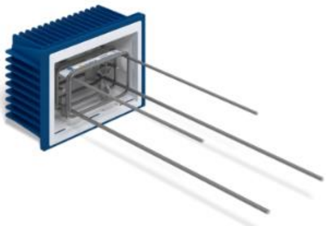


Fig. 13 Impact sound insulation Schöck Tronsole type Z [3]

3.2.3 Flat roof

The flat roof of the staircase area on the 5th floor is thermally insulated with EPS Grey 100 with 2,0% slope and min. thickness 180mm. There are two rainwater drainages on the roof and the waterproofing is ensured by using PVC-P foil.

Above the 4th floor there is the green roof. On top of the waterproofing layer is a substrate layer with greenery. Alternatively, anti-slip, frost-resistant concrete tiles placed on the gravel bed.

The terrace above the 3rd floor has a thermal insulation with min. thickness 180mm and 2,0% slope. Waterproofed with PVC-P foil. The surface is frost-resistant, anti-slip ceramic tiles on adjustable pedestals.

On the 1st floor, above the parking area slab there is another intensive green roof. The sloped layer is made of lightweight concrete screed with 2,0%. Thermal insulation XPS 120mm and waterproofing layer is made of PVC-P foil.

4 Materials

- Concrete:

Basement walls and foundation C25/30 XC1 - Cl0,2 - D_{max}22 - S3

Remaining load-bearing structures C30/37 XC1 - Cl0,2 - D_{max}22 - S3

- Steel B500B
- Non bearing walls Porotherm 11,5
- Lintels Porotherm KP 11,5 11,5x71x1000(1250)mm
  Porotherm 19 AKU P15
  Ytong 100x249x1250mm

5 Facade

The envelope of the building is thermally insulated with Rockwool 200mm and plastered with the Baumit silicone plaster. The waterproof, non-absorbent acrylic based render for splash zone of the plinth will be up to 300mm above the ground level, insulated with XPS and will have base bead profile with drip edge. The façade of the underground floor which is not in contact with the ground will be thermally insulated by 120mm thick Rockwool insulation. The underground perimeter walls will be insulted with EPS thermal insulation.

More detailed composition information is presented in a separate document – "Composition table and thermal calculation"

6 Windows

The windows are triple-glazed plastic white colored. On the ground floor windows are aluminum. The heat transfer coefficient for windows at least 1,1W/m^{2}K.The windows on the South, East and West facades will be equipped with external roll-up shutters SETTA 90.

List of used Norms

[1] ČSN 73 0540 – Tepelná ochrana budov

[2] BUILDING STRUCTURES 1 (124BS01) lectures CTU FCE

[3] CONCRETE AND MASONRY STRUCTURES 1 (133CM01), lectures

[4] EN 1990 Basis of structural design

[5] ČSN 73 4301 Residential building

[6] EN 1992-1 Design of concrete structures

[7] EN 1991-1-1 Eurocode 1: Actions on structures - Part 1-1

[8] The Construction of Buildings, Barry R. BSP 1989

[9] Reguation No. 268/2009 Coll. (Regulation on technical requirements for constructions) of Act No. 183/2006 Coll.

[10] Prague Building Regulations

[11] EN 1997-1: Eurocode 7: Geotechnical design. - Part 1: General rules

References

[1] Fig.1 State Administration of Land Surveying and Cadastre: https://www.cuzk.cz/

[2] Decree No. 398/2009 Coll., on general technical requirements to secure barrier-free usage of buildings

[3] https://www.schoeck.com

List of attachments

1. Composition table and thermal calculation
2. List of windows

List of drawings

1. Situation 1:250
2. Plan view – 2nd underground floor 1:50
3. Plan view – 1st underground floor 1:50
4. Plan view – 1st floor 1:50
5. Plan view – 2nd-3rd floors 1:50
6. Plan view – 4th floor 1:50
7. Plan view – green roof 1:50
8. Plan view – Roof 1:50
9. Section A-A’
10. Section B-B’
11. Elevation view East 1:100
12. Elevation view West 1:100

13. Elevation view North 1:100
14. Elevation view South 1:100
15. Detail 01, attic 1:10
16. Detail 02, terrace 1st floor 1:10
17. Detail 03, terrace 4th floor 1:10
18. Detail 04, balcony 1:10
19. Detail 05, staircase connection 1:10

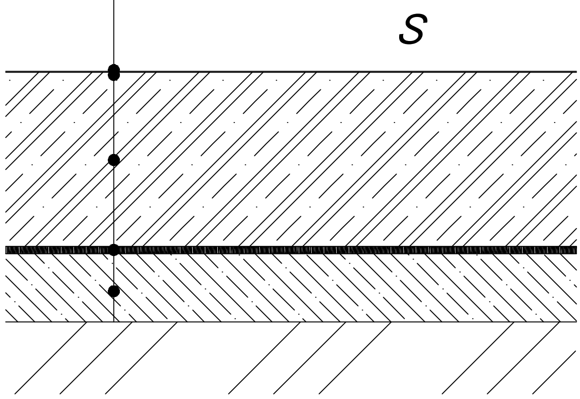
Used software

1. AutoCAD 2022
2. MS office
3. Teplo EDU

designed by	checked by	FACULTY OF CIVIL ENGINEERING	
Akbota Baibatyrova	Ing. Malila Noori, Ph.D.	CTU	
course 124DPP - Diploma Project			
subject Project documentation of a residential building - Chodov		study year	2022 / 2023
		date	03.2023
drawing Composition table and thermal calculation		size	A4
		scale	1:10

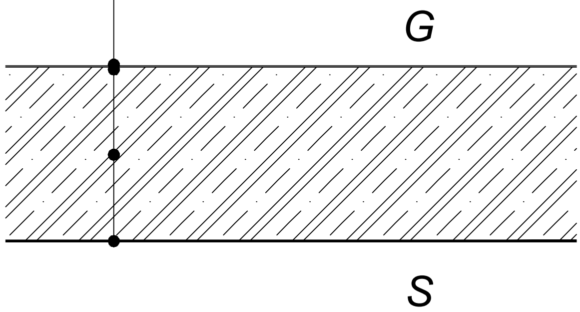
F01 2nd UNDERGROUND FLOOR

- EPOXY FLOORING 1,5mm
- BASE COAT EPOXY PRIMER
- WATERPROOF REINFORCED CONCRETE 400mm
(power trowel machine smoothing)
- 2 x SEPARATION FOIL
- GEOTEXTILE
- PLAIN CONCRETE C16/20, 100mm



F02 1st UNDERGROUND FLOOR (garage)

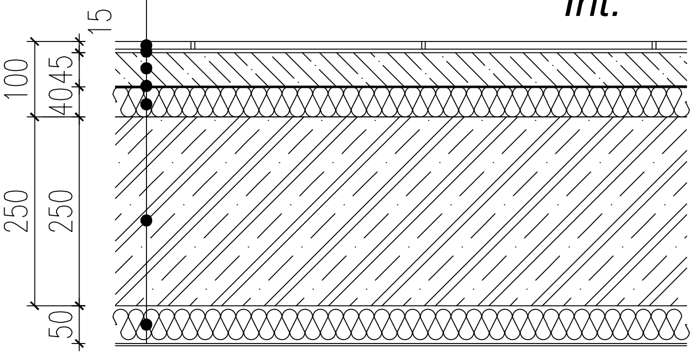
- EPOXY FLOORING 1,5mm
- BASE COAT EPOXY PRIMER
- REINFORCED CONCRETE 250mm
(power trowel machine smoothing)
- PROTECTION COATING 1,5mm



F03 GROUND FLOOR - COMMON AREA FLOORING (corridor)

- CERAMIC TILES 10mm
- FLEXIBLE ADHESIVE 5mm
- LIQUID WATERPROOFING MEMBRANE
- ANHYDRITE SCREED 45mm
- PE FOIL SEPARATION LAYER
- ACOUSTIC INSULATION EPS Rigifloor 4000 40mm
- REINFORCED CONCRETE SLAB C30/37 250mm
- ROCKWOOL FASROCK INSULATION 50mm (with decor plaster)

Int.



G

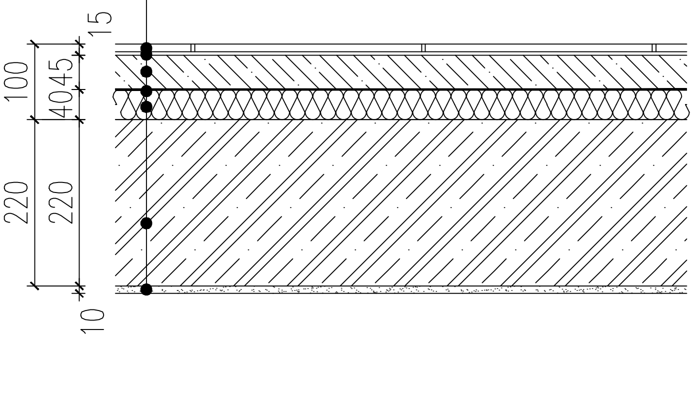
ČSN 730540-2 Thermal requirements
$U = 0{,}392\ W/m^2K \leq U_{rec} = 0{,}4\ W/m^2K$

ČSN 730532-02 Acoustic requirements
Airborne resistance $R'_w \geq R'_w$
$k = 2\ dB$
$R'_w = R_w - k = 63-2=61\ dB \geq R'_w = 57\ dB$ ***OK***

Impact resistance $L'_{nw} = 44\ dB \leq L'n,w = 48\ dB$

F04 TYPICAL FLOOR - COMMON AREA FLOORING (corridor)

- CERAMIC TILES 10mm
- FLEXIBLE ADHESIVE 5mm
- LIQUID WATERPROOFING MEMBRANE
- ANHYDRITE SCREED 45mm
- PE FOIL SEPARATION LAYER
- ACOUSTIC INSULATION EPS Rigifloor 4000 40mm
- REINFORCED CONCRETE SLAB C30/37 220mm
- PLASTER 10mm



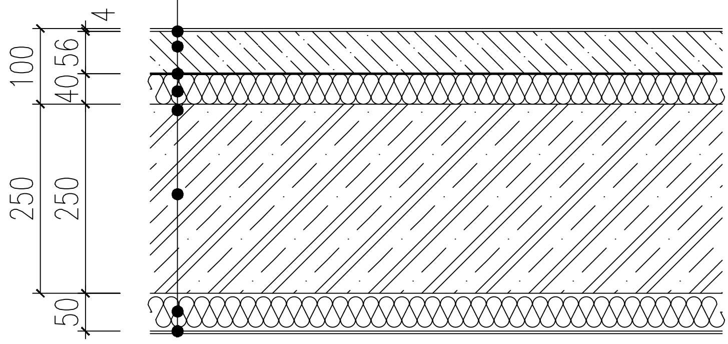
ČSN 730532-02 Acoustic requirements

Airborne resistance $R'_w \geq R'_{w,req} = 47\ dB$
$k = 2\ dB$
$R'_w = R_w - k = 56-2=54\ dB \geq R'_{w,req} = 47\ dB$ ***OK***

Impact resistance $L'_{nw} = 44\ dB \leq L'_{n,w,req} = 55\ dB$

F05 GROUND FLOOR - APARTMENT FLOORING *(dry area: bedroom, living room, room)*

- VINYL FLOORING 3mm
- ADHESIVE LAYER ULTRABOND ECO 4 LVT 1mm
- ANHYDRITE SCREED 40mm
- PE FOIL SEPARATION LAYER
- EPS Rigifloor 4000 ACOUSTIC INSULATION 40mm
- REINFORCED CONCRETE SLAB C30/37 250mm
- ROCKWOOL FASROCK INSULATION 50mm (with decor plaster)



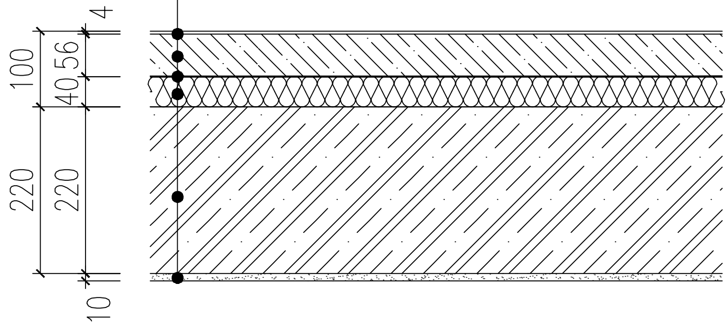
ČSN 730540-2 Thermal requirements
$U = 0{,}391\ W/m^2K \leq U_{rec} = 0{,}4\ W/m^2K$

ČSN 730532-02 Acoustic requirements
Airborne resistance $R'_w \geq R'_w$
$k = 2$ dB
$R'_w = R_w - k = 63-2=61$ dB $\geq R'_w = 57$ dB ***OK***

Impact resistance $L'_{nw} = 44$ dB $\leq L'n,w = 48$ dB

F06 TYPICAL FLOOR - APARTMENT FLOORING *(dry area: bedroom, living room, room)*

- VINYL FLOORING 3mm
- ADHESIVE LAYER ULTRABOND ECO 4 LVT 1mm
- ANHYDRITE SCREED 56mm
- PE FOIL SEPARATION LAYER
- EPS Rigifloor 4000 ACOUSTIC INSULATION 40mm
- REINFORCED CONCRETE SLAB C30/37 220mm
- PLASTER 10mm



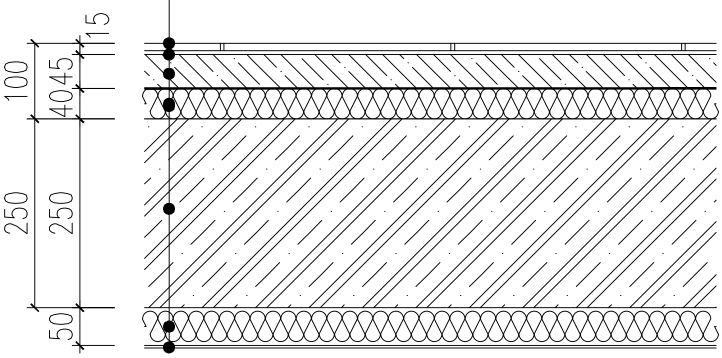
ČSN 730532-02 Acoustic requirements

Airborne resistance $R'_w \geq R'_{w,req} = 47$ dB
$k = 2$ dB
$R'_w = R_w - k = 56-2=54$ dB $\geq R'_{w,req} = 47$ dB ***OK***

Impact resistance $L'_{nw} = 44$ dB $\leq L'_{n,w,req} = 55$ dB

F07 GROUND FLOOR - APARTMENT FLOORING *(dry area: apartment entrance, kitchen)*

- CERAMIC TILES 10mm
- CEMENT ADHESIVE + PENETRATION 5mm
- ANHYDRITE SCREED 45mm
- PE FOIL SEPARATION LAYER
- ACOUSTIC INSULATION EPS Rigifloor 4000 40mm λ=0,044W/mK
- REINFORCED CONCRETE SLAB C30/37 250mm
- ROCKWOOL FASROCK INSULATION 50mm
  (with decor plaster)



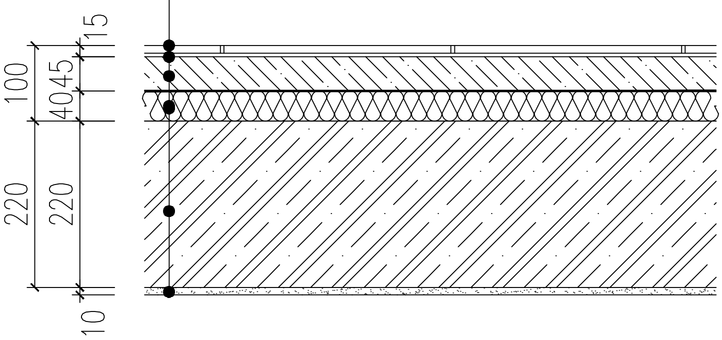
ČSN 730540-2 Thermal requirements
$U = 0,392\ W/m^2K \leq U_{rec} = 0,4\ W/m^2K$

ČSN 730532-02 Acoustic requirements
Airborne resistance $R'_w \geq R'_w$
k = 2 dB
$R'_w = R_w - k = 63-2=61$ dB ≥ R'_w = 57 dB ***OK***

Impact resistance L'_{nw} =44 dB ≤ $L'n,w$ = 48 dB

F08 TYPICAL FLOOR - APARTMENT FLOORING *(dry area: apartment entrance, kitchen)*

- CERAMIC TILES 10mm
- CEMENT ADHESIVE + PENETRATION 5mm
- ANHYDRITE SCREED 45mm
- PE FOIL SEPARATION LAYER
- ACOUSTIC INSULATION EPS Rigifloor 4000 40mm λ=0,044W/mK
- REINFORCED CONCRETE SLAB C30/37 220mm
- ROCKWOOL FASROCK INSULATION 50mm (ceiling of the unheated garage)
  (with decor plaster) λ=0,045W/mK



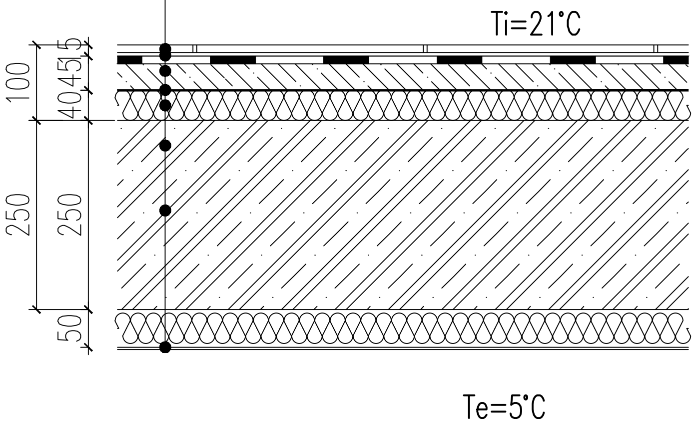
ČSN 730532-02 Acoustic requirements

Airborne resistance $R'_w \geq R'_{w,req}$=47 dB
k = 2 dB
$R'_w = R_w - k = 56-2=54$ dB ≥ $R'_{w,req}$ = 47 dB ***OK***

Impact resistance L'_{nw}= 44 dB ≤ $L'_{n,w,req}$ = 55 dB

F09 GROUND FLOOR- APARTMENT FLOORING *(wet area: bathroom, WC, laundry room)*

- CERAMIC TILES 10mm
- ADHESIVE (according to the manufacturer) 5mm
- LIQUID WATERPROOFING MEMBRANE
- ANHYDRITE SCREED 45mm
- PE FOIL SEPARATION LAYER
- ACOUSTIC INSULATION EPS Rigifloor 4000 40mm
- REINFORCED CONCRETE SLAB C30/37 250mm
- ROCKWOOL FASROCK INSULATION 50mm
  (with decor plaster)



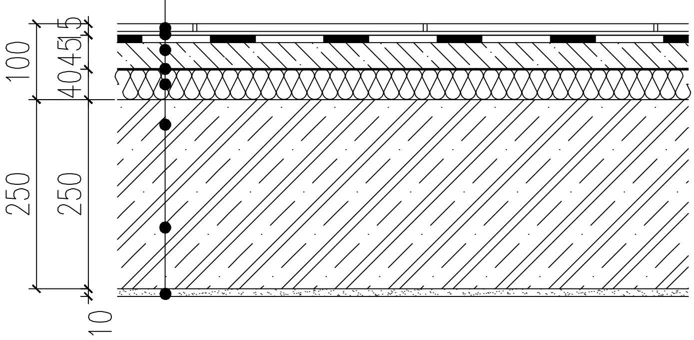
ČSN 730540-2 Thermal requirements
$U = 0{,}392\ W/m^2K \leq U_{rec} = 0{,}4\ W/m^2K$

ČSN 730532-02 Acoustic requirements
Airborne resistance $R'_w \geq R'_w$
k = 2 dB
$R'_w = R_w - k = 63-2=61$ dB ≥ R'_w = 57 dB ***OK***

Impact resistance L'_{nw} =44 dB ≤ L´n,w = 48 dB

F10 GROUND FLOOR- APARTMENT FLOORING *(wet area: bathroom, WC, laundry room)*

- CERAMIC TILES 10mm
- ADHESIVE (according to the manufacturer) 5mm
- LIQUID WATERPROOFING MEMBRANE
- ANHYDRITE SCREED 45mm
- PE FOIL SEPARATION LAYER
- ACOUSTIC INSULATION EPS Rigifloor 4000 40mm
- REINFORCED CONCRETE SLAB C30/37 250mm
- PLASTER 10mm



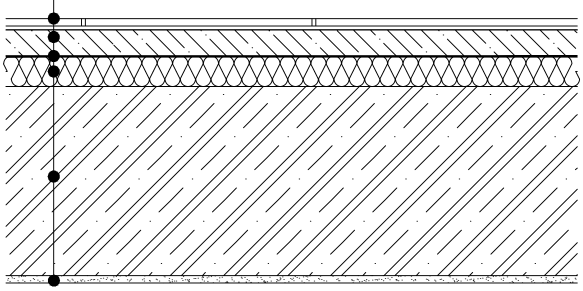
ČSN 730532-02 Acoustic requirements

Airborne resistance $R'_w \geq R'_{w,req}$=47 dB
k = 2 dB
$R'_w = R_w - k = 56-2=54$ dB ≥ $R'_{w,req}$ = 47 dB ***OK***

Impact resistance L'_{nw}= 44 dB ≤ $L'_{n,w,req}$ = 55 dB

F11 STAIRCASE LANDING

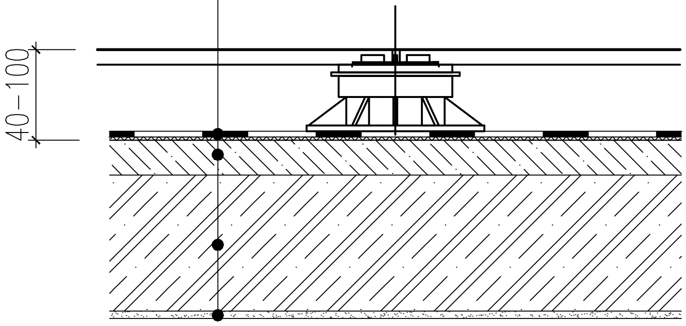
- CERAMIC TILES 10mm
- ADHESIVE (according to the manufacturer) 5mm
- ANHYDRITE SCREED 45mm
- PE FOIL SEPARATION LAYER
- ACOUSTIC INSULATION EPS Rigifloor 4000 40mm
- REINFORCED CONCRETE SLAB C30/37 250mm
- PLASTER 10mm



F12 BALCONY

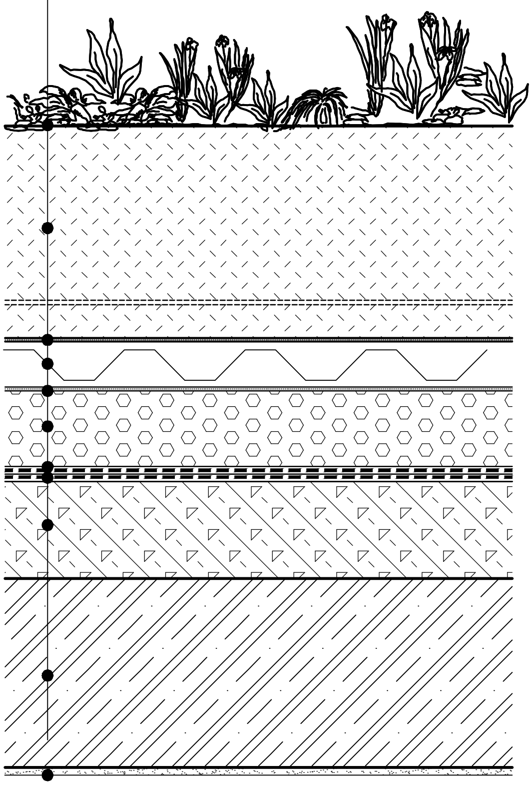
The thermal bridge is solved by thermal break element Schöck Isokorb

- ANTI SLIP FROST-RESISTANT CERAMIC TILES 600x600x20mm
- ADJUSTABLE PEDESTAL SYSTEM PLACED ON DAMPING RUBBER PADS
- HYDRO INSULATION FOIL PVC-P DEKPLAN 77 1,5mm
- SEPARATION FOIL FILTEK V
- CONCRETE SCREED with 2%slope + MESH REINFORCEMENT
- REINFORCED CONCRETE SLAB C30/37 200mm
- PLASTER



F13 GREEN ROOF- unheated garage green roof

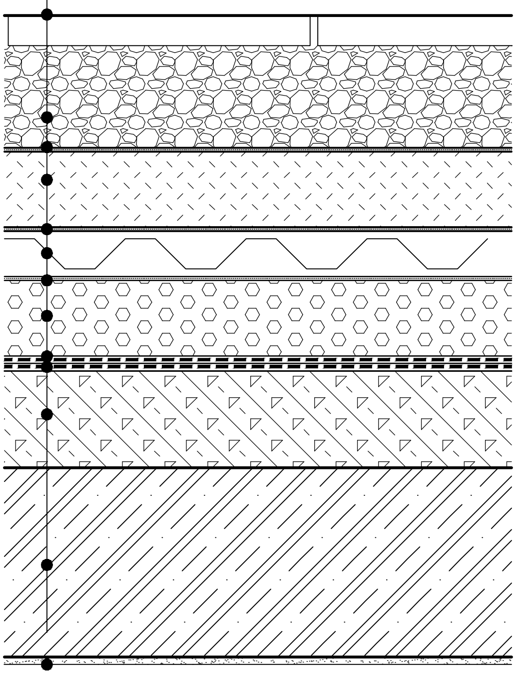
- VEGETATION
- INTENSIVE SUBSTRAT 150-400mm
- GEOTEXTILE FILTEK 200
- DRAINING LAYER NOP FOIL OPTIGRUN FKD 40 FILLED WITH GRAVEL
- SEPARATION LAYER
- HYDRO INSULATION FOIL PVC-P 1,5mm
- THERMAL INSULATION XPS 120mm
- VAPOR BARRIER BITUMINOUS MEMBRANE WITH AL FOIL 4mm
- BITUMINOUS COATING 1mm
- LIGHTWEIGHT CONCRETE SCREED with 2,0% slope min. 40mm
- REINFORCED CONCRETE SLAB C30/37 250mm
- PLASTER 10mm



G

F14 TERRACE - unheated garage green roof

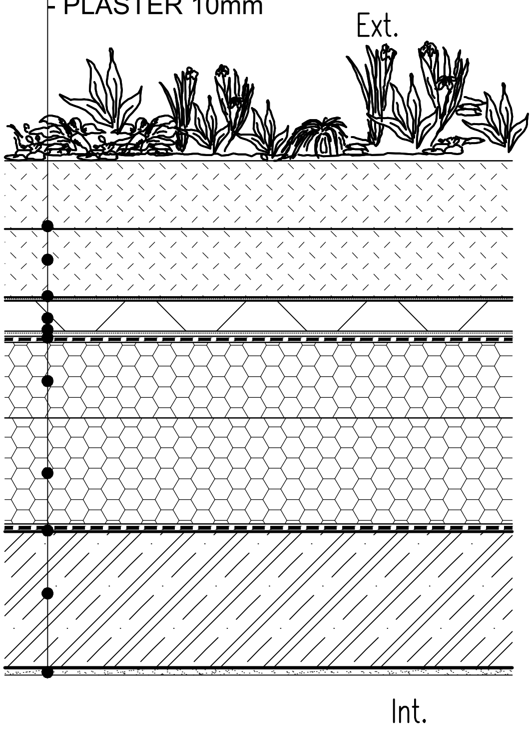
- ANTI SLIP FROST-RESISTANT CONCRETE TILES 400x400x40mm
- DENSELY PACKED GRAVEL fr. 16-32mm 110m
- SEPARATION LAYER
- SUBSTRATE 250mm
- GEOTEXTILE FILTEK 200
- DRAINING LAYER NOP FOIL OPTIGRUN FKD 40 FILLED WITH GRAVEL-SEPARATION LAYER
- HYDRO INSULATION FOIL PVC-P 1,5mm
- THERMAL INSULATION XPS 120mm
- VAPOR BARRIER BITUMINOUS MEMBRANE WITH AL FOIL 4mm
- BITUMINOUS COATING 1mm
- LIGHTWEIGHT CONCRETE SCREED with 2,0% slope min. 40mm
- REINFORCED CONCRETE SLAB C30/37 250mm
- PLASTER 10mm



G

F15 VEGETATION - ROOF

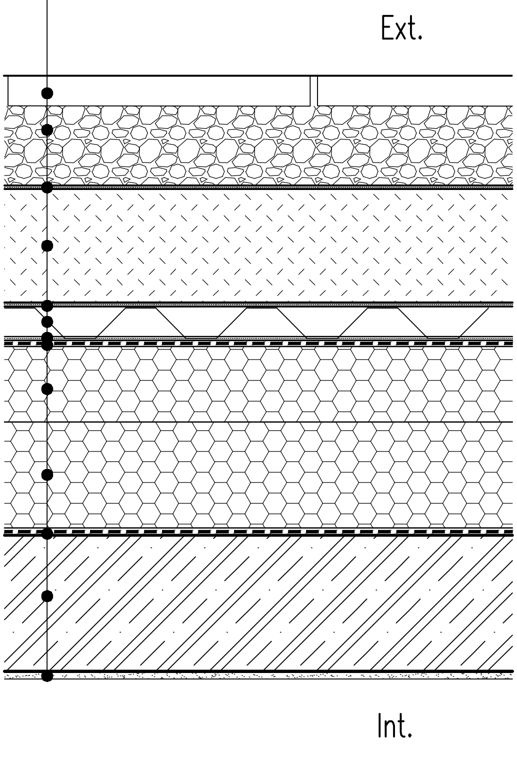
- VEGETATION
- INTENSIVE SUBSTRATE 150mm
- SUBSTRATE 150mm
- GEOTEXTILE FILTEK 200
- DRAINING LAYER NOP FOIL OPTIGRUN FKD 60 FILLED WITH GRAVEL-SEPARATION LAYER
- HYDRO INSULATION FOIL PVC-P 1,5mm
- THERMAL INSULATION EPS 200S,160mm λd=0,034 W/Mk
- SLOPED THERMAL INSULATION EPS 200S, min.60mm 2%
- VAPOR BARRIER BITUMINOUS MEMBRANE WITH AL FOIL 4mm
- BITUMINOUS COATING 1mm
- REINFORCED CONCRETE SLAB C30/37 250mm
- PLASTER 10mm



ČSN 730540-2 Thermal requirements
$U = 0{,}136\ W/m^2K \leq U_{rec}=0{,}16\ W/m^2K$

F16 Terrace - ROOF

- ANTI SLIP FROST-RESISTANT CONCRETE TILES 400x400x40mm
- AGGREGATE DRAINAGE LAYER 110mm
- SEPARATION LAYER
- LIGHTWEIGHT SUBSTRATE 150mm
- GEOTEXTILE FILTEK 200
- DRAINING LAYER NOP FOIL OPTIGRUN FKD 60 FILLED WITH GRAVEL
- SEPARATION LAYER
- HYDRO INSULATION FOIL PVC-P 1,5mm
- THERMAL INSULATION EPS 200S,180mm λd=0,034 W/Mk
- SLOPED THERMAL INSULATION EPS 200S, min.40mm 2%
- VAPOR BARRIER BITUMINOUS MEMBRANE WITH AL FOIL 4mm
- BITUMINOUS COATING 1mm
- REINFORCED CONCRETE SLAB C30/37 250mm
- PLASTER 10mm

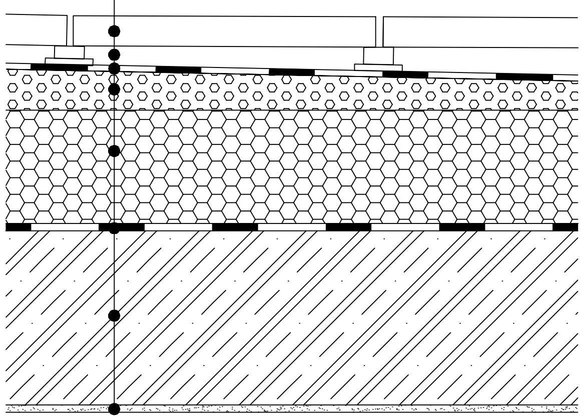


ČSN 730540-2 Thermal requirements
$U = 0,137\ W/m^2K \leq U_{rec}=0,16\ W/m^2K$

F17 TERRACE

ČSN 730540-2 Thermal requirements
$U = 0{,}16 W/m^2K \leq U_{rec} = 0{,}16 W/m^2K$

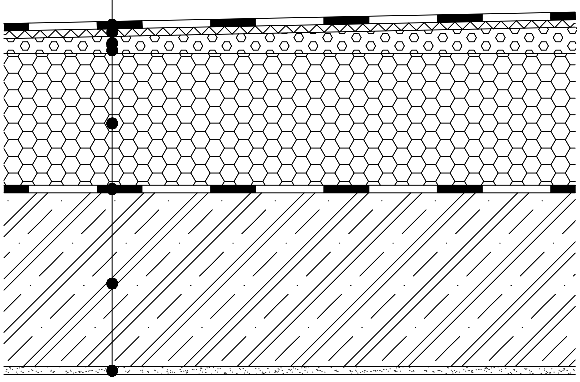
- ANTI-SLIP FROST-RESISTANT CERAMIC TILES 600x600mm 20mm
- ADJUSTABLE PEDESTAL SYSTEM
- HYDRO INSULATION FOIL PVC-P DEKPLAN 77 1,5mm
- SEPARATION FOIL FILTEK V
- SLOPED INSULATION ISOVER EPS Grey 150 S with 2,0% slope min. 20mm
- THERMAL INSULATION ISOVER EPS Grey 100 mechanically fixed 160mm
- VAPOR BARRIER BITUMINOUS MEMBRANE WITH AL FOIL 4mm
- PRIME COAT
- REINFORCED CONCRETE SLAB C30/37 220mm
- PLASTER 10mm



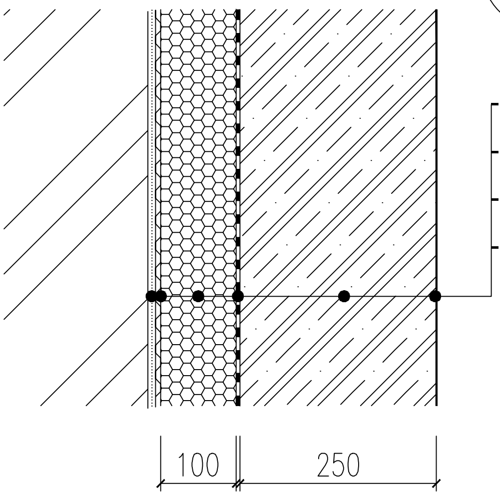
F18 FLAT ROOF

ČSN 730540-2 Thermal requirements
$U = 0,152 W/m^2K \leq U_{rec} = 0,16 W/m^2K$

- PVC-P FOIL mechanically fixed 1,5mm
- GEOTEXTILE LAYER 4mm
- SLOPED INSULATION ISOVER EPS Grey 100 with 2,0% slope 20-180mm
- THERMAL INSULATION ISOVER EPS Grey 100 mechanically fixed 160mm
- VAPOR BARRIER BITUMINOUS MEMBRANE WITH AL FOIL 4mm
- PRIME COAT
- REINFORCED CONCRETE SLAB C30/37 220mm
- PLASTER 10mm



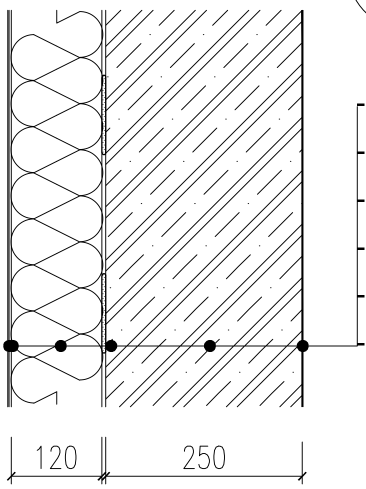
W01 **LOAD BEARING PERIMETER WALL** (*underground floor*)



- GEOTEXTILE
- THERMAL INSULATION BACHL EPS 70 F 100mm
- REINFORCED CONCRETE WALL C25/30 250mm
- PERMEABLE PROTECTION COATING 1,5mm

W02 **LOAD BEARING PERIMETER WALL** (*underground floor*)

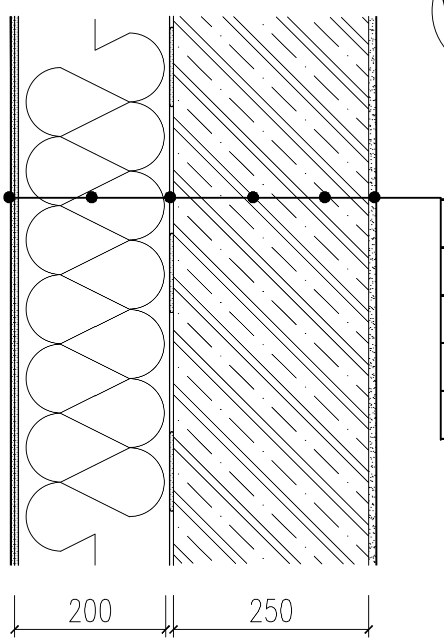
Thermal requirements ČSN 730540-2
$U = 0,264\ W/m^2K \leq U_{rec} = 0,4\ W/m^2K$



- SILICONE PLASTER 3mm
- BASE COAT WITH MESH 7mm
- THERMAL INSULATION ROCKWOOL FRONTROCK PLUS 120mm
- ADHESIVE COAT 5mm
- REINFORCED CONCRETE WALL C25/30 250mm
- PERMEABLE PROTECTION COATING 1,5mm

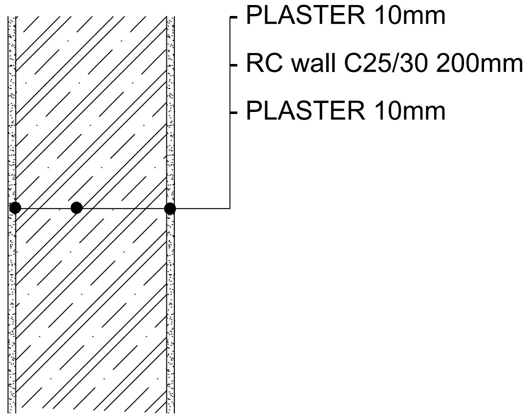
W03 **LOAD BEARING PERIMETER WALL** ($2\text{-}4^{th}$ *floor*)

Thermal requirements ČSN 730540-2
$U = 0,164\ W/m^2K \leq U_{rec} = 0,25\ W/m^2K$



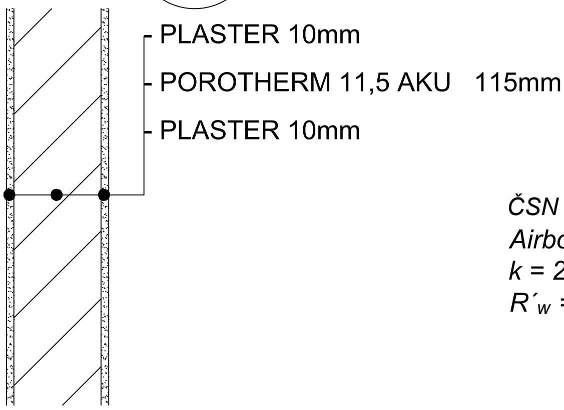
- SILICONE PLASTER 3mm
- BASE COAT WITH MESH 7mm
- ROCKWOOL THERMAL INSULATION mechanically fixed 200mm
- LIGHTWEIGHT ADHESIVE RENDER COAT 5mm
- RC WALL 250mm
- INNER PLASTER 10mm

W04 LOAD BEARING INTERNAL WALL (*2-4th floor*)



ČSN 730532-02 Acoustic requirements
Airborne resistance $R'_w \geq R'_w = 53$ *dB*
$k = 2$ *dB*
$R'_w = R_w - k = 57-2 = 55$ *dB* $\geq R'_w = 53$ *dB* ***OK***
apartment/apartment

W05 PARTITION WALL



ČSN 730532-02 Acoustic requirements
Airborne resistance $R'_w \geq R'_w$
$k = 2$ *dB*
$R'_w = R_w - k = 47 -2 = 45$ *dB* $\geq R'_w = 42$ *dB* ***OK***

SHRNUTI VLASTNOSTI HODNOCENYCH KONSTRUKCI

Teplo 2017 EDU tepelna ochrana budov (CSN 730540, EN ISO 6946, EN ISO 13788)

Nazev kce	Typ	R [m2K/W]	U [W/m2K]	Ma,max[kg/m2]	Odpareni	DeltaT10 [C]
Perimeter wall W01 (un...	stena	2.746	0.348	nedochazi ke kondenzaci v.p.		---

Vysvetlivky:
R tepelny odpor konstrukce
U soucinitel prostupu tepla konstrukce
Ma,max maximalni mnozstvi zkond. vodni pary v konstrukci za rok
DeltaT10 pokles dotykove teploty podlahove konstrukce.

KOMPLEXNI POSOUZENI SKLADBY STAVEBNI KONSTRUKCE Z HLEDISKA SIRENI TEPLA A VODNI PARY

podle EN ISO 13788, EN ISO 6946, CSN 730540 a STN 730540

Teplo 2017 EDU

Nazev ulohy : **Perimeter wall W01 (underground)**
Zpracovatel : Akbota Baibatyrova
Zakazka : Bachelor thesis
Datum : 28.03.2023

ZADANA SKLADBA A OKRAJOVE PODMINKY :

Typ hodnocene konstrukce : Stena suterenni
Korekce soucinitele prostupu dU : 0.000 W/m2K

Skladba konstrukce (od interieru) :

Cislo	Nazev	D [m]	Lambda [W/(m.K)]	c [J/(kg.K)]	Ro [kg/m3]	Mi [-]	Ma [kg/m2]
1	Železobeton 1	0,2500	1,4300	1020,0	2300,0	23,0	0.0000
2	Sindelit SBS	0,0015	0,2100	1470,0	1200,0	12507,0	0.0000
3	Bachl EPS 70 F	0,1000	0,0390	1270,0	16,0	30,0	0.0000

Poznamka: D je tloustka vrstvy, Lambda je navrhova hodnota tepelne vodivosti vrstvy, C je merna tepelna kapacita vrstvy, Ro je objemova hmotnost vrstvy, Mi je faktor difuzniho odporu vrstvy a Ma je pocatecni zabudovana vlhkost ve vrstve.

Cislo	Kompletni nazev vrstvy	Interni vypocet tep. vodivosti
1	Železobeton 1	---
2	Sindelit SBS	---
3	Bachl EPS 70 F	---

Okrajove podminky vypoctu :

Tepelny odpor pri prestupu tepla v interieru Rsi : 0.13 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rsi : 0.25 m2K/W
Tepelny odpor pri prestupu tepla v exterieru Rse : 0.00 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rse : 0.00 m2K/W

Navrhova venkovni teplota Te : -5.0 C
Navrhova teplota vnitrniho vzduchu Tai : 5.0 C
Navrhova relativni vlhkost venkovniho vzduchu RHe : 84.0 %
Navrhova relativni vlhkost vnitrniho vzduchu RHi : 55.0 %

VYSLEDKY VYPOCTU HODNOCENE KONSTRUKCE :

Tepelny odpor a soucinitel prostupu tepla podle EN ISO 6946:

Tepelny odpor konstrukce R : 2.746 m2K/W
Soucinitel prostupu tepla konstrukce U : **0.348 W/m2K**

Soucinitel prostupu zabudovane kce U,kc : 0.37 / 0.40 / 0.45 / 0.55 W/m2K
Uvedene orientacni hodnoty plati pro ruznou kvalitu reseni tep. mostu vyjadrenou pribliznou prirazkou podle poznamek k cl. B.9.2 v CSN 730540-4.

Difuzni odpor a tepelne akumulacni vlastnosti:

Difuzni odpor konstrukce ZpT : 1.5E+0011 m/s

Teplotni utlum konstrukce Ny* podle EN ISO 13786 : 200.7
Fazovy posun teplotniho kmitu Psi* podle EN ISO 13786 : 9.6 h

Teplota vnitrniho povrchu a teplotni faktor podle CSN 730540 a EN ISO 13788:

Vnitrni povrchova teplota v navrhovych podminkach Tsi,p : 4.17 C
Teplotni faktor v navrhovych podminkach f,Rsi,p : **0.917**

Obe hodnoty plati pro odpor pri prestupu tepla na vnitrni strane Rsi=0,25 m2K/W.

Difuze vodni pary v navrh. podminkach a bilance vodni pary podle CSN 730540:

(bez vlivu zabudovane vlhkosti a slunecni radiace)

Prubeh teplot a castecnych tlaku vodni pary v navrhovych okrajovych podminkach:

rozhrani:	i	1-2	2-3	e
theta [C]:	4.5	3.9	3.9	-5.0
p [Pa]:	480	450	353	337
p,sat [Pa]:	845	809	808	401

Poznamka: theta je teplota na rozhrani vrstev, p je predpokladany castecny tlak vodni pary na rozhrani vrstev a p,sat je castecny tlak nasycene vodni pary na rozhrani vrstev.

Pri venkovni navrhove teplote nedochazi v konstrukci ke kondenzaci vodni pary.

Mnozstvi difundujici vodni pary Gd : 1.036E-0009 kg/(m2.s)

Poznamka: Hodnoceni difuze vodni pary bylo provedeno pro predpoklad 1D sireni vodni pary prevazujici skladbou konstrukce. Pro konstrukce s vyraznymi systematickymi tepelnymi mosty je vysledek vypoctu jen orientacni. Presnejsi vysledky lze ziskat s pomoci 2D analyzy.

SHRNUTI VLASTNOSTI HODNOCENYCH KONSTRUKCI

Teplo 2017 EDU tepelna ochrana budov (CSN 730540, EN ISO 6946, EN ISO 13788)

Nazev kce	Typ	R [m2K/W]	U [W/m2K]	Ma,max[kg/m2]	Odpareni	DeltaT10 [C]
Perimeter wall W02 (un...	stena	3.624	0.264	nedochazi ke kondenzaci v.p.		---

Vysvetlivky:
R tepelny odpor konstrukce
U soucinitel prostupu tepla konstrukce
Ma,max maximalni mnozstvi zkond. vodni pary v konstrukci za rok
DeltaT10 pokles dotykove teploty podlahove konstrukce.

KOMPLEXNI POSOUZENI SKLADBY STAVEBNI KONSTRUKCE Z HLEDISKA SIRENI TEPLA A VODNI PARY

podle EN ISO 13788, EN ISO 6946, CSN 730540 a STN 730540

Teplo 2017 EDU

Nazev ulohy : **Perimeter wall W02 (underground)**
Zpracovatel : Akbota Baibatyrova
Zakazka : Bachelor thesis
Datum : 28.03.2023

ZADANA SKLADBA A OKRAJOVE PODMINKY :

Typ hodnocene konstrukce : Stena vnejsi jednoplastova
Korekce soucinitele prostupu dU : 0.000 W/m2K

Skladba konstrukce (od interieru) :

Cislo	Nazev	D [m]	Lambda [W/(m.K)]	c [J/(kg.K)]	Ro [kg/m3]	Mi [-]	Ma [kg/m2]
1	Železobeton 1	0,2500	1,4300	1020,0	2300,0	23,0	0.0000
2	Rockwool Front	0,1200	0,0350	840,0	230,0	2,0	0.0000
3	weber.san 600	0,0100	0,4800	790,0	1120,0	15,0	0.0000

Poznamka: D je tloustka vrstvy, Lambda je navrhova hodnota tepelne vodivosti vrstvy, C je merna tepelna kapacita vrstvy, Ro je objemova hmotnost vrstvy, Mi je faktor difuzniho odporu vrstvy a Ma je pocatecni zabudovana vlhkost ve vrstve.

Cislo	Kompletni nazev vrstvy	Interni vypocet tep. vodivosti
1	Železobeton 1	---
2	Rockwool Frontrock Plus	---
3	weber.san 600 jemná štuková omítka	---

Okrajove podminky vypoctu :

Tepelny odpor pri prestupu tepla v interieru Rsi : 0.13 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rsi : 0.25 m2K/W
Tepelny odpor pri prestupu tepla v exterieru Rse : 0.04 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rse : 0.04 m2K/W

Navrhova venkovni teplota Te : -5.0 C
Navrhova teplota vnitrniho vzduchu Tai : 5.0 C
Navrhova relativni vlhkost venkovniho vzduchu RHe : 84.0 %
Navrhova relativni vlhkost vnitrniho vzduchu RHi : 60.0 %

VYSLEDKY VYPOCTU HODNOCENE KONSTRUKCE :

Tepelny odpor a soucinitel prostupu tepla podle EN ISO 6946:

Tepelny odpor konstrukce R : 3.624 m2K/W
Soucinitel prostupu tepla konstrukce U : **0.264 W/m2K**

Soucinitel prostupu zabudovane kce U,kc : 0.28 / 0.31 / 0.36 / 0.46 W/m2K
Uvedene orientacni hodnoty plati pro ruznou kvalitu reseni tep. mostu vyjadrenou pribliznou prirazkou podle poznamek k cl. B.9.2 v CSN 730540-4.

Difuzni odpor a tepelne akumulacni vlastnosti:

Difuzni odpor konstrukce ZpT : 3.3E+0010 m/s

Teplotni utlum konstrukce Ny* podle EN ISO 13786 : 327.8
Fazovy posun teplotniho kmitu Psi* podle EN ISO 13786 : 13.1 h

Teplota vnitrniho povrchu a teplotni faktor podle CSN 730540 a EN ISO 13788:

Vnitrni povrchova teplota v navrhovych podminkach Tsi,p : 4.36 C
Teplotni faktor v navrhovych podminkach f,Rsi,p : **0.936**

Obe hodnoty plati pro odpor pri prestupu tepla na vnitrni strane Rsi=0,25 m2K/W.

Difuze vodni pary v navrh. podminkach a bilance vodni pary podle CSN 730540:
(bez vlivu zabudovane vlhkosti a slunecni radiace)

Prubeh teplot a castecnych tlaku vodni pary v navrhovych okrajovych podminkach:

rozhrani:	i	1-2	2-3	e
theta [C]:	4.7	4.2	-4.8	-4.9
p [Pa]:	523	349	342	337
p,sat [Pa]:	851	824	407	405

Poznamka: theta je teplota na rozhrani vrstev, p je predpokladany castecny tlak vodni pary na rozhrani vrstev a p,sat je castecny tlak nasycene vodni pary na rozhrani vrstev.

Pri venkovni navrhove teplote nedochazi v konstrukci ke kondenzaci vodni pary.

Mnozstvi difundujici vodni pary Gd : 6.063E-0009 kg/(m2.s)

Poznamka: Hodnoceni difuze vodni pary bylo provedeno pro predpoklad 1D sireni vodni pary prevazujici skladbou konstrukce. Pro konstrukce s vyraznymi systematickymi tepelnymi mosty je vysledek vypoctu jen orientacni. Presnejsi vysledky lze ziskat s pomoci 2D analyzy.

SHRNUTI VLASTNOSTI HODNOCENYCH KONSTRUKCI

Teplo 2017 EDU tepelna ochrana budov (CSN 730540, EN ISO 6946, EN ISO 13788)

Nazev kce	Typ	R [m2K/W]	U [W/m2K]	Ma,max[kg/m2]	Odpareni	DeltaT10 [C]
Perimeter wall W03...	stena	5.912	0.164	nedochazi ke kondenzaci v.p.		---

Vysvetlivky:
R tepelny odpor konstrukce
U soucinitel prostupu tepla konstrukce
Ma,max maximalni mnozstvi zkond. vodni pary v konstrukci za rok
DeltaT10 pokles dotykove teploty podlahove konstrukce.

KOMPLEXNI POSOUZENI SKLADBY STAVEBNI KONSTRUKCE Z HLEDISKA SIRENI TEPLA A VODNI PARY

podle EN ISO 13788, EN ISO 6946, CSN 730540 a STN 730540

Teplo 2017 EDU

Nazev ulohy : **Perimeter wall W03**
Zpracovatel : Akbota Baibatyrova
Zakazka : DIPLOMA thesis
Datum : 28.03.2023

ZADANA SKLADBA A OKRAJOVE PODMINKY :

Typ hodnocene konstrukce : Stena vnejsi jednoplastova
Korekce soucinitele prostupu dU : 0.000 W/m2K

Skladba konstrukce (od interieru) :

Cislo	Nazev	D [m]	Lambda [W/(m.K)]	c [J/(kg.K)]	Ro [kg/m3]	Mi [-]	Ma [kg/m2]
1	weber.san 600	0,0100	0,4800	790,0	1120,0	15,0	0.0000
2	Železobeton 1	0,2500	1,4300	1020,0	2300,0	23,0	0.0000
3	Rockwool Front	0,2000	0,0350	840,0	230,0	2,0	0.0000
4	weber.pas sili	0,0015	0,7500	920,0	1600,0	80,0	0.0000

Poznamka: D je tloustka vrstvy, Lambda je navrhova hodnota tepelne vodivosti vrstvy, C je merna tepelna kapacita vrstvy, Ro je objemova hmotnost vrstvy, Mi je faktor difuzniho odporu vrstvy a Ma je pocatecni zabudovana vlhkost ve vrstve.

Cislo	Kompletni nazev vrstvy	Interni vypocet tep. vodivosti
1	weber.san 600 jemná štuková omítka	---
2	Železobeton 1	---
3	Rockwool Frontrock Plus	---
4	weber.pas silikon - silikonová omítka	---

Okrajove podminky vypoctu :

Tepelny odpor pri prestupu tepla v interieru Rsi : 0.13 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rsi : 0.25 m2K/W
Tepelny odpor pri prestupu tepla v exterieru Rse : 0.04 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rse : 0.04 m2K/W

Navrhova venkovni teplota Te : -13.0 C
Navrhova teplota vnitrniho vzduchu Tai : 21.0 C

Navrhova relativni vlhkost venkovniho vzduchu RHe : 84.0 %
Navrhova relativni vlhkost vnitrniho vzduchu RHi : 55.0 %

Mesic	Delka [dny/hodiny]		Tai [C]	RHi [%]	Pi [Pa]	Te [C]	RHe [%]	Pe [Pa]
1	31	744	21.0	53.9	1339.7	-2.4	81.2	406.1
2	28	672	21.0	56.0	1391.9	-0.9	80.8	457.9
3	31	744	21.0	57.5	1429.2	3.0	79.5	602.1
4	30	720	21.0	59.3	1473.9	7.7	77.5	814.1
5	31	744	21.0	63.4	1575.9	12.7	74.5	1093.5
6	30	720	21.0	67.2	1670.3	15.9	72.0	1300.1
7	31	744	21.0	69.2	1720.0	17.5	70.4	1407.2
8	31	744	21.0	68.5	1702.6	17.0	70.9	1373.1
9	30	720	21.0	64.1	1593.3	13.3	74.1	1131.2
10	31	744	21.0	59.7	1483.9	8.3	77.1	843.7
11	30	720	21.0	57.5	1429.2	2.9	79.5	597.9
12	31	744	21.0	56.5	1404.4	-0.6	80.7	468.9

Poznamka: Tai, RHi a Pi jsou prum. mesicni parametry vnitrniho vzduchu (teplota, relativni vlhkost a castecny tlak vodni pary) a Te, RHe a Pe jsou prum. mesicni parametry v prostredi na vnejsi strane konstrukce (teplota, relativni vlhkost a castecny tlak vodni pary).

Pro vnitrni prostredi byla uplatnena prirazka k vnitrni relativni vlhkosti : 5.0 %

Vychozi mesic vypoctu bilance se stanovuje vypoctem podle EN ISO 13788.
Pocet hodnocenych let : 1

VYSLEDKY VYPOCTU HODNOCENE KONSTRUKCE :

Tepelny odpor a soucinitel prostupu tepla podle EN ISO 6946:

Tepelny odpor konstrukce R : 5.912 m2K/W
Soucinitel prostupu tepla konstrukce U : **0.164 W/m2K**

Soucinitel prostupu zabudovane kce U,kc : 0.18 / 0.21 / 0.26 / 0.36 W/m2K
Uvedene orientacni hodnoty plati pro ruznou kvalitu reseni tep. mostu vyjadrenou probliznou prirazkou podle poznamek k cl. B.9.2 v CSN 730540-4.

Difuzni odpor a tepelne akumulacni vlastnosti:

Difuzni odpor konstrukce ZpT : 3.4E+0010 m/s

Teplotni utlum konstrukce Ny* podle EN ISO 13786 : 1104.0
Fazovy posun teplotniho kmitu Psi* podle EN ISO 13786 : 17.5 h

Teplota vnitrniho povrchu a teplotni faktor podle CSN 730540 a EN ISO 13788:

Vnitrni povrchova teplota v navrhovych podminkach Tsi,p : 19.63 C
Teplotni faktor v navrhovych podminkach f,Rsi,p : **0.960**

Obe hodnoty plati pro odpor pri prestupu tepla na vnitrni strane Rsi=0,25 m2K/W.

Cislo mesice	Minimalni pozadovane hodnoty pri max. rel. vlhkosti na vnitrnim povrchu: --------- 80% ---------		-------- 100% ---------		Vypoctene hodnoty		
	Tsi,m[C]	**f,Rsi,m**	**Tsi,m[C]**	**f,Rsi,m**	**Tsi[C]**	**f,Rsi**	**RHsi[%]**
1	14.7	0.732	11.3	0.586	20.1	0.960	57.1
2	15.3	0.741	11.9	0.584	20.1	0.960	59.1
3	15.7	0.707	12.3	0.516	20.3	0.960	60.1
4	16.2	0.640	12.8	0.381	20.5	0.960	61.3
5	17.3	0.550	13.8	0.131	20.7	0.960	64.7
6	18.2	0.449	14.7	------	20.8	0.960	68.1
7	18.7	0.331	15.1	------	20.9	0.960	69.8
8	18.5	0.374	15.0	------	20.8	0.960	69.2
9	17.4	0.538	14.0	0.085	20.7	0.960	65.3
10	16.3	0.632	12.9	0.360	20.5	0.960	61.6
11	15.7	0.709	12.3	0.519	20.3	0.960	60.1
12	15.5	0.743	12.0	0.585	20.1	0.960	59.6

Poznamka: RHsi je relativni vlhkost na vnitrnim povrchu, Tsi je vnitrni povrchova teplota a f,Rsi je teplotni faktor.

Difuze vodni pary v navrh. podminkach a bilance vodni pary podle CSN 730540:

(bez vlivu zabudovane vlhkosti a slunecni radiace)

Prubeh teplot a castecnych tlaku vodni pary v navrhovych okrajovych podminkach:

rozhrani:	**i**	**1-2**	**2-3**	**3-4**	**e**
theta [C]:	20.3	20.2	19.2	-12.8	-12.8

p [Pa]:	1367	1339	264	189	166
p,sat [Pa]:	2377	2360	2221	202	202

Poznamka: theta je teplota na rozhrani vrstev, p je predpokladany castecny tlak vodni pary na rozhrani vrstev a p,sat je castecny tlak nasycene vodni pary na rozhrani vrstev.

Pri venkovni navrhove teplote nedochazi v konstrukci ke kondenzaci vodni pary.

Mnozstvi difundujici vodni pary Gd : 3.741E-0008 kg/(m2.s)

Bilance zkondenzovane a vyparene vodni pary podle EN ISO 13788:

Rocni cyklus c. 1

V konstrukci nedochazi behem modeloveho roku ke kondenzaci vodni pary.

Poznamka: Hodnoceni difuze vodni pary bylo provedeno pro predpoklad 1D sireni vodni pary prevazujici skladbou konstrukce. Pro konstrukce s vyraznymi systematickymi tepelnymi mosty je vysledek vypoctu jen orientacni. Presnejsi vysledky lze ziskat s pomoci 2D analyzy.

Rozmezi relativnich vlhkosti v jednotlivych materialech (pro posledni rocni cyklus):

		Trvani prislusne relativni vlhkosti v materialu ve dnech za rok				
Cislo	**Nazev**	**pod 60%**	**60-70%**	**70-80%**	**80-90%**	**nad 90%**
1	weber.san 600	151	214	---	---	---
2	Železobeton 1	181	184	---	---	---
3	Rockwool Front	---	---	214	151	---
4	weber.pas sili	---	---	214	151	---

Poznamka: S pomoci teto tabulky lze zjednodusene odhadnout, jake je riziko dosazeni nepripustne hmotnostni vlhkosti materialu ci riziko jeho koroze.

Konkretne pro drevo predepisuje CSN 730540-2/Z1 maximalni pripustnou hmotnostni vlhkost 18 %. Ze sorpcni krivky pro dany typ dreva lze odvodit, pri jake relativni vlhkosti vzduchu dosahuje drevo teto kriticke hmotnostni vlhkosti. Obvykle jde o cca 80 %.
Pokud je v tabulce vyse pro drevo uveden dlouhodobejsi vyskyt relativni vlhkosti nad 80 %, lze predpokladat, ze pozadavek CSN 730540-2 na maximalni hmotnostni vlhkost dreva nebude splnen.

SHRNUTI VLASTNOSTI HODNOCENYCH KONSTRUKCI

Teplo 2017 EDU tepelna ochrana budov (CSN 730540, EN ISO 6946, EN ISO 13788)

Nazev kce	Typ	R [m2K/W]	U [W/m2K]	Ma,max[kg/m2]	Odpareni	DeltaT10 [C]
common area to unheate...	podlaha	3.563	0.256	nedochazi ke kondenzaci v.p.		---

Vysvetlivky:
R tepelny odpor konstrukce
U soucinitel prostupu tepla konstrukce
Ma,max maximalni mnozstvi zkond. vodni pary v konstrukci za rok
DeltaT10 pokles dotykove teploty podlahove konstrukce.

KOMPLEXNI POSOUZENI SKLADBY STAVEBNI KONSTRUKCE Z HLEDISKA SIRENI TEPLA A VODNI PARY

podle EN ISO 13788, EN ISO 6946, CSN 730540 a STN 730540

Teplo 2017 EDU

Nazev ulohy : **common area to unheated space F03**
Zpracovatel : Akbota Baibatyrova
Zakazka : diploma thesis
Datum : 29.03.2023

ZADANA SKLADBA A OKRAJOVE PODMINKY :

Typ hodnocene konstrukce : Podlaha nad nevytapenym ci mene vytap. vnitrnim prostorem
Korekce soucinitele prostupu dU : 0.000 W/m2K

Skladba konstrukce (od interieru) :

Cislo	Nazev	D [m]	Lambda [W/(m.K)]	c [J/(kg.K)]	Ro [kg/m3]	Mi [-]	Ma [kg/m2]
1	Keramický obkl	0,0100	1,0100	840,0	2000,0	200,0	0.0000
2	Anhydritová sm	0,0450	1,2000	840,0	2100,0	20,0	0.0000
3	Isover EPS Rig	0,0400	0,0440	1270,0	12,0	30,0	0.0000
4	Isover EPS 100	0,0500	0,0370	1270,0	20,5	50,0	0.0000
5	Železobeton 3	0,2500	1,7400	1020,0	2500,0	32,0	0.0000
6	Rockwool Fasro	0,0500	0,0450	840,0	135,0	4,8	0.0000

Poznamka: D je tloustka vrstvy, Lambda je navrhova hodnota tepelne vodivosti vrstvy, C je merna tepelna kapacita vrstvy, Ro je objemova hmotnost vrstvy, Mi je faktor difuzniho odporu vrstvy a Ma je pocatecni zabudovana vlhkost ve vrstve.

Cislo	Kompletni nazev vrstvy	Interni vypocet tep. vodivosti
1	Keramický obklad	---
2	Anhydritová směs	---
3	Isover EPS Rigifloor 4000	---
4	Isover EPS 100	---
5	Železobeton 3	---
6	Rockwool Fasrock	---

Okrajove podminky vypoctu :

Tepelny odpor pri prestupu tepla v interieru Rsi : 0.17 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rsi : 0.25 m2K/W
Tepelny odpor pri prestupu tepla v exterieru Rse : 0.17 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rse : 0.17 m2K/W

Navrhova venkovni teplota Te : 5.0 C
Navrhova teplota vnitrniho vzduchu Tai : 21.0 C
Navrhova relativni vlhkost venkovniho vzduchu RHe : 80.0 %
Navrhova relativni vlhkost vnitrniho vzduchu RHi : 55.0 %

Mesic	Delka [dny/hodiny]		Tai [C]	RHi [%]	Pi [Pa]	Te [C]	RHe [%]	Pe [Pa]
1	31	744	21.0	53.9	1339.7	5.0	90.0	784.7
2	28	672	21.0	56.0	1391.9	5.0	90.0	784.7
3	31	744	21.0	57.5	1429.2	6.0	85.0	794.4
4	30	720	21.0	59.3	1473.9	9.0	80.0	918.0
5	31	744	21.0	63.4	1575.9	13.0	75.0	1122.7
6	30	720	21.0	67.2	1670.3	17.0	70.0	1355.7
7	31	744	21.0	69.2	1720.0	20.0	65.0	1519.0
8	31	744	21.0	68.5	1702.6	20.0	65.0	1519.0
9	30	720	21.0	64.1	1593.3	16.0	70.0	1272.1
10	31	744	21.0	59.7	1483.9	10.0	75.0	920.5
11	30	720	21.0	57.5	1429.2	8.0	85.0	911.4
12	31	744	21.0	56.5	1404.4	5.0	90.0	784.7

Poznamka: Tai, RHi a Pi jsou prum. mesicni parametry vnitrniho vzduchu (teplota, relativni vlhkost a castecny tlak vodni pary) a Te, RHe a Pe jsou prum. mesicni parametry v prostredi na vnejsi strane konstrukce (teplota, relativni vlhkost a castecny tlak vodni pary).

Pro vnitrni prostredi byla uplatnena prirazka k vnitrni relativni vlhkosti : 5.0 %

Vychozi mesic vypoctu bilance se stanovuje vypoctem podle EN ISO 13788.
Pocet hodnocenych let : 1

VYSLEDKY VYPOCTU HODNOCENE KONSTRUKCE :

Tepelny odpor a soucinitel prostupu tepla podle EN ISO 6946:

Tepelny odpor konstrukce R : 3.563 m2K/W
Soucinitel prostupu tepla konstrukce U : **0.256 W/m2K**

Soucinitel prostupu zabudovane kce U,kc : 0.28 / 0.31 / 0.36 / 0.46 W/m2K
Uvedene orientacni hodnoty plati pro ruznou kvalitu reseni tep. mostu vyjadrenou pribliznou prirazkou podle poznamek k cl. B.9.2 v CSN 730540-4.

Difuzni odpor a tepelne akumulacni vlastnosti:

Difuzni odpor konstrukce ZpT : 7.9E+0010 m/s

Teplotni utlum konstrukce Ny* podle EN ISO 13786 : 1770.3
Fazovy posun teplotniho kmitu Psi* podle EN ISO 13786 : 13.9 h

Teplota vnitrniho povrchu a teplotni faktor podle CSN 730540 a EN ISO 13788:

Vnitrni povrchova teplota v navrhovych podminkach Tsi,p : 20.00 C
Teplotni faktor v navrhovych podminkach f,Rsi,p : **0.937**

Obe hodnoty plati pro odpor pri prestupu tepla na vnitrni strane Rsi=0,25 m2K/W.

Cislo mesice	Minimalni pozadovane hodnoty pri max. rel. vlhkosti na vnitrnim povrchu: --------- 80% ---------		-------- 100% ---------		Vypoctene hodnoty		
	Tsi,m[C]	f,Rsi,m	Tsi,m[C]	f,Rsi,m	Tsi[C]	f,Rsi	RHsi[%]
1	14.7	0.608	11.3	0.395	20.0	0.937	57.3
2	15.3	0.645	11.9	0.431	20.0	0.937	59.6
3	15.7	0.649	12.3	0.420	20.1	0.937	60.9
4	16.2	0.601	12.8	0.314	20.2	0.937	62.1
5	17.3	0.534	13.8	0.098	20.5	0.937	65.4
6	18.2	0.298	14.7	------	20.7	0.937	68.2
7	18.7	------	15.1	------	20.9	0.937	69.5
8	18.5	------	15.0	------	20.9	0.937	68.8
9	17.4	0.288	14.0	------	20.7	0.937	65.3
10	16.3	0.575	12.9	0.261	20.3	0.937	62.3
11	15.7	0.595	12.3	0.330	20.2	0.937	60.5
12	15.5	0.654	12.0	0.439	20.0	0.937	60.1

Poznamka: RHsi je relativni vlhkost na vnitrnim povrchu, Tsi je vnitrni povrchova teplota a f,Rsi je teplotni faktor.

Difuze vodni pary v navrh. podminkach a bilance vodni pary podle CSN 730540:
(bez vlivu zabudovane vlhkosti a slunecni radiace)

Prubeh teplot a castecnych tlaku vodni pary v navrhovych okrajovych podminkach:

rozhrani:	i	1-2	2-3	3-4	4-5	5-6	e
theta [C]:	20.3	20.3	20.1	16.4	10.8	10.3	5.7
p [Pa]:	1367	1277	1236	1182	1069	708	697
p,sat [Pa]:	2381	2375	2353	1862	1298	1248	915

Poznamka: theta je teplota na rozhrani vrstev, p je predpokladany castecny tlak vodni pary na rozhrani vrstev a p,sat je castecny tlak nasycene vodni pary na rozhrani vrstev.

Pri venkovni navrhove teplote nedochazi v konstrukci ke kondenzaci vodni pary.

Mnozstvi difundujici vodni pary Gd : 9.023E-0009 kg/(m2.s)

Bilance zkondenzovane a vyparene vodni pary podle EN ISO 13788:

Rocni cyklus c. 1

V konstrukci nedochazi behem modeloveho roku ke kondenzaci vodni pary.

Poznamka: Hodnoceni difuze vodni pary bylo provedeno pro predpoklad 1D sireni vodni pary prevazujici skladbou konstrukce. Pro konstrukce s vyraznymi systematickymi tepelnymi mosty je vysledek vypoctu jen orientacni. Presnejsi vysledky lze ziskat s pomoci 2D analyzy.

Rozmezi relativnich vlhkosti v jednotlivych materialech (pro posledni rocni cyklus):

		Trvani prislusne relativni vlhkosti v materialu ve dnech za rok				
Cislo	**Nazev**	**pod 60%**	**60-70%**	**70-80%**	**80-90%**	**nad 90%**
1	Keramický obkl	151	214	---	---	---
2	Anhydritová sm	212	153	---	---	---
3	Isover EPS Rig	---	365	---	---	---
4	Isover EPS 100	---	62	152	151	---
5	Železobeton 3	---	62	152	151	---
6	Rockwool Fasro	---	122	92	151	---

Poznamka: S pomoci teto tabulky lze zjednodusene odhadnout, jake je riziko dosazeni nepripustne hmotnostni vlhkosti materialu ci riziko jeho koroze.

Konkretne pro drevo predepisuje CSN 730540-2/Z1 maximalni pripustnou hmotnostni vlhkost 18 %. Ze sorpcni krivky pro dany typ dreva lze odvodit, pri jake relativni vlhkosti vzduchu dosahuje drevo teto kriticke hmotnostni vlhkosti. Obvykle jde o cca 80 %.
Pokud je v tabulce vyse pro drevo uveden dlouhodobejsi vyskyt relativni vlhkosti nad 80 %, lze predpokladat, ze pozadavek CSN 730540-2 na maximalni hmotnostni vlhkost dreva nebude splnen.

SHRNUTI VLASTNOSTI HODNOCENYCH KONSTRUKCI

Teplo 2017 EDU tepelna ochrana budov (CSN 730540, EN ISO 6946, EN ISO 13788)

Nazev kce	Typ	R [m2K/W]	U [W/m2K]	Ma,max[kg/m2]	Odpareni	DeltaT10 [C]
apartm dry area to unh...	podlaha	3.567	0.256	nedochazi ke kondenzaci v.p.		---

Vysvetlivky:
R tepelny odpor konstrukce
U soucinitel prostupu tepla konstrukce
Ma,max maximalni mnozstvi zkond. vodni pary v konstrukci za rok
DeltaT10 pokles dotykove teploty podlahove konstrukce.

KOMPLEXNI POSOUZENI SKLADBY STAVEBNI KONSTRUKCE Z HLEDISKA SIRENI TEPLA A VODNI PARY

podle EN ISO 13788, EN ISO 6946, CSN 730540 a STN 730540

Teplo 2017 EDU

Nazev ulohy : **apartm dry area to unheated space F05**
Zpracovatel : Akbota Baibatyrova
Zakazka : diploma thesis
Datum : 29.03.2023

ZADANA SKLADBA A OKRAJOVE PODMINKY :

Typ hodnocene konstrukce : Podlaha nad nevytapenym ci mene vytap. vnitrnim prostorem
Korekce soucinitele prostupu dU : 0.000 W/m2K

Skladba konstrukce (od interieru) :

Cislo	Nazev	D [m]	Lambda [W/(m.K)]	c [J/(kg.K)]	Ro [kg/m3]	Mi [-]	Ma [kg/m2]
1	Vinyl	0,0030	0,2100	1050,0	1600,0	94000,0	0.0000
2	Anhydritová sm	0,0450	1,2000	840,0	2100,0	20,0	0.0000
3	Isover EPS Rig	0,0400	0,0440	1270,0	12,0	30,0	0.0000
4	Isover EPS 100	0,0500	0,0370	1270,0	20,5	50,0	0.0000
5	Železobeton 3	0,2500	1,7400	1020,0	2500,0	32,0	0.0000
6	Rockwool Fasro	0,0500	0,0450	840,0	135,0	4,8	0.0000

Poznamka: D je tloustka vrstvy, Lambda je navrhova hodnota tepelne vodivosti vrstvy, C je merna tepelna kapacita vrstvy, Ro je objemova hmotnost vrstvy, Mi je faktor difuzniho odporu vrstvy a Ma je pocatecni zabudovana vlhkost ve vrstve.

Cislo	Kompletni nazev vrstvy	Interni vypocet tep. vodivosti
1	Vinyl	---
2	Anhydritová směs	---
3	Isover EPS Rigifloor 4000	---
4	Isover EPS 100	---
5	Železobeton 3	---
6	Rockwool Fasrock	---

Okrajove podminky vypoctu :

Tepelny odpor pri prestupu tepla v interieru Rsi : 0.17 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rsi : 0.25 m2K/W
Tepelny odpor pri prestupu tepla v exterieru Rse : 0.17 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rse : 0.17 m2K/W

Navrhova venkovni teplota Te :	5.0 C
Navrhova teplota vnitrniho vzduchu Tai :	21.0 C
Navrhova relativni vlhkost venkovniho vzduchu RHe :	80.0 %
Navrhova relativni vlhkost vnitrniho vzduchu RHi :	55.0 %

Mesic	**Delka [dny/hodiny]**		**Tai [C]**	**RHi [%]**	**Pi [Pa]**	**Te [C]**	**RHe [%]**	**Pe [Pa]**
1	31	744	21.0	53.9	1339.7	5.0	90.0	784.7
2	28	672	21.0	56.0	1391.9	5.0	90.0	784.7
3	31	744	21.0	57.5	1429.2	6.0	85.0	794.4
4	30	720	21.0	59.3	1473.9	9.0	80.0	918.0
5	31	744	21.0	63.4	1575.9	13.0	75.0	1122.7
6	30	720	21.0	67.2	1670.3	17.0	70.0	1355.7
7	31	744	21.0	69.2	1720.0	20.0	65.0	1519.0
8	31	744	21.0	68.5	1702.6	20.0	65.0	1519.0
9	30	720	21.0	64.1	1593.3	16.0	70.0	1272.1
10	31	744	21.0	59.7	1483.9	10.0	75.0	920.5
11	30	720	21.0	57.5	1429.2	8.0	85.0	911.4
12	31	744	21.0	56.5	1404.4	5.0	90.0	784.7

Poznamka: Tai, RHi a Pi jsou prum. mesicni parametry vnitrniho vzduchu (teplota, relativni vlhkost a castecny tlak vodni pary) a Te, RHe a Pe jsou prum. mesicni parametry v prostredi na vnejsi strane konstrukce (teplota, relativni vlhkost a castecny tlak vodni pary).

Pro vnitrni prostredi byla uplatnena prirazka k vnitrni relativni vlhkosti : 5.0 %

Vychozi mesic vypoctu bilance se stanovuje vypoctem podle EN ISO 13788.
Pocet hodnocenych let : 1

VYSLEDKY VYPOCTU HODNOCENE KONSTRUKCE :

Tepelny odpor a soucinitel prostupu tepla podle EN ISO 6946:

Tepelny odpor konstrukce R : 3.567 m2K/W
Soucinitel prostupu tepla konstrukce U : **0.256 W/m2K**

Soucinitel prostupu zabudovane kce U,kc : 0.28 / 0.31 / 0.36 / 0.46 W/m2K
Uvedene orientacni hodnoty plati pro ruznou kvalitu reseni tep. mostu vyjadrenou pribliznou prirazkou podle poznamek k cl. B.9.2 v CSN 730540-4.

Difuzni odpor a tepelne akumulacni vlastnosti:

Difuzni odpor konstrukce ZpT : 1.6E+0012 m/s

Teplotni utlum konstrukce Ny* podle EN ISO 13786 : 1682.3
Fazovy posun teplotniho kmitu Psi* podle EN ISO 13786 : 13.7 h

Teplota vnitrniho povrchu a teplotni faktor podle CSN 730540 a EN ISO 13788:

Vnitrni povrchova teplota v navrhovych podminkach Tsi,p : 20.00 C
Teplotni faktor v navrhovych podminkach f,Rsi,p : **0.937**

Obe hodnoty plati pro odpor pri prestupu tepla na vnitrni strane Rsi=0,25 m2K/W.

Cislo mesice	Minimalni pozadovane hodnoty pri max. rel. vlhkosti na vnitrnim povrchu:				Vypoctene hodnoty		
	--------- 80% ---------		-------- 100% ---------				
	Tsi,m[C]	**f,Rsi,m**	**Tsi,m[C]**	**f,Rsi,m**	**Tsi[C]**	**f,Rsi**	**RHsi[%]**
1	14.7	0.608	11.3	0.395	20.0	0.937	57.3
2	15.3	0.645	11.9	0.431	20.0	0.937	59.6
3	15.7	0.649	12.3	0.420	20.1	0.937	60.9
4	16.2	0.601	12.8	0.314	20.2	0.937	62.1
5	17.3	0.534	13.8	0.098	20.5	0.937	65.4
6	18.2	0.298	14.7	------	20.7	0.937	68.2
7	18.7	------	15.1	------	20.9	0.937	69.5
8	18.5	------	15.0	------	20.9	0.937	68.8
9	17.4	0.288	14.0	------	20.7	0.937	65.3
10	16.3	0.575	12.9	0.261	20.3	0.937	62.3
11	15.7	0.595	12.3	0.330	20.2	0.937	60.5
12	15.5	0.654	12.0	0.439	20.0	0.937	60.1

Poznamka: RHsi je relativni vlhkost na vnitrnim povrchu, Tsi je vnitrni povrchova teplota a f,Rsi je teplotni faktor.

Difuze vodni pary v navrh. podminkach a bilance vodni pary podle CSN 730540:
(bez vlivu zabudovane vlhkosti a slunecni radiace)

Prubeh teplot a castecnych tlaku vodni pary v navrhovych okrajovych podminkach:

rozhrani:	i	1-2	2-3	3-4	4-5	5-6	e
theta [C]:	20.3	20.2	20.1	16.4	10.8	10.2	5.7
p [Pa]:	1367	727	725	722	716	698	697
p,sat [Pa]:	2381	2373	2350	1861	1298	1248	915

Poznamka: theta je teplota na rozhrani vrstev, p je predpokladany castecny tlak vodni pary na rozhrani vrstev a p,sat je castecny tlak nasycene vodni pary na rozhrani vrstev.

Pri venkovni navrhove teplote nedochazi v konstrukci ke kondenzaci vodni pary.

Mnozstvi difundujici vodni pary Gd : 4.542E-0010 kg/(m2.s)

Bilance zkondenzovane a vyparene vodni pary podle EN ISO 13788:

Rocni cyklus c. 1

V konstrukci nedochazi behem modeloveho roku ke kondenzaci vodni pary.

Poznamka: Hodnoceni difuze vodni pary bylo provedeno pro predpoklad 1D sireni vodni pary prevazujici skladbou konstrukce. Pro konstrukce s vyraznymi systematickymi tepelnymi mosty je vysledek vypoctu jen orientacni. Presnejsi vysledky lze ziskat s pomoci 2D analyzy.

Rozmezi relativnich vlhkosti v jednotlivych materialech (pro posledni rocni cyklus):

		Trvani prislusne relativni vlhkosti v materialu ve dnech za rok				
Cislo	**Nazev**	**pod 60%**	**60-70%**	**70-80%**	**80-90%**	**nad 90%**
1	Vinyl	151	214	---	---	---
2	Anhydritová sm	303	62	---	---	---
3	Isover EPS Rig	303	62	---	---	---
4	Isover EPS 100	31	334	---	---	---
5	Železobeton 3	31	334	---	---	---
6	Rockwool Fasro	---	122	92	151	---

Poznamka: S pomoci teto tabulky lze zjednodusene odhadnout, jake je riziko dosazeni nepripustne hmotnostni vlhkosti materialu ci riziko jeho koroze.

Konkretne pro drevo predepisuje CSN 730540-2/Z1 maximalni pripustnou hmotnostni vlhkost 18 %. Ze sorpcni krivky pro dany typ dreva lze odvodit, pri jake relativni vlhkosti vzduchu dosahuje drevo teto kriticke hmotnostni vlhkosti. Obvykle jde o cca 80 %.
Pokud je v tabulce vyse pro drevo uveden dlouhodobejsi vyskyt relativni vlhkosti nad 80 %, lze predpokladat, ze pozadavek CSN 730540-2 na maximalni hmotnostni vlhkost dreva nebude splnen.

SHRNUTI VLASTNOSTI HODNOCENYCH KONSTRUKCI

Teplo 2017 EDU tepelna ochrana budov (CSN 730540, EN ISO 6946, EN ISO 13788)

Nazev kce	Typ	R [m2K/W]	U [W/m2K]	Ma,max[kg/m2]	Odpareni	DeltaT10 [C]
green roof F13...	strecha	3.745	0.257	nedochazi ke kondenzaci v.p.		---

Vysvetlivky:
R tepelny odpor konstrukce
U soucinitel prostupu tepla konstrukce
Ma,max maximalni mnozstvi zkond. vodni pary v konstrukci za rok
DeltaT10 pokles dotykove teploty podlahove konstrukce.

KOMPLEXNI POSOUZENI SKLADBY STAVEBNI KONSTRUKCE Z HLEDISKA SIRENI TEPLA A VODNI PARY

podle EN ISO 13788, EN ISO 6946, CSN 730540 a STN 730540

Teplo 2017 EDU

Nazev ulohy : **green roof F13**
Zpracovatel : Akbota Baibatyrova
Zakazka : Diploma thesis
Datum : 28.03.2023

ZADANA SKLADBA A OKRAJOVE PODMINKY :

Typ hodnocene konstrukce : Strecha jednoplastova
Korekce soucinitele prostupu dU : 0.000 W/m2K

Skladba konstrukce (od interieru) :

Cislo	Nazev	D [m]	Lambda [W/(m.K)]	c [J/(kg.K)]	Ro [kg/m3]	Mi [-]	Ma [kg/m2]
1	Železobeton 3	0,2500	1,7400	1020,0	2500,0	32,0	0.0000
2	Asfaltový nátě	0,0010	0,2100	1470,0	1400,0	1200,0	0.0000
3	Paraelast Al+V	0,0040	0,2100	1470,0	1200,0	480000,0	0.0000
4	Cementová litá	0,0400	1,2000	840,0	2100,0	20,0	0.0000
5	Austrotherm XP	0,1200	0,0350	1270,0	40,0	100,0	0.0000
6	PVC-P Fatrafol	0,0015	0,1410	960,0	1400,0	15000,0	0.0000
7	Substrát Green	0,2100	2,0000	1010,0	1200,0	50,0	0.0000

Poznamka: D je tloustka vrstvy, Lambda je navrhova hodnota tepelne vodivosti vrstvy, C je merna tepelna kapacita vrstvy, Ro je objemova hmotnost vrstvy, Mi je faktor difuzniho odporu vrstvy a Ma je pocatecni zabudovana vlhkost ve vrstve.

Cislo	Kompletni nazev vrstvy	Interni vypocet tep. vodivosti
1	Železobeton 3	---
2	Asfaltový nátěr	---
3	Paraelast Al+V35	---
4	Cementová litá pěna	---
5	Austrotherm XPS TOP 30 SF	---
6	PVC-P Fatrafol-S	---
7	Substrát Greendek	---

Okrajove podminky vypoctu :

Tepelny odpor pri prestupu tepla v interieru Rsi : 0.10 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rsi : 0.25 m2K/W
Tepelny odpor pri prestupu tepla v exterieru Rse : 0.04 m2K/W

dtto pro vypocet vnitrni povrchove teploty Rse : 0.04 m2K/W

Navrhova venkovni teplota Te : -13.0 C
Navrhova teplota vnitrniho vzduchu Tai : 5.0 C
Navrhova relativni vlhkost venkovniho vzduchu RHe : 84.0 %
Navrhova relativni vlhkost vnitrniho vzduchu RHi : 55.0 %

Mesic	Delka [dny/hodiny]		Tai [C]	RHi [%]	Pi [Pa]	Te [C]	RHe [%]	Pe [Pa]
1	31	744	21.0	53.9	1339.7	-2.4	81.2	406.1
2	28	672	21.0	56.0	1391.9	-0.9	80.8	457.9
3	31	744	21.0	57.5	1429.2	3.0	79.5	602.1
4	30	720	21.0	59.3	1473.9	7.7	77.5	814.1
5	31	744	21.0	63.4	1575.9	12.7	74.5	1093.5
6	30	720	21.0	67.2	1670.3	15.9	72.0	1300.1
7	31	744	21.0	69.2	1720.0	17.5	70.4	1407.2
8	31	744	21.0	68.5	1702.6	17.0	70.9	1373.1
9	30	720	21.0	64.1	1593.3	13.3	74.1	1131.2
10	31	744	21.0	59.7	1483.9	8.3	77.1	843.7
11	30	720	21.0	57.5	1429.2	2.9	79.5	597.9
12	31	744	21.0	56.5	1404.4	-0.6	80.7	468.9

Poznamka: Tai, RHi a Pi jsou prum. mesicni parametry vnitrniho vzduchu (teplota, relativni vlhkost a castecny tlak vodni pary) a Te, RHe a Pe jsou prum. mesicni parametry v prostredi na vnejsi strane konstrukce (teplota, relativni vlhkost a castecny tlak vodni pary).

Pro vnitrni prostredi byla uplatnena prirazka k vnitrni relativni vlhkosti : 5.0 %

Vychozi mesic vypoctu bilance se stanovuje vypoctem podle EN ISO 13788.
Pocet hodnocenych let : 1

VYSLEDKY VYPOCTU HODNOCENE KONSTRUKCE :

Tepelny odpor a soucinitel prostupu tepla podle EN ISO 6946:

Tepelny odpor konstrukce R : 3.745 m2K/W
Soucinitel prostupu tepla konstrukce U : **0.257 W/m2K**

Soucinitel prostupu zabudovane kce U,kc : 0.28 / 0.31 / 0.36 / 0.46 W/m2K
Uvedene orientacni hodnoty plati pro ruznou kvalitu reseni tep. mostu vyjadrenou priblizno u prirazkou podle poznamek k cl. B.9.2 v CSN 730540-4.

Difuzni odpor a tepelne akumulacni vlastnosti:

Difuzni odpor konstrukce ZpT : 1.0E+0013 m/s

Teplotni utlum konstrukce Ny* podle EN ISO 13786 : 696.9
Fazovy posun teplotniho kmitu Psi* podle EN ISO 13786 : 15.9 h

Teplota vnitrniho povrchu a teplotni faktor podle CSN 730540 a EN ISO 13788:

Vnitrni povrchova teplota v navrhovych podminkach Tsi,p : 3.88 C
Teplotni faktor v navrhovych podminkach f,Rsi,p : **0.938**

Obe hodnoty plati pro odpor pri prestupu tepla na vnitrni strane Rsi=0,25 m2K/W.

Cislo mesice	Minimalni pozadovane hodnoty pri max. rel. vlhkosti na vnitrnim povrchu: --------- 80% ---------		--------- 100% ---------		Vypoctene hodnoty		
	Tsi,m[C]	f,Rsi,m	Tsi,m[C]	f,Rsi,m	Tsi[C]	f,Rsi	RHsi[%]
1	14.7	0.732	11.3	0.586	19.6	0.938	58.9
2	15.3	0.741	11.9	0.584	19.6	0.938	60.9
3	15.7	0.707	12.3	0.516	19.9	0.938	61.6
4	16.2	0.640	12.8	0.381	20.2	0.938	62.4
5	17.3	0.550	13.8	0.131	20.5	0.938	65.4
6	18.2	0.449	14.7	------	20.7	0.938	68.5
7	18.7	0.331	15.1	------	20.8	0.938	70.1
8	18.5	0.374	15.0	------	20.8	0.938	69.6
9	17.4	0.538	14.0	0.085	20.5	0.938	66.0
10	16.3	0.632	12.9	0.360	20.2	0.938	62.7
11	15.7	0.709	12.3	0.519	19.9	0.938	61.6
12	15.5	0.743	12.0	0.585	19.7	0.938	61.4

Poznamka: RHsi je relativni vlhkost na vnitrnim povrchu, Tsi je vnitrni povrchova teplota a f,Rsi je teplotni faktor.

Difuze vodni pary v navrh. podminkach a bilance vodni pary podle CSN 730540:

(bez vlivu zabudovane vlhkosti a slunecni radiace)

Prubeh teplot a castecnych tlaku vodni pary v navrhovych okrajovych podminkach:

rozhrani:	i	1-2	2-3	3-4	4-5	5-6	6-7	e
theta [C]:	4.5	3.9	3.8	3.8	3.6	-12.3	-12.3	-12.8
p [Pa]:	480	478	478	174	173	172	168	166
p,sat [Pa]:	844	805	804	799	791	211	210	201

Poznamka: theta je teplota na rozhrani vrstev, p je predpokladany castecny tlak vodni pary na rozhrani vrstev a p,sat je castecny tlak nasycene vodni pary na rozhrani vrstev.

Pri venkovni navrhove teplote nedochazi v konstrukci ke kondenzaci vodni pary.

Mnozstvi difundujici vodni pary Gd : 3.172E-0011 kg/(m2.s)

Bilance zkondenzovane a vyparene vodni pary podle EN ISO 13788:

Rocni cyklus c. 1

V konstrukci nedochazi behem modeloveho roku ke kondenzaci vodni pary.

Poznamka: Hodnoceni difuze vodni pary bylo provedeno pro predpoklad 1D sireni vodni pary prevazujici skladbou konstrukce. Pro konstrukce s vyraznymi systematickymi tepelnymi mosty je vysledek vypoctu jen orientacni. Presnejsi vysledky lze ziskat s pomoci 2D analyzy.

Rozmezi relativnich vlhkosti v jednotlivych materialech (pro posledni rocni cyklus):

		Trvani prislusne relativni vlhkosti v materialu ve dnech za rok				
Cislo	**Nazev**	**pod 60%**	**60-70%**	**70-80%**	**80-90%**	**nad 90%**
1	Železobeton 3	31	303	31	---	---
2	Asfaltový nátě	31	303	31	---	---
3	Paraelast Al+V	31	303	31	---	---
4	Cementová litá	365	---	---	---	---
5	Austrotherm XP	---	---	365	---	---
6	PVC-P Fatrafol	---	---	365	---	---
7	Substrát Green	---	---	365	---	---

Poznamka: S pomoci teto tabulky lze zjednodusene odhadnout, jake je riziko dosazeni nepripustne hmotnostni vlhkosti materialu ci riziko jeho koroze.

Konkretne pro drevo predepisuje CSN 730540-2/Z1 maximalni pripustnou hmotnostni vlhkost 18 %. Ze sorpcni krivky pro dany typ dreva lze odvodit, pri jake relativni vlhkosti vzduchu dosahuje drevo teto kriticke hmotnostni vlhkosti. Obvykle jde o cca 80 %.
Pokud je v tabulce vyse pro drevo uveden dlouhodobejsi vyskyt relativni vlhkosti nad 80 %, lze predpokladat, ze pozadavek CSN 730540-2 na maximalni hmotnostni vlhkost dreva nebude splnen.

SHRNUTI VLASTNOSTI HODNOCENYCH KONSTRUKCI

Teplo 2017 EDU tepelna ochrana budov (CSN 730540, EN ISO 6946, EN ISO 13788)

Nazev kce	Typ	R [m2K/W]	U [W/m2K]	Ma,max[kg/m2]	Odpareni	DeltaT10 [C]
green roof F15...	strecha	7.224	0.136	nedochazi ke kondenzaci v.p.		---

Vysvetlivky:
R tepelny odpor konstrukce
U soucinitel prostupu tepla konstrukce
Ma,max maximalni mnozstvi zkond. vodni pary v konstrukci za rok
DeltaT10 pokles dotykove teploty podlahove konstrukce.

KOMPLEXNI POSOUZENI SKLADBY STAVEBNI KONSTRUKCE Z HLEDISKA SIRENI TEPLA A VODNI PARY

podle EN ISO 13788, EN ISO 6946, CSN 730540 a STN 730540

Teplo 2017 EDU

Nazev ulohy : **green roof F15**
Zpracovatel : Akbota Baibatyrova
Zakazka : Diploma thesis
Datum : 28.03.2023

ZADANA SKLADBA A OKRAJOVE PODMINKY :

Typ hodnocene konstrukce : Strecha jednoplastova
Korekce soucinitele prostupu dU : 0.000 W/m2K

Skladba konstrukce (od interieru) :

Cislo	Nazev	D [m]	Lambda [W/(m.K)]	c [J/(kg.K)]	Ro [kg/m3]	Mi [-]	Ma [kg/m2]
1	Baumit štuková	0,0100	0,4700	790,0	1800,0	25,0	0.0000
2	Železobeton 3	0,2500	1,7400	1020,0	2500,0	32,0	0.0000
3	Asfaltový nátě	0,0010	0,2100	1470,0	1400,0	1200,0	0.0000
4	Paraelast Al+V	0,0040	0,2100	1470,0	1200,0	480000,0	0.0000
5	Isover EPS Gre	0,2200	0,0320	1270,0	20,0	50,0	0.0000
6	PVC-P Fatrafol	0,0015	0,1410	960,0	1400,0	15000,0	0.0000
7	Substrát Green	0,3000	2,0000	1010,0	1200,0	50,0	0.0000

Poznamka: D je tloustka vrstvy, Lambda je navrhova hodnota tepelne vodivosti vrstvy, C je merna tepelna kapacita vrstvy, Ro je objemova hmotnost vrstvy, Mi je faktor difuzniho odporu vrstvy a Ma je pocatecni zabudovana vlhkost ve vrstve.

Cislo	Kompletni nazev vrstvy	Interni vypocet tep. vodivosti
1	Baumit štuková omítka	---
2	Železobeton 3	---
3	Asfaltový nátěr	---
4	Paraelast Al+V35	---
5	Isover EPS Grey 100	---
6	PVC-P Fatrafol-S	---
7	Substrát Greendek	---

Okrajove podminky vypoctu :

Tepelny odpor pri prestupu tepla v interieru Rsi : 0.10 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rsi : 0.25 m2K/W
Tepelny odpor pri prestupu tepla v exterieru Rse : 0.04 m2K/W

dtto pro vypocet vnitrni povrchove teploty Rse : 0.04 m2K/W

Navrhova venkovni teplota Te :	-13.0 C
Navrhova teplota vnitrniho vzduchu Tai :	21.0 C
Navrhova relativni vlhkost venkovniho vzduchu RHe :	84.0 %
Navrhova relativni vlhkost vnitrniho vzduchu RHi :	55.0 %

Mesic	Delka [dny/hodiny]		Tai [C]	RHi [%]	Pi [Pa]	Te [C]	RHe [%]	Pe [Pa]
1	31	744	21.0	53.9	1339.7	-2.4	81.2	406.1
2	28	672	21.0	56.0	1391.9	-0.9	80.8	457.9
3	31	744	21.0	57.5	1429.2	3.0	79.5	602.1
4	30	720	21.0	59.3	1473.9	7.7	77.5	814.1
5	31	744	21.0	63.4	1575.9	12.7	74.5	1093.5
6	30	720	21.0	67.2	1670.3	15.9	72.0	1300.1
7	31	744	21.0	69.2	1720.0	17.5	70.4	1407.2
8	31	744	21.0	68.5	1702.6	17.0	70.9	1373.1
9	30	720	21.0	64.1	1593.3	13.3	74.1	1131.2
10	31	744	21.0	59.7	1483.9	8.3	77.1	843.7
11	30	720	21.0	57.5	1429.2	2.9	79.5	597.9
12	31	744	21.0	56.5	1404.4	-0.6	80.7	468.9

Poznamka: Tai, RHi a Pi jsou prum. mesicni parametry vnitrniho vzduchu (teplota, relativni vlhkost a castecny tlak vodni pary) a Te, RHe a Pe jsou prum. mesicni parametry v prostredi na vnejsi strane konstrukce (teplota, relativni vlhkost a castecny tlak vodni pary).

Pro vnitrni prostredi byla uplatnena prirazka k vnitrni relativni vlhkosti : 5.0 %

Vychozi mesic vypoctu bilance se stanovuje vypoctem podle EN ISO 13788.
Pocet hodnocenych let : 1

VYSLEDKY VYPOCTU HODNOCENE KONSTRUKCE :

Tepelny odpor a soucinitel prostupu tepla podle EN ISO 6946:

Tepelny odpor konstrukce R : 7.224 m2K/W
Soucinitel prostupu tepla konstrukce U : **0.136 W/m2K**

Soucinitel prostupu zabudovane kce U,kc : 0.16 / 0.19 / 0.24 / 0.34 W/m2K
Uvedene orientacni hodnoty plati pro ruznou kvalitu reseni tep. mostu vyjadrenou pribliznou prirazkou podle poznamek k cl. B.9.2 v CSN 730540-4.

Difuzni odpor a tepelne akumulacni vlastnosti:

Difuzni odpor konstrukce ZpT : 1.0E+0013 m/s

Teplotni utlum konstrukce Ny* podle EN ISO 13786 : 2071.1
Fazovy posun teplotniho kmitu Psi* podle EN ISO 13786 : 17.6 h

Teplota vnitrniho povrchu a teplotni faktor podle CSN 730540 a EN ISO 13788:

Vnitrni povrchova teplota v navrhovych podminkach Tsi,p : 19.87 C
Teplotni faktor v navrhovych podminkach f,Rsi,p : **0.967**

Obe hodnoty plati pro odpor pri prestupu tepla na vnitrni strane Rsi=0,25 m2K/W.

Cislo mesice	Minimalni pozadovane hodnoty pri max. rel. vlhkosti na vnitrnim povrchu: --------- 80% ---------		-------- 100% ---------		Vypoctene hodnoty		
	Tsi,m[C]	f,Rsi,m	Tsi,m[C]	f,Rsi,m	Tsi[C]	f,Rsi	RHsi[%]
1	14.7	0.732	11.3	0.586	20.2	0.967	56.5
2	15.3	0.741	11.9	0.584	20.3	0.967	58.6
3	15.7	0.707	12.3	0.516	20.4	0.967	59.7
4	16.2	0.640	12.8	0.381	20.6	0.967	60.9
5	17.3	0.550	13.8	0.131	20.7	0.967	64.5
6	18.2	0.449	14.7	------	20.8	0.967	67.9
7	18.7	0.331	15.1	------	20.9	0.967	69.7
8	18.5	0.374	15.0	------	20.9	0.967	69.1
9	17.4	0.538	14.0	0.085	20.7	0.967	65.1
10	16.3	0.632	12.9	0.360	20.6	0.967	61.3
11	15.7	0.709	12.3	0.519	20.4	0.967	59.7
12	15.5	0.743	12.0	0.585	20.3	0.967	59.1

Poznamka: RHsi je relativni vlhkost na vnitrnim povrchu, Tsi je vnitrni povrchova teplota a f,Rsi je teplotni faktor.

Difuze vodni pary v navrh. podminkach a bilance vodni pary podle CSN 730540:

(bez vlivu zabudovane vlhkosti a slunecni radiace)

Prubeh teplot a castecnych tlaku vodni pary v navrhovych okrajovych podminkach:

rozhrani:	**i**	**1-2**	**2-3**	**3-4**	**4-5**	**5-6**	**6-7**	**e**
theta [C]:	20.5	20.4	19.8	19.8	19.7	-12.1	-12.1	-12.8
p [Pa]:	1367	1367	1362	1361	196	189	175	166
p,sat [Pa]:	2416	2401	2305	2302	2289	215	214	201

Poznamka: theta je teplota na rozhrani vrstev, p je predpokladany castecny tlak vodni pary na rozhrani vrstev a p,sat je castecny tlak nasycene vodni pary na rozhrani vrstev.

Pri venkovni navrhove teplote nedochazi v konstrukci ke kondenzaci vodni pary.

Mnozstvi difundujici vodni pary Gd : 1.214E-0010 kg/(m2.s)

Bilance zkondenzovane a vyparene vodni pary podle EN ISO 13788:

Rocni cyklus c. 1

V konstrukci nedochazi behem modeloveho roku ke kondenzaci vodni pary.

Poznamka: Hodnoceni difuze vodni pary bylo provedeno pro predpoklad 1D sireni vodni pary prevazujici skladbou konstrukce. Pro konstrukce s vyraznymi systematickymi tepelnymi mosty je vysledek vypoctu jen orientacni. Presnejsi vysledky lze ziskat s pomoci 2D analyzy.

Rozmezi relativnich vlhkosti v jednotlivych materialech (pro posledni rocni cyklus):

		Trvani prislusne relativni vlhkosti v materialu ve dnech za rok				
Cislo	**Nazev**	**pod 60%**	**60-70%**	**70-80%**	**80-90%**	**nad 90%**
1	Baumit štuková	151	214	---	---	---
2	Železobeton 3	151	214	---	---	---
3	Asfaltový nátě	151	214	---	---	---
4	Paraelast Al+V	151	214	---	---	---
5	Isover EPS Gre	---	---	334	31	---
6	PVC-P Fatrafol	---	---	334	31	---
7	Substrát Green	---	---	306	59	---

Poznamka: S pomoci teto tabulky lze zjednodusene odhadnout, jake je riziko dosazeni nepripustne hmotnostni vlhkosti materialu ci riziko jeho koroze.

Konkretne pro drevo predepisuje CSN 730540-2/Z1 maximalni pripustnou hmotnostni vlhkost 18 %. Ze sorpcni krivky pro dany typ dreva lze odvodit, pri jake relativni vlhkosti vzduchu dosahuje drevo teto kriticke hmotnostni vlhkosti. Obvykle jde o cca 80 %.
Pokud je v tabulce vyse pro drevo uveden dlouhodobejsi vyskyt relativni vlhkosti nad 80 %, lze predpokladat, ze pozadavek CSN 730540-2 na maximalni hmotnostni vlhkost dreva nebude splnen.

SHRNUTI VLASTNOSTI HODNOCENYCH KONSTRUKCI

Teplo 2017 EDU tepelna ochrana budov (CSN 730540, EN ISO 6946, EN ISO 13788)

Nazev kce	Typ	R [m2K/W]	U [W/m2K]	Ma,max[kg/m2]	Odpareni	DeltaT10 [C]
terrace F16...	strecha	7.149	0.137	nedochazi ke kondenzaci v.p.		---

Vysvetlivky:

R	tepelny odpor konstrukce
U	soucinitel prostupu tepla konstrukce
Ma,max	maximalni mnozstvi zkond. vodni pary v konstrukci za rok
DeltaT10	pokles dotykove teploty podlahove konstrukce.

KOMPLEXNI POSOUZENI SKLADBY STAVEBNI KONSTRUKCE Z HLEDISKA SIRENI TEPLA A VODNI PARY

podle EN ISO 13788, EN ISO 6946, CSN 730540 a STN 730540

Teplo 2017 EDU

Nazev ulohy : **terrace F16**
Zpracovatel : Akbota Baibatyrova
Zakazka : Diploma thesis
Datum : 28.03.2023

ZADANA SKLADBA A OKRAJOVE PODMINKY :

Typ hodnocene konstrukce : Strecha jednoplastova
Korekce soucinitele prostupu dU : 0.000 W/m2K

Skladba konstrukce (od interieru) :

Cislo	Nazev	D [m]	Lambda [W/(m.K)]	c [J/(kg.K)]	Ro [kg/m3]	Mi [-]	Ma [kg/m2]
1	Baumit štuková	0,0100	0,4700	790,0	1800,0	25,0	0.0000
2	Železobeton 3	0,2500	1,7400	1020,0	2500,0	32,0	0.0000
3	Asfaltový nátě	0,0010	0,2100	1470,0	1400,0	1200,0	0.0000
4	Paraelast Al+V	0,0040	0,2100	1470,0	1200,0	480000,0	0.0000
5	Isover EPS Gre	0,2200	0,0320	1270,0	20,0	50,0	0.0000
6	PVC-P Fatrafol	0,0015	0,1410	960,0	1400,0	15000,0	0.0000
7	Substrát Green	0,1500	2,0000	1010,0	1200,0	50,0	0.0000

Poznamka: D je tloustka vrstvy, Lambda je navrhova hodnota tepelne vodivosti vrstvy, C je merna tepelna kapacita vrstvy, Ro je objemova hmotnost vrstvy, Mi je faktor difuzniho odporu vrstvy a Ma je pocatecni zabudovana vlhkost ve vrstve.

Cislo	Kompletni nazev vrstvy	Interni vypocet tep. vodivosti
1	Baumit štuková omítka	---
2	Železobeton 3	---
3	Asfaltový nátěr	---
4	Paraelast Al+V35	---
5	Isover EPS Grey 100	---
6	PVC-P Fatrafol-S	---
7	Substrát Greendek	---

Okrajove podminky vypoctu :

Tepelny odpor pri prestupu tepla v interieru Rsi : 0.10 m2K/W
dtto pro vypocet vnitrni povrchove teploty Rsi : 0.25 m2K/W
Tepelny odpor pri prestupu tepla v exterieru Rse : 0.04 m2K/W

dtto pro vypocet vnitrni povrchove teploty Rse : 0.04 m2K/W

Navrhova venkovni teplota Te : -13.0 C
Navrhova teplota vnitrniho vzduchu Tai : 21.0 C
Navrhova relativni vlhkost venkovniho vzduchu RHe : 84.0 %
Navrhova relativni vlhkost vnitrniho vzduchu RHi : 55.0 %

Mesic	Delka [dny/hodiny]		Tai [C]	RHi [%]	Pi [Pa]	Te [C]	RHe [%]	Pe [Pa]
1	31	744	21.0	53.9	1339.7	-2.4	81.2	406.1
2	28	672	21.0	56.0	1391.9	-0.9	80.8	457.9
3	31	744	21.0	57.5	1429.2	3.0	79.5	602.1
4	30	720	21.0	59.3	1473.9	7.7	77.5	814.1
5	31	744	21.0	63.4	1575.9	12.7	74.5	1093.5
6	30	720	21.0	67.2	1670.3	15.9	72.0	1300.1
7	31	744	21.0	69.2	1720.0	17.5	70.4	1407.2
8	31	744	21.0	68.5	1702.6	17.0	70.9	1373.1
9	30	720	21.0	64.1	1593.3	13.3	74.1	1131.2
10	31	744	21.0	59.7	1483.9	8.3	77.1	843.7
11	30	720	21.0	57.5	1429.2	2.9	79.5	597.9
12	31	744	21.0	56.5	1404.4	-0.6	80.7	468.9

Poznamka: Tai, RHi a Pi jsou prum. mesicni parametry vnitrniho vzduchu (teplota, relativni vlhkost a castecny tlak vodni pary) a Te, RHe a Pe jsou prum. mesicni parametry v prostredi na vnejsi strane konstrukce (teplota, relativni vlhkost a castecny tlak vodni pary).

Pro vnitrni prostredi byla uplatnena prirazka k vnitrni relativni vlhkosti : 5.0 %

Vychozi mesic vypoctu bilance se stanovuje vypoctem podle EN ISO 13788.
Pocet hodnocenych let : 1

VYSLEDKY VYPOCTU HODNOCENE KONSTRUKCE :

Tepelny odpor a soucinitel prostupu tepla podle EN ISO 6946:

Tepelny odpor konstrukce R : 7.149 m2K/W
Soucinitel prostupu tepla konstrukce U : **0.137 W/m2K**

Soucinitel prostupu zabudovane kce U,kc : 0.16 / 0.19 / 0.24 / 0.34 W/m2K
Uvedene orientacni hodnoty plati pro ruznou kvalitu reseni tep. mostu vyjadrenou pribliznou prirazkou podle poznamek k cl. B.9.2 v CSN 730540-4.

Difuzni odpor a tepelne akumulacni vlastnosti:

Difuzni odpor konstrukce ZpT : 1.0E+0013 m/s

Teplotni utlum konstrukce Ny* podle EN ISO 13786 : 979.4
Fazovy posun teplotniho kmitu Psi* podle EN ISO 13786 : 14.4 h

Teplota vnitrniho povrchu a teplotni faktor podle CSN 730540 a EN ISO 13788:

Vnitrni povrchova teplota v navrhovych podminkach Tsi,p : 19.86 C
Teplotni faktor v navrhovych podminkach f,Rsi,p : **0.966**

Obe hodnoty plati pro odpor pri prestupu tepla na vnitrni strane Rsi=0,25 m2K/W.

Cislo mesice	Minimalni pozadovane hodnoty pri max. rel. vlhkosti na vnitrnim povrchu: --------- 80% ---------		-------- 100% ---------		Vypoctene hodnoty		
	Tsi,m[C]	f,Rsi,m	Tsi,m[C]	f,Rsi,m	Tsi[C]	f,Rsi	RHsi[%]
1	14.7	0.732	11.3	0.586	20.2	0.966	56.6
2	15.3	0.741	11.9	0.584	20.3	0.966	58.6
3	15.7	0.707	12.3	0.516	20.4	0.966	59.7
4	16.2	0.640	12.8	0.381	20.6	0.966	61.0
5	17.3	0.550	13.8	0.131	20.7	0.966	64.5
6	18.2	0.449	14.7	------	20.8	0.966	67.9
7	18.7	0.331	15.1	------	20.9	0.966	69.7
8	18.5	0.374	15.0	------	20.9	0.966	69.1
9	17.4	0.538	14.0	0.085	20.7	0.966	65.1
10	16.3	0.632	12.9	0.360	20.6	0.966	61.3
11	15.7	0.709	12.3	0.519	20.4	0.966	59.7
12	15.5	0.743	12.0	0.585	20.3	0.966	59.1

Poznamka: RHsi je relativni vlhkost na vnitrnim povrchu, Tsi je vnitrni povrchova teplota a f,Rsi je teplotni faktor.

Difuze vodni pary v navrh. podminkach a bilance vodni pary podle CSN 730540:

(bez vlivu zabudovane vlhkosti a slunecni radiace)

Prubeh teplot a castecnych tlaku vodni pary v navrhovych okrajovych podminkach:

rozhrani:	i	1-2	2-3	3-4	4-5	5-6	6-7	e
theta [C]:	20.5	20.4	19.8	19.7	19.7	-12.4	-12.5	-12.8
p [Pa]:	1367	1367	1362	1361	191	185	171	166
p,sat [Pa]:	2415	2401	2303	2300	2287	209	208	201

Poznamka: theta je teplota na rozhrani vrstev, p je predpokladany castecny tlak vodni pary na rozhrani vrstev a p,sat je castecny tlak nasycene vodni pary na rozhrani vrstev.

Pri venkovni navrhove teplote nedochazi v konstrukci ke kondenzaci vodni pary.

Mnozstvi difundujici vodni pary Gd : 1.219E-0010 kg/(m2.s)

Bilance zkondenzovane a vyparene vodni pary podle EN ISO 13788:

Rocni cyklus c. 1

V konstrukci nedochazi behem modeloveho roku ke kondenzaci vodni pary.

Poznamka: Hodnoceni difuze vodni pary bylo provedeno pro predpoklad 1D sireni vodni pary prevazujici skladbou konstrukce. Pro konstrukce s vyraznymi systematickymi tepelnymi mosty je vysledek vypoctu jen orientacni. Presnejsi vysledky lze ziskat s pomoci 2D analyzy.

Rozmezi relativnich vlhkosti v jednotlivych materialech (pro posledni rocni cyklus):

		Trvani prislusne relativni vlhkosti v materialu ve dnech za rok				
Cislo	**Nazev**	**pod 60%**	**60-70%**	**70-80%**	**80-90%**	**nad 90%**
1	Baumit štuková	151	214	---	---	---
2	Železobeton 3	151	214	---	---	---
3	Asfaltový nátě	151	214	---	---	---
4	Paraelast Al+V	151	214	---	---	---
5	Isover EPS Gre	---	---	275	90	---
6	PVC-P Fatrafol	---	---	275	90	---
7	Substrát Green	---	---	334	31	---

Poznamka: S pomoci teto tabulky lze zjednodusene odhadnout, jake je riziko dosazeni nepripustne hmotnostni vlhkosti materialu ci riziko jeho koroze.

Konkretne pro drevo predepisuje CSN 730540-2/Z1 maximalni pripustnou hmotnostni vlhkost 18 %. Ze sorpcni krivky pro dany typ dreva lze odvodit, pri jake relativni vlhkosti vzduchu dosahuje drevo teto kriticke hmotnostni vlhkosti. Obvykle jde o cca 80 %.
Pokud je v tabulce vyse pro drevo uveden dlouhodobejsi vyskyt relativni vlhkosti nad 80 %, lze predpokladat, ze pozadavek CSN 730540-2 na maximalni hmotnostni vlhkost dreva nebude splnen.

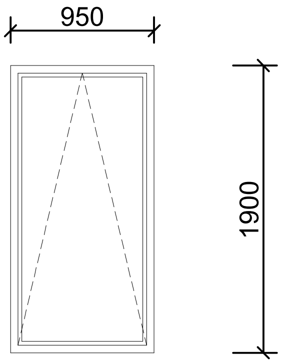
designed by	checked by	FACULTY OF CIVIL ENGINEERING CTU	
Akbota Baibatyrova	Ing. Malila Noori, Ph.D.		
course 124DPP - Diploma Project			
subject Project documentation of a residential building - Chodov		study year	2022 / 2023
		date	05.2023
drawing List of windows		size	A4
		scale	1:50

LIST OF WINDOWS

Project documentation of a residential building - Chodov

CODE	SCHEME	PCS.

A.01

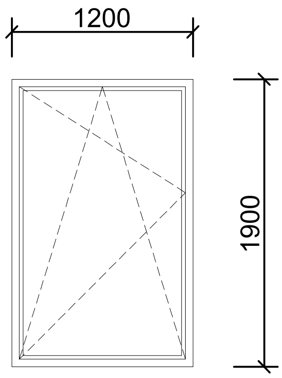


Double glazed window
Uw=1,0 W/m^{2}K
Plastic profile
White colored

Rw = 42dB

1.F	2.F	3.F	4.F	5.F
1	1	1	0	0

A.02

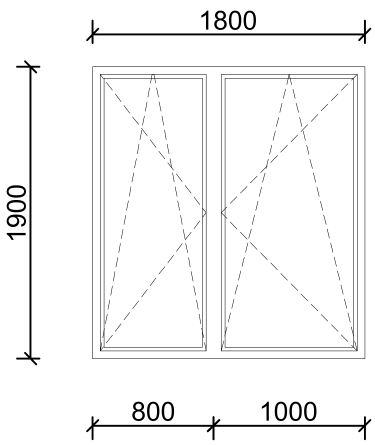


Double glazed window
Uw=1,0 W/m^{2}K
Plastic profile
White colored

Rw = 42dB

1.F	2.F	3.F	4.F	5.F
1	1	1	0	0

A.03

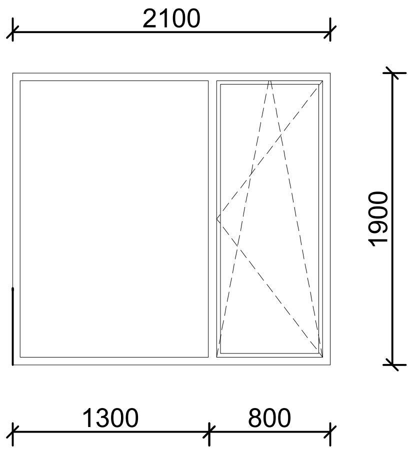


Double glazed window
Uw=1,0 W/m^{2}K
Plastic profile
White colored

Rw = 42dB

1.F	2.F	3.F	4.F	5.F
1	1	1	0	0

A.04



Double glazed window
Uw=1,0 W/m^{2}K
Plastic profile
White colored

Rw = 42dB

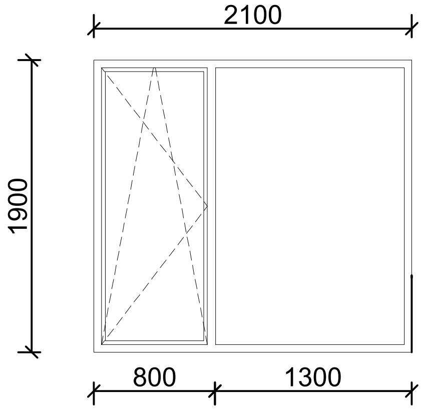
1.F	2.F	3.F	4.F	5.F
5	4	4	0	0

LIST OF WINDOWS

Project documentation of a residential building - Chodov

CODE	SCHEME	PCS.

A.05

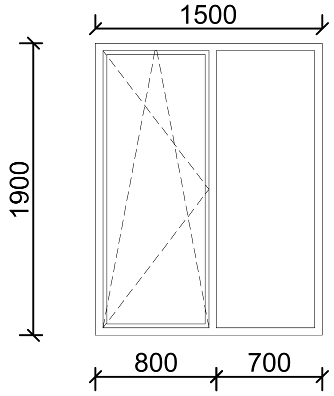


Double glazed window
U_w=1,0 W/m^{2}K
Plastic profile
White colored

Rw = 42dB

1.F	2.F	3.F	4.F	5.F
4	7	7	0	0

A.06

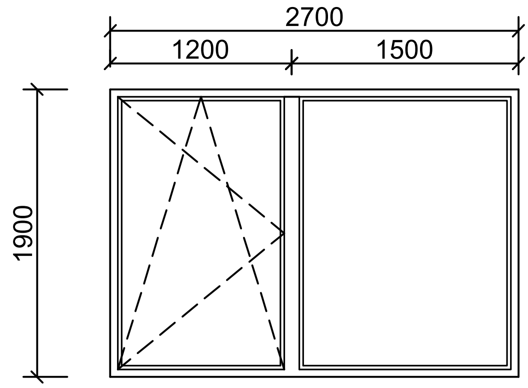


Double glazed window
U_w=1,0 W/m^{2}K
Plastic profile
White colored

Rw = 42dB

1.F	2.F	3.F	4.F	5.F
2	0	0	0	0

A.07

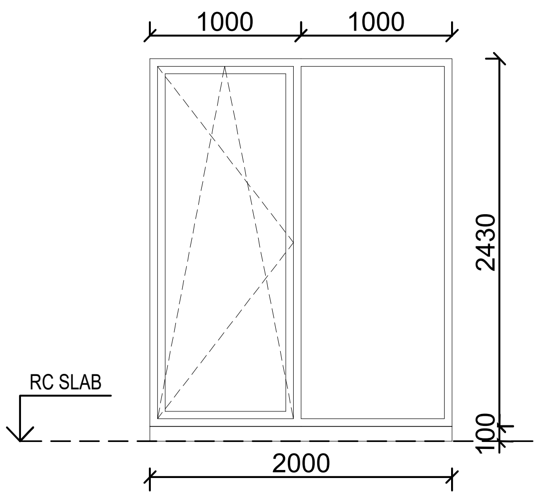


Double glazed window
U_w=1,0 W/m^{2}K
Plastic profile
White colored

Rw = 42dB

1.F	2.F	3.F	4.F	5.F
1	1	1	0	0

A.08



Triple glazed window
U_w=0,92 W/m^{2}K
Plastic profile
White colored

Rw = 32dB

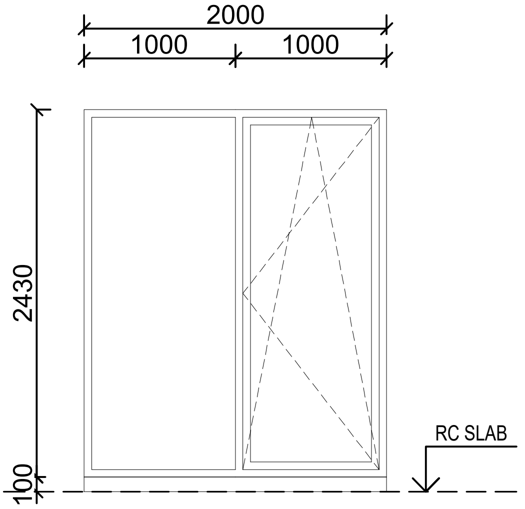
1.F	2.F	3.F	4.F	5.F
1	1	1	0	0

LIST OF WINDOWS

Project documentation of a residential building - Chodov

CODE | SCHEME | PCS.

A.09

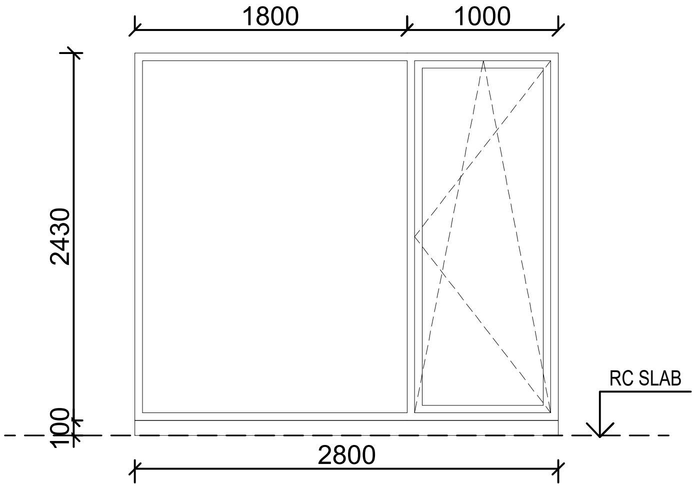


Triple glazed window
Uw=0,92 W/m^{2}K
Plastic profile
White colored

Rw = 32dB

1.F	2.F	3.F	4.F	5.F
1	1	1	0	0

A.10

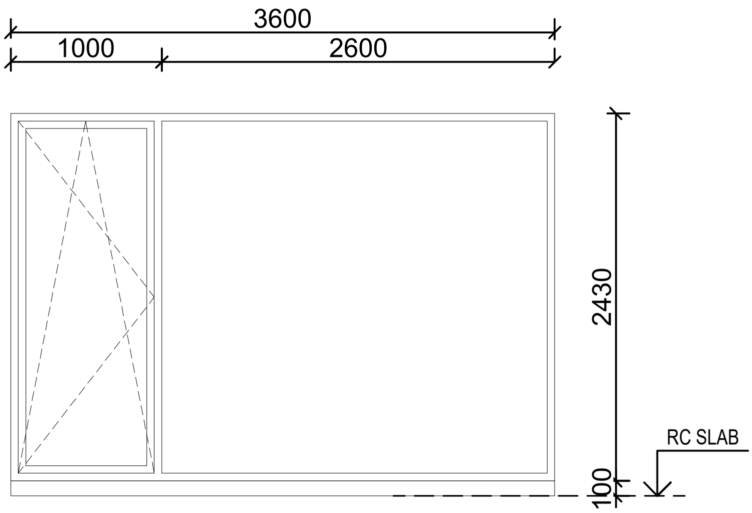


Triple glazed window
Uw=0,92 W/m^{2}K
Plastic profile
White colored

Rw = 32dB

1.F	2.F	3.F	4.F	5.F
1	1	1	0	0

A.11



Triple glazed window
Uw=0,92 W/m^{2}K
Plastic profile
White colored

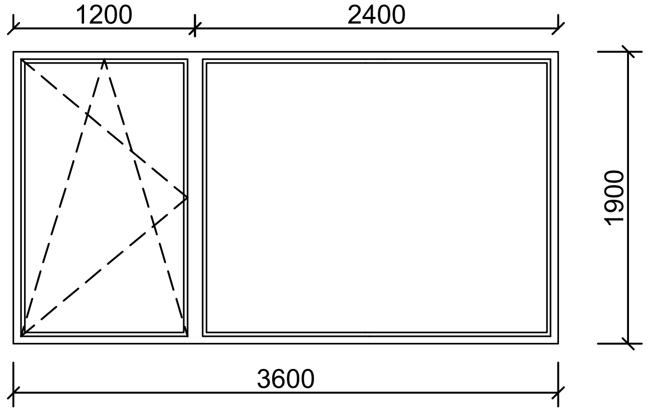
Rw = 32dB

1.F	2.F	3.F	4.F	5.F
1	1	1	0	0

LIST OF WINDOWS
Project documentation of a residential building - Chodov

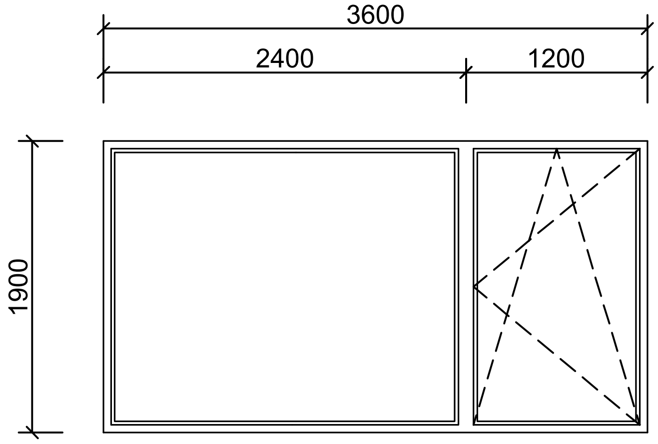
CODE	SCHEME	PCS.

A.12



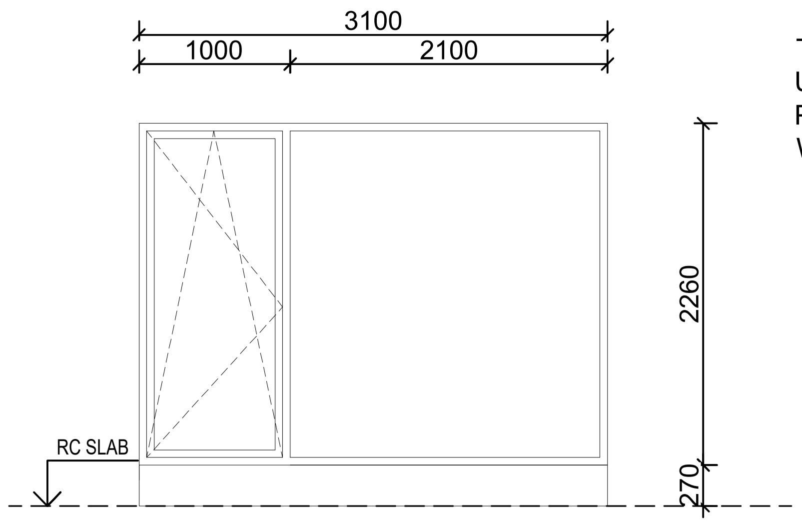
1.F	2.F	3.F	4.F	5.F
1	1	1	0	0

A.13



1.F	2.F	3.F	4.F	5.F
1	1	1	0	0

A.14



Triple glazed window
Uw=0,92 W/m^{2}K
Plastic profile
White colored

Rw = 32dB

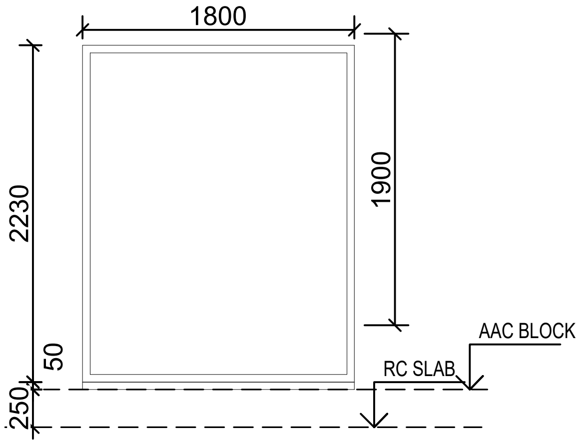
1.F	2.F	3.F	4.F	5.F
1	1	1	0	0

LIST OF WINDOWS

Project documentation of a residential building - Chodov

CODE	SCHEME	PCS.

A.15

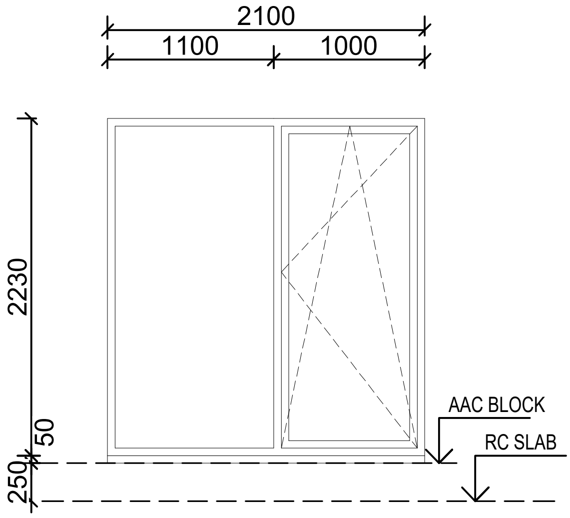


Triple glazed window
Uw=0,92 W/m^{2}K
Plastic profile
White colored

Rw = 32dB

1.F	2.F	3.F	4.F	5.F
0	0	0	2	0

A.16

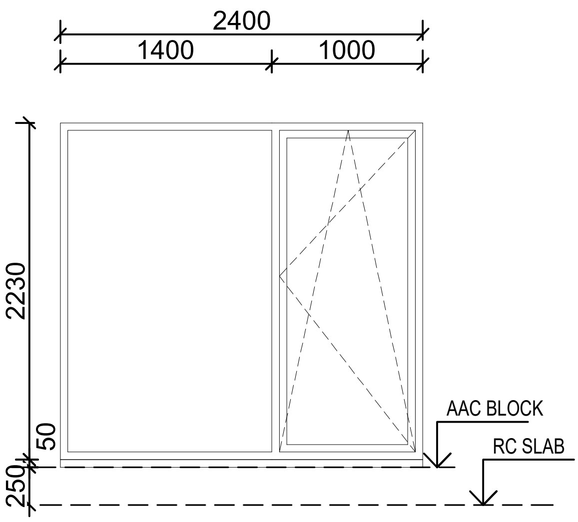


Triple glazed window
Uw=0,92 W/m^{2}K
Plastic profile
White colored

Rw = 32dB

1.F	2.F	3.F	4.F	5.F
0	0	0	1	0

A.17



Triple glazed window
Uw=0,92 W/m^{2}K
Plastic profile
White colored

Rw = 32dB

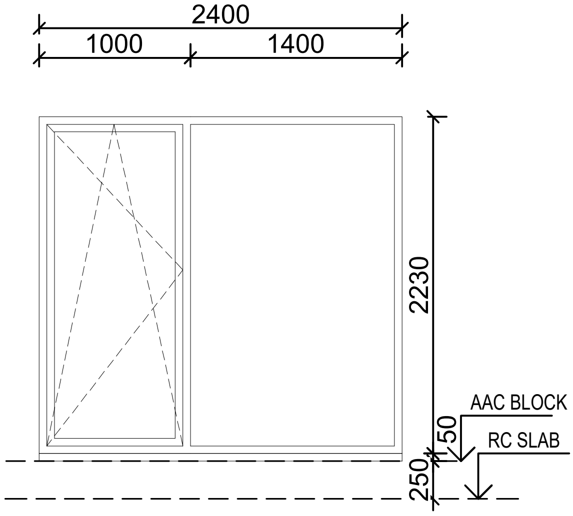
1.F	2.F	3.F	4.F	5.F
0	0	0	1	0

LIST OF WINDOWS

Project documentation of a residential building - Chodov

CODE	SCHEME	PCS.

A.18

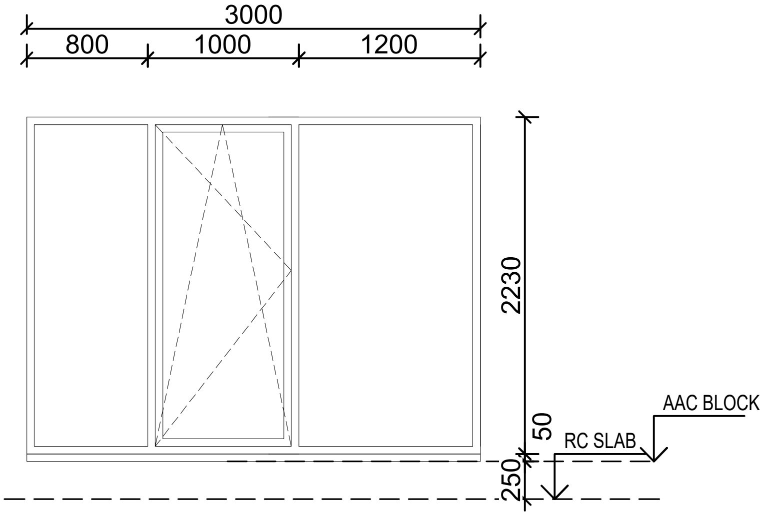


Triple glazed window
Uw=0,92 W/m^2K
Plastic profile
White colored

Rw = 32dB

1.F	2.F	3.F	4.F	5.F
0	0	0	2	0

A.19

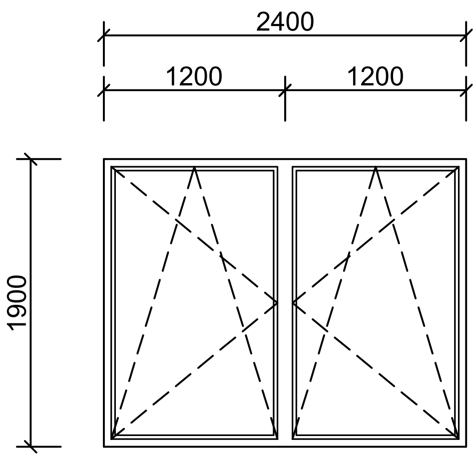


Triple glazed window
Uw=0,92 W/m^2K
Plastic profile
White colored

Rw = 32dB

1.F	2.F	3.F	4.F	5.F
0	0	0	1	0

A.20



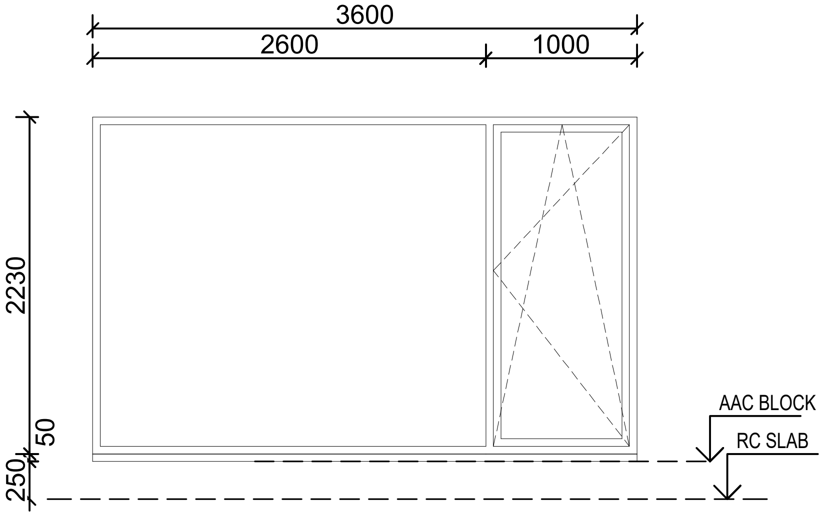
1.F	2.F	3.F	4.F	5.F
0	0	0	2	0

LIST OF WINDOWS

Project documentation of a residential building - Chodov

CODE		PCS.

A.21

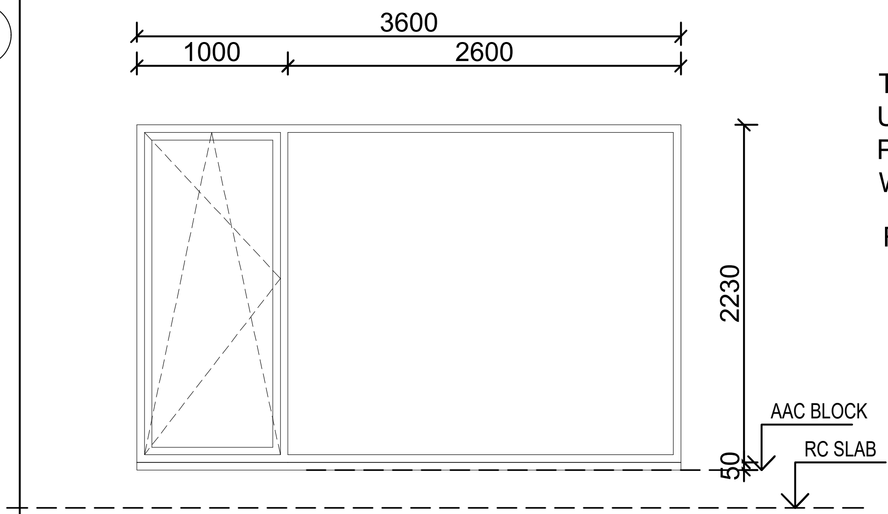


Triple glazed window
Uw=0,92 W/m^2K
Plastic profile
White colored

Rw = 32dB

1.F	2.F	3.F	4.F	5.F
0	0	0	2	0

A.22

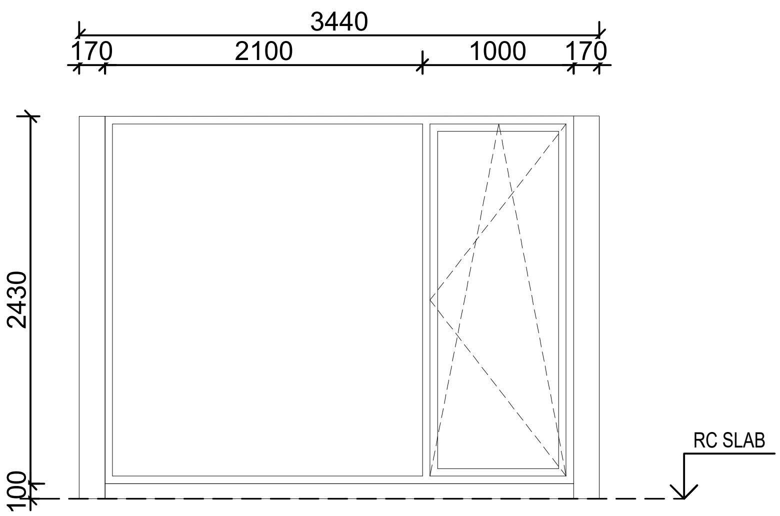


Triple glazed window
Uw=0,92 W/m^2K
Plastic profile
White colored

Rw = 32dB

1.F	2.F	3.F	4.F	5.F
0	0	0	1	0

A.23



Triple glazed window
Uw=0,92 W/m^2K
Plastic profile
White colored

Rw = 32dB

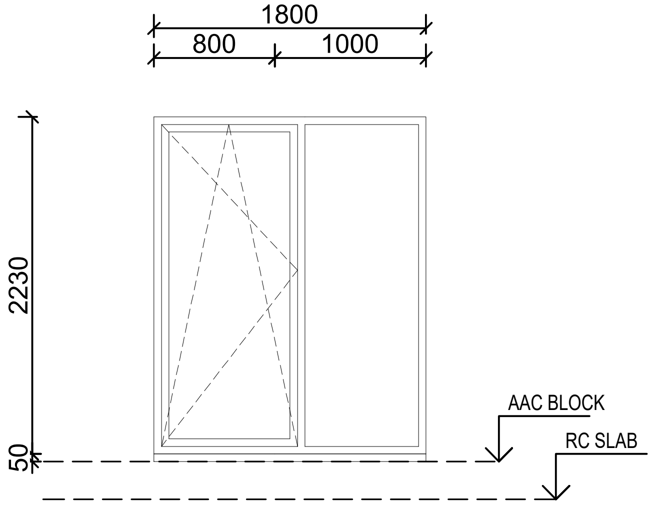
1.F	2.F	3.F	4.F	5.F
0	1	1	0	0

LIST OF WINDOWS

Project documentation of a residential building - Chodov

CODE		PCS.

A.24

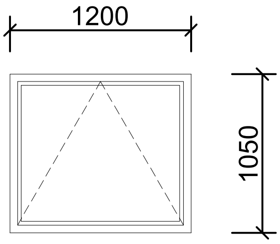


Triple glazed window
Uw=0,92 W/m^{2}K
Plastic profile
White colored

Rw = 32dB

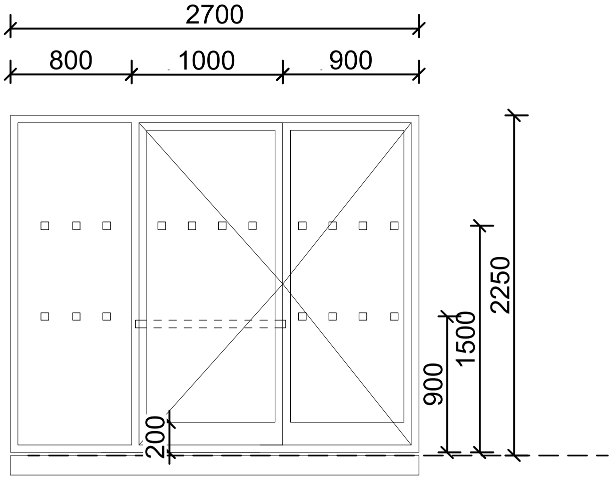
1.F	2.F	3.F	4.F	5.F
0	0	0	1	0

A.25



1.F	2.F	3.F	4.F	5.F
0	0	0	1	0

A.26



Triple glazed window
Uw=0,92 W/m^{2}K
Al profile
White colored

Rw = 32dB

1.F	2.F	3.F	4.F	5.F
1	0	0	0	0

CZECH TECHNICAL UNIVERSITY IN PRAGUE

Faculty of Civil Engineering

Department of Building Structures

Project documentation of a residential building – Chodov

TECHNICAL REPORT

STATIC PART

Designed by: Bc. Akbota Baibatyrova

Consulted with: doc. Ing. Iva Broukalová, Ph.D.

Supervisor: Ing. Malila Noori, Ph.D.

Content:

1. GENERAL INFORMATION

The new residential buildings is build in Prague 11, Chodov. There will be two separate buidlings “A” and “B” with shared two underground floors. Each building has its own main entrance from the East side. The buidling is located in parcels n.174 and 176.

Fig. 1 Boundaries of land parcels n.174 and n.176 in cadastral map [10]

Building A has 2 underground floors, 4 upper ground floors. There are 5 apartments on the 1-3rd floors and 3 apartments on the 4th floor. In total there are 18 apartments in each building (A,B). Apartments range from 1+KK to 4+KK. On the 1st underground floor there are 40 parking spaces, 2 janitorial rooms and 2 stroller rooms. On the 2nd underground floor 40 storage rooms, UPS rooms, 2 air handling unit rooms and technical room. The 4th floor roof is designed as green roof.

The long-side length of the building A is 25,34m, short-side length is 19,10m. The 1 ground floor level ±0,000 is 296,300 m a.s.l. Height of the floor is 3m, total height of the building is 15,40m. A barrier-free solution is ensured by a walk-through lift and access to the building is designed in accordance with the Decree No. 398/2009 Coll.[2]. There are 2 disabled parking spaces available on 1st underground floor (in total 40 parking spaces).

2. GEOLOGICAL SURVEY

The topsoil approximately 0,4m will be removed from the job site. After the end of construction, the excavated topsoil will be reused for landscaping the area. The demolished structures will be taken to landfill or recycled and crushed for use in backfill. For stability of a foundation pit from the East and South of the building there are pile walls. The anchors are temporary with a lifespan of up to 2 years and will not be removed.

The upper layer of the site backfill is 1,4m. Below the upper layer is clayey gravel G5 to the 1,8m depth, to the 2,4m depth there is a slate with grade R4, from 2,4m slate R2. The groundwater level is below the foundation structure.

3. LOAD-BEARING STRUCTURES

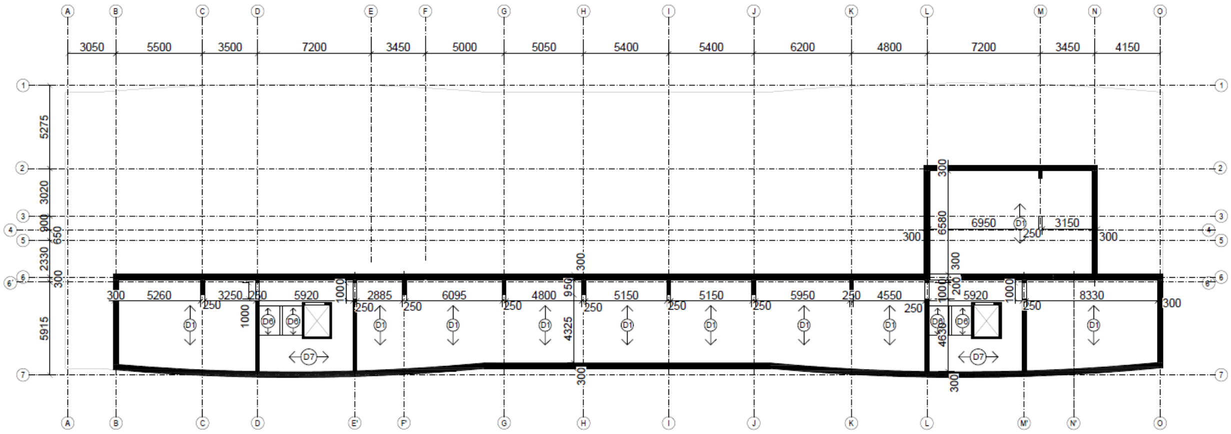


Fig.2 Structural system of the 2nd underground floor

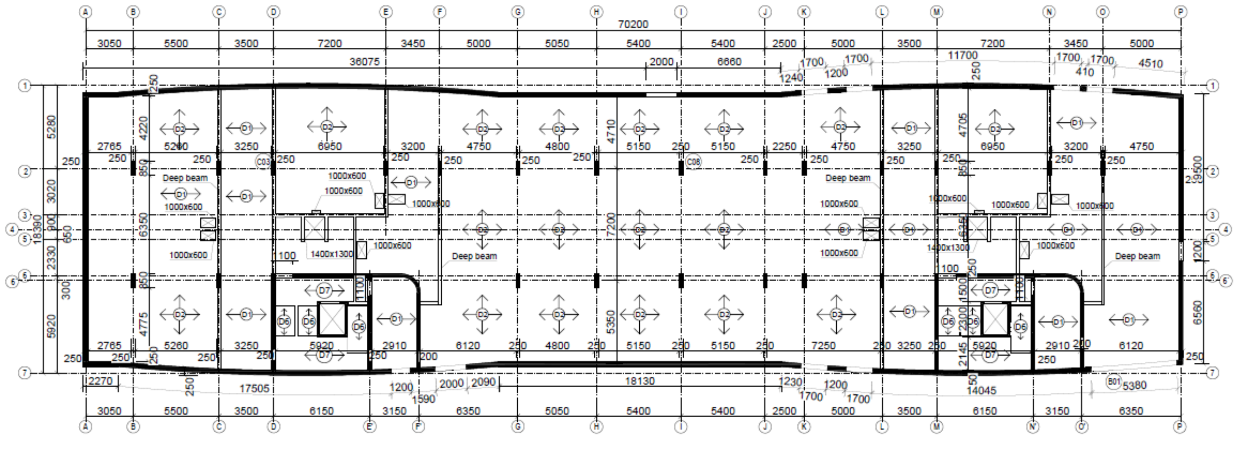


Fig.3 Structural system of the 1st underground floor

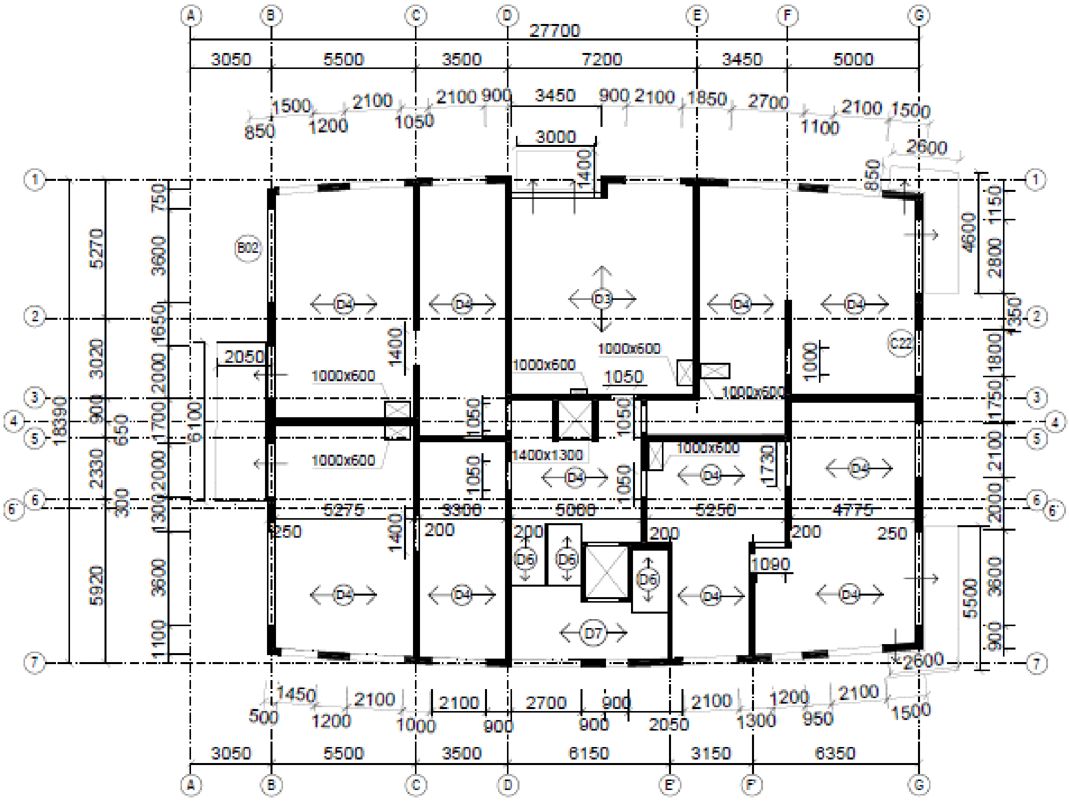


Fig.4 Structural system of the 1st floor

The vertical load bearing structures of the underground floors are made of reinforced concrete. The perimeter wall of the 2nd underground floor is 300mm, inner load bearing wall is 250mm. The 1st underground floor perimeter wall is 250mm thick, inner vertical load bearing wall 200-250mm and load bearing columns 250x850mm. The reinforced concrete perimeter wall of the 1st -4th floors is 250mm thick, 5th floor wall is 200mm. Load bearing inner walls of the upper ground floors are 200-250mm thick.

The monolithic one/two-way reinforced concrete slab of the 2nd underground floor supported on the reinforced concrete walls is designed with the thickness of 250mm. The reinforced concrete monolithic flat slab of the 1st underground floor with the thickness of 250mm is locally supported on the inner columns with dimensions of 250x850mm and 250mm perimeter wall. The reinforced concrete slab of the 1st-3rd floors and roof have a thickness of 220mm. The 4th floor with the green roof has the 250mm reinforced concrete slab.

Structural design is on page 12.

3.1 STAIRCASE

Precast two-flight concrete staircase designed with depth of 170mm and bedded on the Shock Tronsole type F (Fig.5) which is acoustically separates stair flights and landings. Shock Tronsole type L (Fig.6) acts as an impact sound insulation at the joint between stairs and wall. The landing with the 200mm thickness is connected using shock Tronsole type Z (Fig. 7) to eliminate the impact sound propagation.

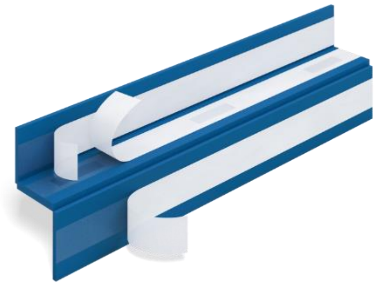


Fig. 5 Impact sound insulation Schöck Tronsole type F [8]

Fig. 6 Impact sound insulation Schöck Shock Tronsole type L [8]

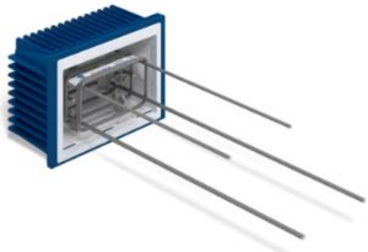


Fig. 7 Impact sound insulation Schöck Tronsole type Z [8]

Structural design of the staircase on page 22.

3.2 ELEVATOR SHAFT

Elevator shaft is designed as monolithic reinforced concrete with shaft width 1570mm and depth 2000mm and the wall thickness of 200mm. Dilatation of the elevator shaft from the rest of the structures is provided by 20mm flexible rubber insulation boards.

KONE Monospace 300 DX (Fig. 8) with car size 1100x1400mm is designed as a passenger elevator for the building. An elevator has the capacity of 630kg, speed 1.0 m/s.

BB - car width 1100mm
DD – car depth 1400mm
CH – car clear height 2200mm
FW - side wall machine side 370mm
FW1 - side wall opposite machine 30mm
FW2 - side wall right - frame door application only
HH - door clear opening height 2100mm
HR - door raw opening height 2100mm
LL - door clear opening width 900mm
LR - door raw opening width 1600mm
LA - front panel width, left 490mm
LB - front panel width, right 150mm
WW - shaft width 1570mm
WD - shaft dept 2000mm

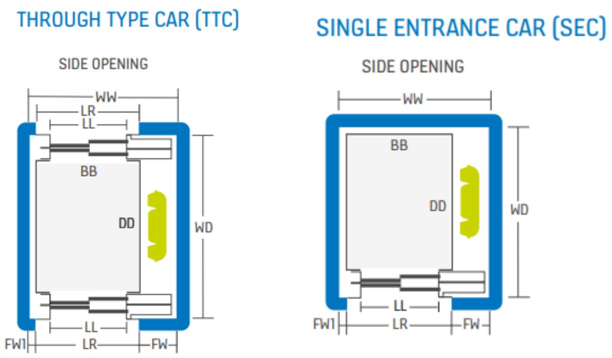


Fig. 8 KONE Monospace 300 DX

3.3 BALCONIES

The designed 200mm high reinforced concrete cantilever balconies are connected using a load bearing thermal insulating element Shock Isokorb XT type K (Fig.5) with 120mm insulation. The concrete is frost resistant. The surface of the balconies will be from anti-slip, frost resistant ceramic tiles placed on adjustable pedestals. The surface water from the balconies is collected with 2,0% slope in the rainwater drainage outlet.

Fig.5 Schöck Isokorb® XT for reinforced concrete structures

Structural design is on page 20.

4. PRELIMINARY STRUCTURAL ANALYSIS

4.1 USED MATERIALS

- Concrete:

  basement walls and foundation C25/30 XC1 - Cl0,2 - D_{max}22 - S3

  remaining load-bearing structures C30/37 XC1 - Cl0,2 - D_{max}22 - S3

- Steel B500B

4.3 PERMANENT LOAD

4.3.1 FLOORING

Flooring A - underground level			
material	t [mm]	ρ [kg/m3]	fk [kN/m2]
epoxy flooring	1,5	1400	0,02
		Σ	**0,02**

Flooring B - 1st floor (bedroom, living room, room)			
material	t [mm]	ρ [kg/m3]	fk [kN/m2]
vinyl flooring + underlay	4	1600	0,064
anhydrite screed	40	2100	0,84
foil separation	-	-	-
EPS acoustic insulation	40	12	0,005
Acoustic/thermal insulation	50	135	0,068

		Σ	**0,99**

Flooring C - typical floor (bedroom, living room, room)			
material	t [mm]	ρ [kg/m3]	fk [kN/m2]
vinyl flooring + underlay	4	1600	0,064
anhydrite screed	40	2100	0,84
foil separation	-	-	-
EPS acoustic insulation	40	12	0,005
		Σ	**0,92**

Flooring D - 1st floor (common areas: corridor)			
material	t [mm]	ρ [kg/m3]	fk [kN/m2]
ceramic tiles + cement adhesive	15	2800	0,42
anhydrite screed	45	2100	0,95
foil separation	-	-	-
EPS acoustic insulation	40	12	0,005
thermal insulation	50	135	0,068
		Σ	**1,45**

Flooring E - typical floor (common areas: corridor)			
material	t [mm]	ρ [kg/m3]	fk [kN/m2]
ceramic tiles + cement adhesive	15	2800	0,42
anhydrite screed	45	2100	0,95
foil separation	-	-	-
EPS acoustic insulation	40	12	0,005
		Σ	**1,38**

Flooring F - green roof (garage)			
material	t [mm]	ρ [kg/m3]	fk [kN/m2]
substrat	250	800	2
geotextile layer	-	-	-
nop dranage	40	950	0,38

water resistant textile	-	-	-
PVC waterproofing layer	1,5	1400	0,02
XPS thermal insulation	120	30	0,036
sloped concrete screed	100	750	0,75
vapor barrier	4	1200	0,048
primer coat	-	-	-
		Σ	**3,24**

Flooring G - Green roof (4th floor)			
substrat	300	800	2,4
geotextile layer	-	-	-
nop dranage	40	950	0,38
water resistant textile	-	-	-
PVC waterproofing layer	1,5	1400	0,02
EPS 100 thermal insulation	220	18	0,04
vapor barrier	4	1200	0,048
primer coat	-	-	-
		Σ	2,89

Flooring H - balcony			
material	t [mm]	ρ [kg/m3]	fk [kN/m2]
ceramic tiles + cement adhesive	15	2800	0,42
polymer cement waterproofing	-	-	-
sloped concrete screed	40-60	2400	1,08
		Σ	**1,5**

4.3.2 FAÇADE

Underground levels: Load bearing reinforced concrete wall C25/30 t=250mm

1st , 2nd , 3rd, 4th, floors: Load bearing reinforced concrete wall C30/37 t=250mm

Thermal insulation Rockwool 200mm $g=0{,}2m*28kg/m^3=0{,}056kN/m^2$

EPS 140mm, $g=\gamma \cdot t=0{,}35*0{,}14=0{,}05\ kN/m^2$

⇨ **Can be neglected**

4.3.3 PARTITIONS

POROTHERM 11,5 AKU thickness 115mm $g_k=151\ kg/m^2 = 1{,}51\ kN/m^2$

RC wall C30/37 thickness 200mm, height 2780mm, $g_k = 14{,}25\ kN/m$

4.4 VARIABLE LOAD

4.4.1 CATEGORIES OF LOADED AREAS

Underground floor – parking space – Category F: $q_k=2{,}5\ kN/m^2$

1st -4th floor – residential property – Category A:

Slab $q_k=1{,}5\ kN/m^2$

Staircase $q_k=3\ kN/m^2$

Balcony $q_k=3\ kN/m^2$

Non-walkable roof – Category H: $q_k=0{,}75\ kN/m^2$

Walkable roof – Category C5: $q_k=5\ kN/m^2$

4.4.2 SNOW LOAD

Flat roof $\alpha < 30°$ ⇨ $\mu = 0{,}8$

Exposure coefficient Ce=1

Thermal coefficient Ct=1

Snow load area I

Basic snow load according to snow map $0{,}7\ kN/m^2$

Characteristic snow load

$s = \mu \cdot C_e \cdot C_t \cdot s_k=0{,}8 \cdot 1 \cdot 1 \cdot 0{,}7 = 0{,}56\ kN/m^2$

⇨ Variable roof load $q_k=0{,}75\ kN/m^2$

4.4.3 WIND LOAD

Location: Prague

Wind load area: I

Basic wind load velocity: v_b = 22,5 m/s

Air density ρ = 1,25kg/m^3

Reference mean velocity pressure $q_b = \frac{1}{2} \cdot \rho \cdot v_b^2 = \frac{1}{2} \cdot 1{,}25 \cdot 22{,}5 = 0{,}32 kN/m^2$

Terrain category – III

h=15,4m

Exposure factor: $C_{e(z)}$ =1,9

Perimeter wall dimensions: transverse direction d=18,50m ⇨ h/d = 15,4/19,10 = 0,81

longitudinal direction d=25,50m ⇨ h/d =15,4/25,30 = 0,60

Pressure coefficient:

Zone	A	B	C	D	E
Transverse direction	-1,2	-0,8	-0,5	0,8	-0,5
Longitudinal direction	-1,2	-0,8	-0,5	0,8	-0,5

Characteristic wind load $w_k = q_b \cdot c_e \cdot c_{pe}$ = 0,32*1,9*(-1,2)=0,73kN/m2

W_d=0,73*1,5=1,46kN/m2

4.5 PRELIMINARY DESIGN

4.5.1 REINFORCED CONCRETE SLAB

One-way slab (D1) - 2nd underground floor L=6,6m

Concrete C25/30 $f_{cd} = \frac{f_{ck}}{\lambda_c} = \frac{25}{1{,}5} = 16{,}67 MPa$

- Empirical design of a slab thickness:

$$h_s \geq \left(\frac{1}{30} \div \frac{1}{25}\right) \cdot L = \left(\frac{1}{30} \div \frac{1}{25}\right) \cdot 6{,}6 = 220 - 264 mm$$

h_s=250mm; d=218mm

- Span/depth ratio:

$\lambda = \frac{L}{d} = \frac{6600}{218} = 30{,}28 \leq \lambda_d = 31{,}2$ ⇨ **OK**

Design 2nd underground floor slab D1 h_s=250mm; d=218mm

- Preliminary check of a bending:

One-way slab **D1**				
Load	**calculation**	**fk [kN/m2]**	**γ [-]**	**fd [kN/m2]**
RC slab, hs=250mm	0,25*25	6,25	1,35	8,44
epoxy flooring		0,02	1,35	0,03
			Σ	**8,47**
variable load	page 6	2,5	1,5	3,75
			(g+q)d	**12,22**

$$m_{Ed} = \frac{1}{12} \cdot (g+q)_d \cdot L^2 = \frac{1}{12} \cdot 12{,}22 \cdot 6{,}6^2 = 44{,}36\ kNm/m'$$

Two-way locally supported flat slab (D2) - 1st underground floor 7,2 x 5,4m

- Empirical design of a flat slab thickness:

$$h_{s,1} = \frac{L_{n,max}}{33} = \frac{6350}{33} = 192mm$$

Where:

$L_{n,max}$ the longest clear span

- Span/depth ratio:

$$h_{s,2} = c + \frac{\emptyset_s}{2} + \frac{L_{max}}{\kappa_{c1}\kappa_{c2}\kappa_{c3}\lambda_{d,tab}} = 25 + \frac{14}{2} + \frac{7200}{1 \cdot 0{,}97 \cdot 1{,}2 \cdot 24{,}6} = 284mm$$

Where:

$\kappa_{c1} = 1$ coefficient of cross-section (rectangular cross-section 1; T-shape cross-section 0.8)

$\kappa_{c2} = 1$ coefficient of span (L=<7m, other cases κc2 = 7/l)

$\kappa_{c1} = 1{,}2$ coefficient of stress in tensile reinforcement (κc3 =1.1 - 1.3)

$\lambda_{d,tab}$ = 24,6 design span to depth ratio (reinfor. ratio 0.5 %)

$$h_s = d_s + c + \frac{\emptyset}{2}$$

Ø14mm assumed bar diameter

c =25mm concrete cover

$c = c_{min}+c_{dev}$ = 15+10=25mm

c_{min}=max ($c_{min,b}$; $c_{min,dur}$; 10mm) = max (10; 15; 10mm) = 15mm

Design 1st underground floor slab D2 h_s=250mm; d=218mm

- Preliminary check of a bending:

Locally supported RC slab **D2** Two-way flat slab				
Load	**calculation**	**fk [kN/m2]**	**γ [-]**	**fd [kN/m2]**
RC slab, hs=250mm	0,25*25	6,25	1,35	8,44
flooring	page 8	3,24	1,35	4,37
			Σ	**12,81**
variable load	page 6	1,5	1,5	2,25
snow load		0,75	1,5	1,125
			(g+q)d	**15,96**

max. moment:

$$M_{tot} = \frac{1}{8}(g+q)_d \cdot L_y \cdot L_{n,x}^2 = \frac{1}{8} \cdot 15{,}96 \cdot 5{,}4 \cdot (7{,}2 - 0{,}85)^2 = 434{,}39\ kNm$$

$$b_{column\ strip} = 2\frac{L_y}{4} = 2{,}7m$$

$$m_{Ed} = \frac{M_{tot} \cdot \gamma \cdot \omega}{b_{column\ strip}} = \frac{434{,}39 \cdot 0{,}65 \cdot 0{,}75}{2{,}7} = 78{,}43\ kNm/m'$$

Two-way RC slab D3 (1-3rd floors) 7,20 x 8,30 m

Concrete C30/37 $f_{cd} = \frac{f_{ck}}{\lambda_c} = \frac{30}{1{,}5} = 20MPa$

- Empirical design of a slab thickness:

$$hs \geq \frac{1}{75}\left(L_{1,x} + L_{1,y}\right) = \frac{1}{75}(7{,}20 + 8{,}30) = 207mm$$

- Span/depth ratio:

$$h_{s,2} = c + \frac{\emptyset_s}{2} + \frac{L}{\kappa_{c1}\kappa_{c2}\kappa_{c3}\lambda_{d,tab}} = 25 + \frac{14}{2} + \frac{7200}{1 \cdot 0{,}97 \cdot 1{,}2 \cdot 26} = 269mm$$

Where:

$\kappa_{c1} = 1$ coefficient of cross-section (rectangular cross-section 1; T-shape cross-section 0.8)

$\kappa_{c2} = 1$ coefficient of span (L=<7m, other cases κc2 = 7/l)

$\kappa_{c1} = 1{,}2$ coefficient of stress in tensile reinforcement (κc3 =1.1 - 1.3)

$\lambda_{d,tab} = 26$ design span to depth ratio (reinfor. ratio 0.5 %)

$h_s = d_s + c + \frac{\varnothing}{2}$

Ø14mm assumed bar diameter

c =25mm concrete cover

$c = c_{min} + c_{dev} = 15+10=25mm$

$c_{min}=\max(c_{min,b}; c_{min,dur}; 10mm) = \max(10; 15; 10mm) = 15mm$

Design 1-3rd floors slab D3 h_s = 220 mm; d = 188 mm

- <u>Preliminary check of a bending:</u>

Slab **D3** Two-way slab				
Load	**calculation**	**fk [kN/m2]**	**γ [-]**	**fd [kN/m2]**
RC slab, hs=220mm	0,22*25	5,5	1,35	7,43
flooring	page 7	0,99	1,35	1,34
partition walls	page 8	1,51	1,35	2,04
			Σ	10,81
variable load	page 6	1,5	1,5	2,25
			(g+q)d	<u>**13,06**</u>

max. moment:

$$M_{0,1} = (g+q)_d \cdot L_{x,1}^2 = 13{,}06 \cdot (7{,}2)^2 = 677{,}03\ kNm/m'$$

$$\frac{L_{y,1}}{L_{x,1}} = \frac{8{,}3}{7{,}2} = 1{,}15 \quad ⇨ \quad \beta_1 = 0{,}039$$

$$M_{Ed,1} = \beta_1 \cdot M_{0,1} + \frac{1}{4} \cdot g_{k,p} \cdot b \cdot L = 0{,}039 \cdot 677{,}03 + \frac{1}{4} \cdot 1{,}35 \cdot 1{,}51 \cdot 7{,}2 =$$

$$= 30{,}07\ kNm/m'$$

One-way slab D7 (4th floor, green roof) L=5,600m

$$hs \geq \left(\frac{1}{30} \div \frac{1}{25}\right) \cdot L_3 = \left(\frac{1}{30} \div \frac{1}{25}\right) \cdot 5600 = 186 \sim 224mm$$

h_s=220mm; d=188mm

$\lambda = \frac{L}{d} = \frac{5600}{188} = 29{,}79 \ \leq \ \lambda_d = 31{,}2$ ⇨ **OK**

Design 4th floor slab D7 h_s = 220 mm; d = 188 mm

- Preliminary check of a bending:

Slab **D7** One-way slab				
Load	**calculation**	**fk [kN/m2]**	**γ [-]**	**fd [kN/m2]**
RC slab, hs=220mm	0,22*25	5,5	1,35	7,43
flooring (green roof)	page 5	2,89	1,35	3,90
			Σ	**11,33**
variable load	page 6	1,5	1,5	2,25
snow load		0,75	1,5	1,125
			(g+q)d	**14,71**

$$m_{Ed} = \frac{1}{12} \cdot (g+q)_d \cdot L^2 = \frac{1}{12} \cdot 14{,}71 \cdot 5{,}60^2 = 38{,}44\ kNm/m'$$

Verification of the relative height of the compressed area ξ and the degree of reinforcement with flexural reinforcement ρ:

$$\mu = \frac{M_{Ed}}{b \cdot d^2 \cdot f_{cd}}$$

$$A_{s,req} = \frac{0{,}8 \cdot b \cdot d \cdot \xi \cdot f_{cd}}{f_{yd}}$$

$$\rho = \frac{A_{s,req}}{b \cdot d}$$

slab	**hs [mm]**	**d [mm]**	**Med [kNm/m']**	**μ [-]**	**ξ [-]**	**As,req**	**ρ [%]**
S01	250	218	44,36	0,047	0,060	481,10	0,22
S02	250	218	78,43	0,083	0,106	849,95	0,39
S03	220	188	30,07	0,043	0,054	373,41	0,20
S04	220	188	38,44	0,054	0,071	490,96	0,26

The design is OK.

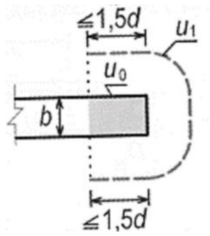
- C08 Preliminary check of punching

Pillar 250 x 850mm

Slab height: hs=250mm

Effective depth: d = h_s-c-Ø/2 = 250-25-14/2=218mm

- <u>Control perimeters</u>



$u_0 = 2 \cdot (b+1{,}5\ d) = 2 \cdot (250 + 1{,}5 \cdot 218) = 1154$ mm

$u_1 = u_0 + 2\pi \cdot 2d = 1154 + 2\ \pi \cdot 2 \cdot 218 = 3893$ mm

- <u>Maximum punching shear resistance</u>

$$\nu_{Ed,0} = \frac{\beta \cdot V_{Ed}}{u_0 \cdot d} \leq \nu_{Rd,max} = 0{,}4 \cdot \nu \cdot f_{cd}$$

β= 1,15

A_{load}=42,12/2= 21,06m^2

V_{Ed}=A_{load} · f_d=21,06 · 16,93 = 356,55 kN

$\upsilon = 0{,}6 \cdot \left(1 - \frac{f_{ck}}{250}\right) = 0{,}6 \cdot \left(1 - \frac{30}{250}\right) = 0{,}528$ coefficient of additional stress effect

$f_{ck} = 30MPa$

$\nu_{Ed,0} = \frac{\beta \cdot V_{Ed}}{u_0 \cdot d} = \frac{1{,}15 \cdot 356{,}55 \cdot 10^3}{1154 \cdot 218} = 1{,}63\ MPa\ \leq\ \nu_{Rd,max} = 0{,}4 \cdot \nu \cdot f_{cd} = 0{,}4 \cdot 0{,}528 \cdot 20 = 4{,}22MPa$

⇨ **OK**

- <u>Maximum resistance with reinforcement</u>

$$\nu_{Ed,1} = \frac{\beta \cdot V_{Ed}}{u_1 \cdot d} \leq k_{max} \cdot \vartheta_{Rd,c} = k_{max} \cdot C_{Rd,c} \cdot k \cdot \sqrt[3]{(100\rho_l \cdot f_{ck})}$$

Where:

$k_{max} = 1{,}8$ coefficient of maximum resistance for double-headed studs connected to a space bar

$C_{Rd,c} = 0{,}12$ reduction factor

$k = 1 + \sqrt{\frac{200}{d}} = 1 + \sqrt{\frac{200}{218}} = 1{,}96\ \leq 2$ effective depth

$\rho_l = 0{,}005$ reinforcement ratio of tensile reinforcement

$\nu_{Ed,1} = \frac{\beta \cdot V_{Ed}}{u_1 \cdot d} = \frac{1{,}15 \cdot 356{,}55 \cdot 10^3}{3893 \cdot 218} = 0{,}48\ MPa$

$\vartheta_{Rd,c} = 0{,}12 \cdot 1{,}96 \cdot \sqrt[3]{100 \cdot 0{,}005 \cdot 30} = 0{,}58$MPa

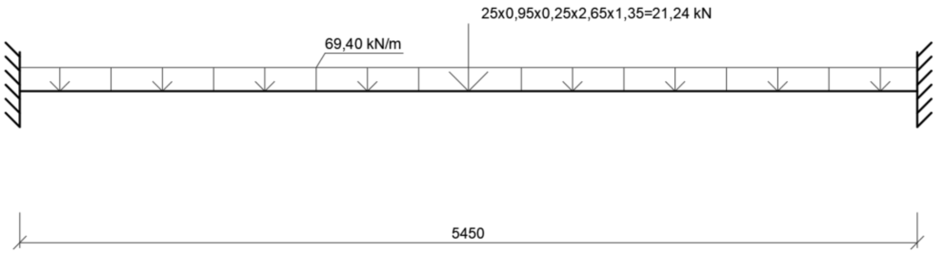
$k_{max} \cdot\ \vartheta_{Rd,c} = 1{,}8 \cdot 0{,}58 = 1{,}044MPa\ >\ \nu_{Ed,1} = 0{,}48MPa$

$$\nu_{Ed,1} = 0{,}48\ MPa\ \leq\ \vartheta_{Rd,c} = 0{,}58MPa$$

⇨ No punching reinforcement needed

4.5.2 REINFORCED CONCRETE BEAM DESIGN

- Beam **B01** underground floor



$$h_B = \left(\frac{1}{12}\sim\frac{1}{10}\right)\cdot L_B = \left(\frac{1}{12}\sim\frac{1}{10}\right)\cdot 5450 = 454\sim545mm$$

$$h_B = 500mm$$

$$b_B = \left(\frac{1}{3}\sim\frac{2}{3}\right)\cdot h_B = \left(\frac{1}{3}\sim\frac{2}{3}\right)\cdot 500 = 166\sim333mm$$

$$b_B = 250mm$$

- Preliminary check of bending

$(g+q)_d = (2\cdot s.w.slab + 2\cdot s.w.beam + 2\cdot flooring)\cdot 1{,}35 + (2\cdot variable\ load)\cdot 1{,}5 = (2\cdot 25\cdot 0{,}25\cdot 2{,}625 + 2\cdot 25\cdot(0{,}5-0{,}25)\cdot 0{,}25 + 2\cdot 1{,}28\cdot 2{,}625 + 25\cdot 0{,}25\cdot 0{,}95)\cdot 1{,}35 + 2\cdot 1{,}5\cdot 2{,}625\cdot 1{,}5 = 69{,}40\ kN/m$

$$M_{Ed,max} = \frac{1}{12}\cdot(g+q)_d\cdot l_b^2 + F\cdot \boldsymbol{l}$$

$$M_{Ed,max} = \frac{1}{12}\cdot 69{,}40\cdot 5{,}45^2 + (25\cdot 0{,}25\cdot 0{,}95\cdot 2{,}65\cdot 1{,}35)\cdot 5{,}25/2 =$$

$$= 227{,}54\ kNm$$

$$d_B = h_B - c - \frac{\emptyset}{2} - \emptyset_s = 500 - 25 - \frac{20}{2} - 14 = 451mm$$

$\mu = \frac{M_{Ed,max}}{b_B\cdot d_B^2\cdot f_{cd}} = \frac{227{,}54\cdot 10^6}{250\cdot 451^2\cdot 20} = 0{,}22$ ⇨ table ξ =0,315

$$A_{s,req} = \frac{0{,}8\cdot b\cdot d\cdot \xi\cdot f_{cd}}{f_{yd}} = \frac{0{,}8\cdot 250\cdot 451\cdot 0{,}315\cdot 20}{435} = 1306{,}34mm^2$$

$\rho = \frac{A_{s,req}}{b\cdot d} = \frac{1306{,}34}{250\cdot 451} = 0{,}011 = 1{,}1\%$ ⇨ **OK**

- Shear reinforcement check

$$V_{Rd,max} = v \cdot f_{cd} \cdot b_b \cdot \zeta \cdot \frac{cot\theta}{1+cot^2\theta} = 0,6 \cdot \left(1 - \frac{f_{ck}}{250}\right) \cdot f_{cd} \cdot b_b \cdot \zeta \cdot \frac{cot\theta}{1+cot^2\theta}$$

$$\geq \ V_{Ed,max} \ cot\theta = 1,5$$

$$V_{Ed,max} = 0,6 \cdot (g+q)_d \cdot L_p = 0,6 \cdot 69,40 \cdot 5,45 + (25 \cdot 0,25 \cdot 0,96 \cdot 2,65) +$$

$$+(25 \cdot 0,25 \cdot 2 \cdot 2,65) = 267,64 \ kN$$

$$V_{Rd,max} = 0,6 \cdot \left(1 - \frac{30}{250}\right) \cdot 20 \cdot 250 \cdot 0,9 \cdot 451 \cdot \frac{1,5}{1+1,5^2} = 494,57 \ kN$$

$$\geq \ V_{Ed,max} = 267,64 \ kN$$

Beam B01 design 500x250mm

- <u>Beam **B02** 1st floor</u>

$$h_B = \left(\frac{1}{12} \sim \frac{1}{10}\right) \cdot L_B = \left(\frac{1}{12} \sim \frac{1}{10}\right) \cdot 4100 = 341 \sim 410mm$$

$$h_B = 350mm$$

$$b_B = \left(\frac{1}{3} \sim \frac{2}{3}\right) \cdot h_B = \left(\frac{1}{3} \sim \frac{2}{3}\right) \cdot 350 = 116 \sim 233mm$$

$$b_B = 250mm$$

- <u>Preliminary check of bending</u>

$$(g+q)_d = (0,22 \cdot 25 \cdot 3,35 + 0,92 \cdot 3,35) \cdot 1,35 + 1,5 \cdot 1,5 = 31,28kN/m$$

$$M_{Ed,max} = \frac{1}{8} \cdot (g+q)_d \cdot l_b^2 = \frac{1}{8} \cdot 31,28 \cdot 4,1^2 = 65,72kN/m$$

$$d_B = h_B - c - \frac{\emptyset}{2} - \emptyset_s = 350 - 25 - \frac{20}{2} - 14 = 301 \ mm$$

$\mu = \frac{M_{Ed,max}}{b_B \cdot d_B^2 \cdot f_{cd}} = \frac{65,72 \cdot 10^6}{250 \cdot 301^2 \cdot 20} = \ 0,15$ ⇨ table ξ = 0,204

$$A_{s,req} = \frac{0,8 \cdot b \cdot d \cdot \xi \cdot f_{cd}}{f_{yd}} = \frac{0,8 \cdot 250 \cdot 301 \cdot 0,204 \cdot 20}{435} = 564,63mm^2$$

$\rho = \frac{A_{s,req}}{b \cdot d} = \frac{564,63}{250 \cdot 301} = 0,008 = 0,8\%$ ⇨ **OK**

- <u>Shear reinforcement check</u>

$$V_{Rd,max} = v \cdot f_{cd} \cdot b_b \cdot \zeta \cdot \frac{cot\theta}{1+cot^2\theta} = 0,6 \cdot \left(1 - \frac{f_{ck}}{250}\right) \cdot f_{cd} \cdot b_b \cdot \zeta \cdot \frac{cot\theta}{1+cot^2\theta} \ \geq \ V_{Ed,max}$$

$$cot\theta = 1,5$$

$$V_{Ed,max} = 0,6 \cdot (g+q)_d \cdot L_p = 0,6 \cdot 31,28 \cdot 4,1 = 76,95kN$$

$$V_{Rd,max} = 0,6 \cdot \left(1 - \frac{30}{250}\right) \cdot 20 \cdot 250 \cdot 0,9 \cdot 301 \cdot \frac{1,5}{1+1,5^2} = 330,08 \ kN$$

$V_{Rd,max} = 330,08 \ kN \quad \geq \quad V_{Ed,max} = 76,95kN$ ⇨ **OK**

Final beam B03 design 350x250mm

4.5.3 REINFORCED CONCRETE COLUMN DESIGN

Column **C03** underground floor - 250 x 850mm, A=0,2125m^2

A_{load}=5,35·6,4=34,24 m^2

$h_{columnn}$=2,75m

load	calculation	Nk [kN]	γ [-]	Nd [kN]
RC slab	4·0,25·25·34,24	856,00	1,35	1155,6
flooring	4·0,92·34,24	126,00	1,35	170,10
partitions	1,51·34,24	51,70	1,35	69,80
RC wall t=200mm	4·0,2·25·2,78·6,4	355,84	1,35	679,29
RC column	0,25·0,85·2,75·25	14,61	1,35	19,72
roof	2,89·34,24	98,95	1,35	133,59
			Σ	2228,1
variable load	4·1,5·34,24+5·34,24	376,64	1,50	564,96
snow load	0,75·34,24	25,68	1,50	38,52
			Σ	603,48
			TOTAL	**2831,58**

$N_{Rd} \geq N_{Ed}$

$N_{Rd}=0,8 \cdot A_c \cdot f_{cd} + A_s \cdot \sigma_s = 0,8 \cdot 0,2125 \cdot 20000 + 0,2125 \cdot 0,02 \cdot 400000 = 5100kN$ ⇨ **OK**

f_{cd}=20MPa

σ_s=400MPa

4.5.4 BALCONY DESIGN

- Empirical design of a slab thickness:

$$h_{balc} = \frac{1}{10} \cdot L_k = \frac{1}{10} \cdot 2050 = 205mm$$

- Span/depth ratio:

$$\lambda \;= \frac{l}{d} \leq \lambda_{lim} = \kappa_{c1}\kappa_{c2}\kappa_{c3}\lambda_{d,tab}$$

$$d \geq \frac{l}{\lambda_d} = \frac{2050}{1 \cdot 1 \cdot 1{,}2 \cdot 8} = 214mm$$

Where:

$\kappa_{c1} = 1$ coefficient of cross-section (rectangular cross-section 1; T-shape cross-section 0.8)

$\kappa_{c2} = 1$ coefficient of span (L=<7m, other cases κc2 = 7/l)

$\kappa_{c1} = 1{,}2$ coefficient of stress in tensile reinforcement (κc3 =1.1 - 1.3)

$\lambda_{d,tab}$ =8 design span to depth ratio (reinfor. ratio 0.5 %), concrete C30/37

$h_s = d_s + c + \frac{\emptyset}{2}$

Ø10mm assumed bar diameter

c =25mm concrete cover

c = c_{min}+c_{dev} = 15+10=25mm

c_{min}=max ($c_{min,b}$; $c_{min,dur}$; 10mm) = max (10; 15; 10mm) = 15mm

Design h=200mm

load	calculation	fk [kN/m2]	γ [-]	fd [kN/m2]
flooring	15·2800+45·2400	1,5	1,35	2,025
RC slab t=200 mm	25·0,20	5	1,35	6,75
			Σ	8,78
variable load	page 6	3	1,5	4,5
			(g+q)d	13,28

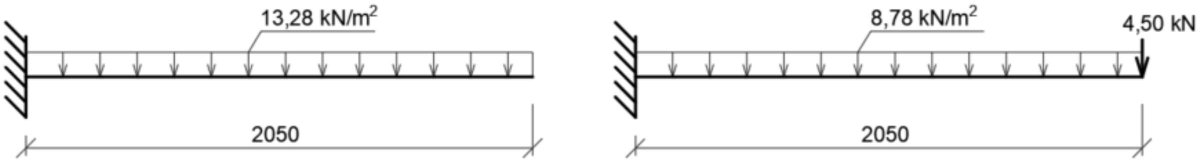


Fig. 8 Static scheme

1) $M_{Ed} = \frac{1}{2} \cdot (g+q)_d \cdot L^2 = \frac{1}{2} \cdot 13{,}28 \cdot 2{,}05^2 = 26{,}48 kNm/m'$

2) $M_{Ed} = \frac{1}{2} \cdot g_d \cdot L^2 + F \cdot L = \frac{1}{2} \cdot 8{,}78 \cdot 2{,}05^2 + 4{,}5 \cdot 2{,}05 = 26{,}25 kNm/m'$

	h [mm]	d [mm]	Med [kNm/m']	μ [-]	ξ [-]	As,req	ρ [%]
balcony	200	170	26,25	0,045	0,059	368,92	0,22

$\mu = \frac{M_{Ed,max}}{b_B \cdot d_B^2 \cdot f_{cd}}$

$A_{s,req} = \frac{0{,}8 \cdot b \cdot d \cdot \xi \cdot f_{cd}}{f_{yd}}$

$\rho = \frac{A_{s,req}}{b \cdot d}$

Designed balcony is OK

Design 200mm thick RC balcony

4.5.5 STAIRCASE DESIGN

- Scheme

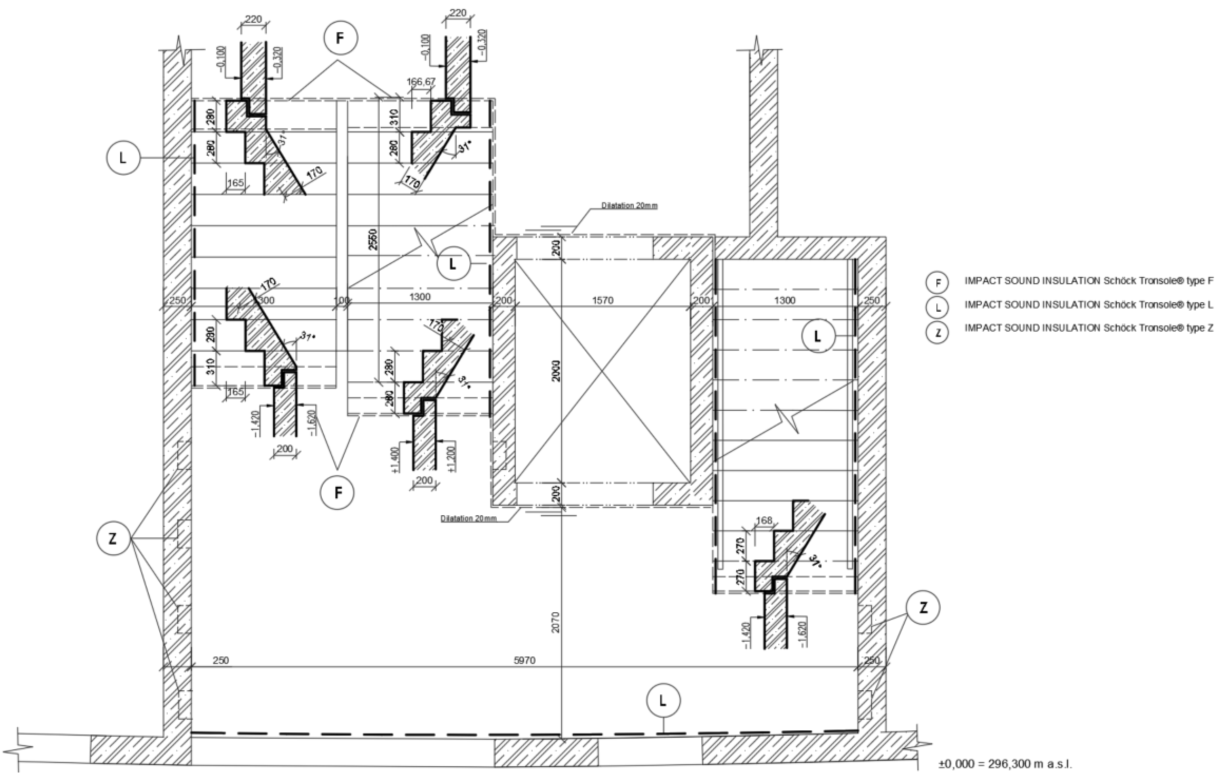


Fig.9 Formwork of the precast staircase

- Two-flight staircase geometry design

Reinforced concrete staircase

Height of the floor 3000mm

Depth of the main slab 220mm

Depth of the floor structure 100mm

Thickness of staircase cladding 15mm

Width of the flight 1300mm

Width of the landing 1500mm

Length of the landing 5970mm

Thickness of the landing $5970 \cdot (1/30 \div 1/25) = 199 - 239mm$ ⇨ D_7=200mm

Two flights with 9 steps on each flight

Height of one step h=$\frac{3000}{2\cdot 9}$=167mm

Width of one step b=280mm

Slope of the staircase a = arctan (167/280) = 30,76°

- Perpendicular and head clearance of the staircase

Head clearance of the staircase should be more than

1500+750/cosa = 1500+750/cos(30,76°) = 2373 mm > 2100 mm.

Head clearance of the staircase is $h_1 = h_k - h_s - h_f$ = 3000 – 220 – 150 - 167= 2463 mm

Perpendicular clearance of the staircase should be more than

750+1500·cosa = 750+1500·cos(30,76°) = 2039 mm > 1900 mm.

Perpendicular clearance of our staircase

$h_2 = h_1$cosa = 2463·cos(30,76°) = 2117 mm ⇨ **OK.**

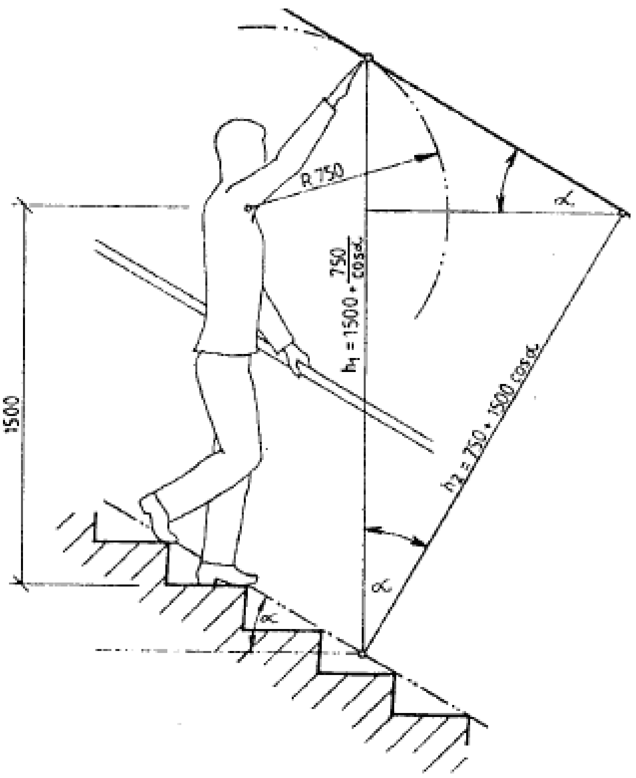


Fig.10 Staircase clearance scheme [6]

- Reinforcement design

Variable load $q_k = 3kN/m^2$

Cladding $g_1 = 0{,}42kN/m^2$

Step $g_2 = (\frac{167}{2})\frac{25}{1000} = 2{,}09kN/m^2$

RC flight $g_3 = \frac{170}{cos30{,}76}\frac{25}{1000} = 4{,}95kN/m^2$

$f_d = 1{,}35 \cdot (0{,}42 + 2{,}09 + 4{,}96) + 1{,}5 \cdot 3 = 14{,}59kN/m^2$

$f_d{}' = 14{,}59 \cdot 1{,}3 = 18{,}97kN/m$

$M_{Ed} = \frac{1}{8} \cdot f_d \cdot l^2 = \frac{1}{8} \cdot 18{,}97 \cdot 2{,}52^2 = 15{,}06kN/m^2$

$d = h_s - c - Ø/2 = 200 - 25 - 10/2 = 170mm$

$A_{s,req} = \frac{M_{Ed}}{0{,}9 \cdot d \cdot f_{yd}} = \frac{15{,}06 \cdot 10^6}{0{,}9 \cdot 170 \cdot 435} = 226{,}28mm^2$

⇨ 5xØ10mm $A_{s,prov} = 392{,}7mm^2$

- Check for a brittle failure

$A_{prov} \geq A_{s,min1} = max(0{,}26 \cdot \frac{f_{ctm}}{f_{yk}} \cdot b \cdot d; 0{,}0013 \cdot b \cdot d) = max(0{,}26 \cdot \frac{2{,}9}{500} \cdot 1300 \cdot$

$170; 0{,}0013 \cdot 1300 \cdot 170) = max(333{,}27; 287{,}3) = 333{,}27mm2$

⇨ **OK**

- <u>Check for an excessive cracking</u>

$A_{s,prov} \geq A_{s,min2} = \frac{k_c \cdot k \cdot f_{ct,eff} \cdot A_{ct}}{\sigma_s} = \frac{0.4 \cdot 1 \cdot 2{,}9 \cdot 0{,}5 \cdot 1300 \cdot 170}{500} = 256{,}36mm^2$ ⇨ **OK**

Where:

$k_c = 0{,}4$ coefficient of stress distribution in cross-section

$k = 1$

A_{ct} area of concrete in the tensile zone

- <u>Design check</u>

$$x = \frac{A_{prov} \cdot f_{yd}}{0{,}8 \cdot b \cdot f_{cd}} = \frac{392{,}7 \cdot 435}{0{,}8 \cdot 1300 \cdot 20} = 8{,}2mm$$

$$z = d - 0{,}4 \cdot x = 170 - 0{,}4 \cdot 8{,}2 = 167mm$$

$$\xi = \frac{x}{d} = \frac{8{,}2}{170} = 0{,}048 \leq 0{,}45$$

$$M_{Rd} \geq M_{Ed}$$

$$M_{Rd} = A_{prov} \cdot f_{yd} \cdot z = 392{,}7 \cdot 435 \cdot 167 \cdot 10^{-6} = 28{,}53kN/m^2$$

$M_{Rd} = 28{,}53kN/m^2 \geq M_{Ed} = 15{,}06kN/m^2$ ⇨ **OK**

DESIGN ⇨ 5xØ10mm $\boldsymbol{A_{s,prov} = 392{,}7mm^2}$

5. STANDARD NORMS AND LITERATURE

[1] EN 1990: Eurocode - Basis of structural design

[2] EN 1991-1-1 Eurocode 1: Actions on structures - Part 1-1: General actions - densities, self-weight, imposed loads for buildings

[3] EN 1992-1-1 Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings

[4] EN 1997-1: Eurocode 7: Geotechnical design. - Part 1: General rules

[5] EN 1992-3: Eurocode 2: Design of concrete structures - Part 3: Liquid retaining and containment structures

[6] Concrete and Masonry Structures 1 lectures (133CM01), doc.Ing. Petr Bílý, Ph.D.

6. USED WEB PAGES

[7] https://www.schoeck.com/en/isokorb-xt

[8] https://www.schoeck.com/en/stairs

[9] https://www.schindler.com/

[10] Fig.1 State Administration of Land Surveying and Cadastre: https://www.cuzk.cz/

7. LIST OF DRAWINGS

1. Structural system of the 2nd underground floor 1:200
2. Structural system of the 1st underground floor 1:200
3. Structural system of the 1st floor 1:200
4. Structural system of the 4th floor 1:200
5. Formwork of the 1st underground floor 1:50
6. Formwork of the 1st floor 1:50
7. Staircase formwork 1:30
8. Staircase reinforcement 1:20

CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF CIVIL ENGINEERING

DEPARTMENT OF ARCHITECTURAL ENGINEERING (K124)

DIPLOMA PROJECT

Project documentation of a residential building - Chodov

FOUNDATION STRUCTURES

TECHNICAL REPORT

Author: Bc. Akbota Baibatyrova

Supervisor: Ing. Malila Noori, Ph.D.

Content:

1.GENERAL INFORMATION

The new residential buildings is build in Prague, Chodov. There will be two buidlings “A” and “B” with shared two underground floors. Each building has its own main entrance from the East side. The buidling is located in parcels n.174 and 176. Existing family house with two apartments and garages in parcel n.176 will be demolished.

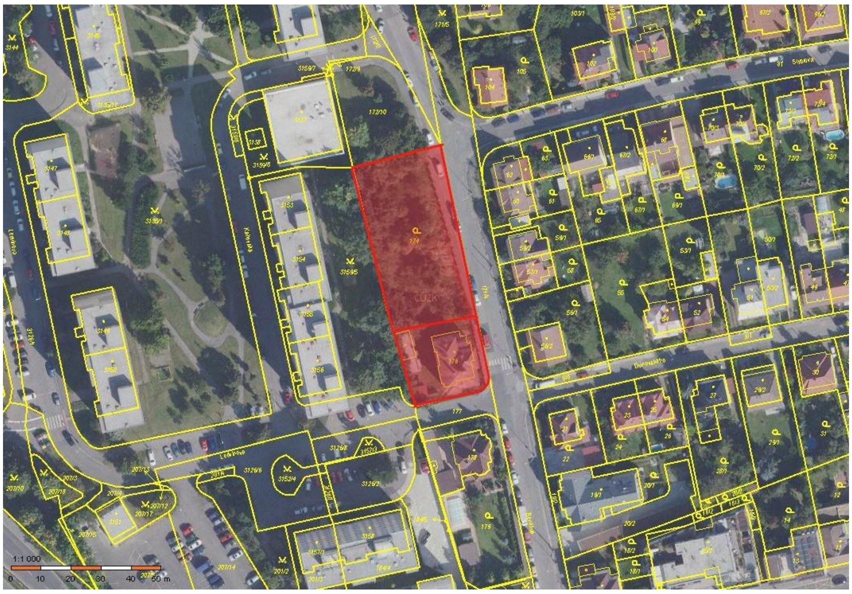


Fig. 1 Boundaries of land parcels n.174 and n.176 in cadastral map [1]

Building A has 2 underground floors, 4 upper ground floors. There are 5 apartments on the 1-3rd floors and 3 apartments on the 4th floor. In total there are 18 apartments in each building (A,B). Apartments range from 1+KK to 4+KK. On the 1st underground floor there are 40 parking spaces, on the 2nd underground floor 40 storage rooms, 2 UPS rooms,2 A.H.U. rooms and technical room. The 4th floor roof is designed as green roof.

The long-side length of the building A is 27,7m, short-side length is 18,39m. The 1 ground floor level ±0,000 is 296,300 m a.s.l. Height of the floor is 3m, total height of the building is 15,4m. A barrier-free solution is ensured by a walk-through lift and access to the building is designed in accordance with the Decree No. 398/2009 Coll.[2]. There are 2 disabled parking spaces available on 1st underground floor (in total 40 parking spaces).

2. SITE GEOLOGICAL SURVEY

- The upper layer of the site backfill is 1,4m,
- Below the upper layer is clayey gravel G5 to the 1,8m depth
- Slate with grade R4 to the 2,4m depth,
- from 2,4m there is a slate R2

The groundwater level is below the foundation. At the bottom of the construction pit will be a drainage. The corrugated plastic pipe will be placed in embedment and protected by geotextile.

2. FOUNDATION

The topsoil approximately 0,4m will be removed from the job site. After the end of construction, the excavated topsoil will be reused for landscaping the area. For stability of a foundation pit from the East and South of the building there are pile walls. The anchors are temporary with a lifespan of up to 2 years and will not be removed.

The underground structure is waterproofed by crystalline waterproofing of reinforced concrete. Plain concrete C12/15 with the thickness of 100 mm.

All the loads from upper floors will be transferred by beams and columns to the slab foundation. Slab foundation with the thickness 350mm and strengthening of a foundation to 600mm near the columns, 1100mm from the face of a column in 45˚. The foundation thickness is designed according to the engineering and geological survey. Waterproofing of the underground structures is solved by using Xypex crystallization admixture. Total area of the slab foundation is 1257,8m^2.

3. CALCULATION

Soil slate R2

$\varphi_{ef} = 30^\circ$ Angle of internal friction

$c_{ef} = 40kPa$ Cohesion of soil

$\gamma = 23\ kN/m^3$ bulk density

$\gamma_{su} = 14\ kN/m^3$

δ = 10 ˚ str-soil friction angle

υ = 0,15 Poisson's ratio

Edef = 80MPa Deformation modulus

γ_{su} = 24 kN/m^3 Saturated unit weight

Concrete 25/30

$$f_{ctk} = 1{,}8\ MPa$$

$$f_{ctd} = \frac{f_{ctk}}{\gamma_M} = \frac{1{,}8}{1{,}5} = 1{,}2\ MPa$$

N_{ed}=2831,58 kN (see "static part" page 22)

Punching check of the RC slab foundation

Concrete reinforcement cover c=50mm

Reinforcement diameter Ø16mm

bf= 5,35m,

lf=3,45m

Aload=5,35·3,45=18,46 m2

RC column 0,25x0,85m

⇨ Strengthening of the foundation slab h=600mm near the columns

h=600mm

d=hd-c-3*Ø/2=600-50-16/2=542mm

r=2d=2*526mm=1052 mm

u0=2*(250+850)=2200mm

u1=2(250+850)+2π2d=9011mm

$$v_{Ed,0} = \frac{\beta \cdot V_{Ed}}{u_0 \cdot d} = \frac{1{,}15 \cdot 2831{,}58 \cdot 10^3}{2200 \cdot 542} = 2{,}73\ MPa\ \leq\ v_{Rd,max} = 0{,}4 \cdot \nu \cdot f_{cd}$$
$$= 0{,}4 \cdot 0{,}54 \cdot 16{,}67 = 3{,}6 MPa$$

⇨ **OK**

- Maximum resistance with reinforcement

$$v_{Ed,1} = \frac{\beta \cdot V_{Ed}}{u_1 \cdot d} \leq k_{max} \cdot \vartheta_{Rd,c} = k_{max} \cdot C_{Rd,c} \cdot k \cdot \sqrt[3]{(100\rho_l \cdot f_{ck})}$$

Where:

$k_{max} = 1{,}8$ coefficient of maximum resistance for double-headed studs connected to a space bar

$C_{Rd,c} = 0{,}12$ reduction factor

$k = 1 + \sqrt{\frac{200}{d}} = 1 + \sqrt{\frac{200}{542}} = 1{,}61 \leq 2$ effective depth

$\rho_l = 0{,}005$ reinforcement ratio of tensile reinforcement

$\nu_{Ed,1} = \frac{\beta \cdot V_{Ed}}{u_1 \cdot d} = \frac{1{,}15 \cdot 2831{,}58 \cdot 10^3}{8810 \cdot 542} = 0{,}65\ MPa$

$\vartheta_{Rd,c} = 0{,}12 \cdot 1{,}61 \cdot \sqrt[3]{100 \cdot 0{,}005 \cdot 25} = 0{,}45\ M\text{Pa}$

$k_{max} \cdot \vartheta_{Rd,c} = 1{,}8 \cdot 0{,}45 = 0{,}81 MPa > \nu_{Ed,1} = 0{,}68 MPa$

$\nu_{Ed,1} = 0{,}68\ MPa \leq \vartheta_{Rd,c} = 0{,}81 MPa$

⇨ **OK**

The slab foundation thickness is strengthened near the columns to 600mm. The remaining thickness of the foundation slab is 350mm. Since the designed slab is “white tub” further, the foundation should be checked for cracks. Therefore, it’s necessary to pay more attention to the correct layout and design of the foundation reinforcement.

4. USED MATERIALS

Reinforced Concrete slab foundation C25/30 XC1-Cl0,2-Dmax22-S3

Reinforced concrete basement perimeter wall C25/30 XC1-Cl0,2-Dmax22-S3

Plain concrete C12/15

Steel B500B

Pile wall steel S275, timber C20

5. STANDARD NORMS AND LITERATURE

EN 1997-1 Geotechnical design

EN 1990 Basis of structural design

ČSN 73 1001 Subsoil under shallow foundation

ČSN 73 1004 Large diameter piles

Foundation of structures 01 lectures Doc. Ing. Jan Záleský, CSc.

6. LIST OF DRAWINGS

1. Plan and sections of a reinforced concrete slab foundation 1:100

CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF CIVIL ENGINEERING

K125 DEPARTMENT OF BUILDING SERVICES ENGINEERING

Project documentation of a residential building - Chodov

Technical report

Author: Bc. Akbota Baibatyrova

Consulted with: Ing. Pavla Dvořáková, Ph.D.

CONTENT:

1 General information

The new residential buildings is build in Prague 11, Chodov. There will be two separate buidlings “A” and “B” with shared two underground floors. Each building has its own main entrance from the East side. The buidling is located in parcels n.174 and 176. Building A has 2 underground floors, 4 upper ground floors. There are 5 apartments on the 1-3rd floors and 3 apartments on the 4th floor. In total there are 18 apartments in each building (A,B). Apartments range from 1+KK to 4+KK. On the 1st underground floor there are 40 parking spaces, 2 janitorial rooms and 2 stroller rooms. On the 2nd underground floor 40 storage rooms, UPS rooms, 2 air handling unit rooms and technical room. The 4th floor roof is designed as green roof.

The long-side length of the building A is 25,34m, short-side length is 19,10m. The 1 ground floor level ±0,000 is 296,300 m a.s.l. Height of the floor is 3m, total height of the building is 15,40m. A barrier-free solution is ensured by a walk-through lift and access to the building is designed in accordance with the Decree No. 398/2009 Coll.[2]. There are 2 disabled parking spaces available on 1st underground floor (in total 40 parking spaces).

1.1 Structural system

The vertical load bearing structures of the underground floors are made of reinforced concrete. The perimeter wall of the 2nd underground floor is 300mm, inner load bearing wall is 250mm. The 1st underground floor perimeter wall is 250mm thick, inner vertical load bearing wall 200-250mm and load bearing columns 250x850mm. The reinforced concrete perimeter wall of the 1st -4th floors is 250mm thick, 5th floor wall is 200mm. Load bearing inner walls of the upper ground floors are 200-250mm thick.

The monolithic one/two-way reinforced concrete slab of the 2nd underground floor supported on the reinforced concrete walls is designed with the thickness of 250mm. The reinforced concrete monolithic flat slab of the 1st underground floor with the thickness of 250mm is locally supported on the inner columns with dimensions of 250x850mm and 250mm perimeter wall. The reinforced concrete slab of the 1st-3rd floors and roof have a thickness of 220mm. The 4th floor with the green roof has the 250mm reinforced concrete slab.

2.1 Wastewater sewage

The building drain branch DN125 for a building A will be laid under the land surface with 2% slope and connected to the public drainage system from the East side of the building.

The sewage wastewater will be collected from the apartments of the building, cleaning room and floor drains in technical rooms. Wastewater stack will be led through installation shafts. The ventilation of a wastewater stack will be above the roof level because of the walkable roof. On the wastewater stack above the connection the draining branch will be the wastewater cleaning fittings. Horizontal wastewater drain branch will be led under the ceiling of the 1st underground floor with 2% slope and go towards the East side perimeter wall where will be connected to horizontal branch drain. The horizontal fixture branch is led in the plumbing chase wall and under the bathtub.

The parking space is not drained into the sewer. The water from the parking area will be collected in drainless tanks pits in 2.PP. Water from drainless pits will be disposed of by a specialized company.

Horizontal fixture branches and soil stacks are designed from PP multilayer sound insulating plastic pipes, pipes in garage are made of PP.

2.1.1 Wastewater drain design

Plumbing fixture of building A	DU [q/l]	psc.	ΣDU [l/s]
cleaners sink	0,8	1	0,8
floor intake	2	1	2
Washbasin	0,5	28	14
WC	2	20	40
Bath	0,3	18	5,4
Dish washer	0,8	18	14,4
Sink	0,8	18	14,4
Washing machine	0,8	18	14,4
		total	105,4

2x105=210,8l/s

$$Q_{WW} = k \cdot \sqrt{\sum DU} = 0{,}5 \cdot \sqrt{210{,}8} = 7{,}26\ l/s$$

Where

DU Design drain [l/s]

k drain coefficient (k=0,5 for residential buidling)

Qww<Qmax

Qmax for DN 125, decline 2% and fullness 70% is 9,6 l/s

Qww=5,13l/s < Qmax=9,6l/s

DESIGN PVC DN125

2.2 Rainwater sewage

Rainwater building drainage pipe DN 125 will be connected to the public sewer from the East side of the building.

Rainwater will be drained from the roofs of the building, balconies, terraces, the entrance to the building and the entrance to the parking space by rainwater pipes. The flat roof above the 5th floor staircase area will be drained by two rainwater inlets DN100 with rainwater stack DN 75 drainage branch is led under the corridor ceiling to the installation shaft. The walkable roof above the 4th floor will be drained by 10 inlets DN100 and will be placed in the roof insulation in 1% slope and connected to rainwater vertical pipes in the façade insulation of the building. Rainwater of the balconies will be collected in inlets and connected to the vertical rainwater pipes in the façade. Inlets on the walkable roof will be equipped with a smell trap and an access shaft. The cleanouts will be placed at the last floor on the rainwater stack, near the bend of a pipe.

The entrance and exit ramp of the garage will be drained at the façade of the building in a drainage channel and will be connected to the building branch. The garage drain water will not be connected to the building branch..

The rainwater welded PE stack is placed in the façade and roof will be designed with thermal/acoustic insulation.

2.2.1 Rainwater drain design for building A

$$Q_{RW} = i \cdot A \cdot C \ \leq \ Q_{max}$$

Where:

i rain intensity [l/ms^2]

0,03 l/ms^2 for Czech Republic

A roof area

C coefficient of rainwater drain flow (C=1,0)

$A_{5floor} = 231{,}47m^2/2 = 115{,}74m^2$

$Q_{RW} = 0{,}03 \cdot 115{,}74 \cdot 1$ =3,45l/s → **Design PVC DN100**

$A_{terrace4F} = 171{,}4m^2/10 = 17{,}14m^2$

$Q_{RW} = 0{,}03 \cdot 17{,}14 \cdot 1$=0,5l/s → **Design PVC DN100**

$A_{Terrace1UL} = 256{,}63m^2\ /2\ = 128{,}3\ m^2$

$Q_{RW} = 0{,}03 \cdot 128{,}3 \cdot 1 = 3{,}85\ l/s$ → **Design PVC DN100**

$A_{roof} = 39{,}34m^2\ /2\ = 19{,}67\ m^2$

$Q_{RW} = 0{,}03 \cdot 19{,}67 \cdot 1 = 0{,}6\ l/s$ → **Design PVC DN100**

3 Water supply

3.1 Water supply connection

The residential building is connected to the public water supply system from the East of the building. The water supply DN50 will be connected to the water meter in the water meter room om the 1st underground floor in the East side. In the water meter room, after the supply connection the distribution will be divided into drinking water and fire water branches. The water supply pipes will be placed under the ceiling of an underground floor at 0,3% slope. All vertical piping to apartments will be in the installation shafts. The horizontal branches are laid in the plumbing chase wall and under the bathtub.

Water meters will be placed in the installation shafts and accessed with an inspection door. The terrace water supply will have anti-freeze valve.

Cold water, hot water and circulation pipes will be prepared on the second underground floor in the technical room.

3.2 Water supply design

The average daily water consumption:

$$Q_p = q \cdot n[l/day]$$

Where

q water consumption q=120 l/day for Czech Republic

n number of people

$Q_p = 120 \cdot 101 = 12120\ l/day$

Maximum water consumption a day:

$$Q_m = Q_p \cdot k_d$$

Where

k_d development coefficient

$Q_m = 12120 \cdot 1{,}5 = 18180\ l/day$

The maximum hourly water consumption:

$$Q_h = Q_m \cdot k_h$$

Where

k_h development coefficient

$Q_h = 18180 \cdot 1{,}8/24 = 1364\ l/h$

Flow volume for a residential building:

$$Q_v = \sqrt{\sum_{i=1}^{n} q_{iv}^2 ni}$$

Where

n number of outlets

q water flow

Plumbing fixture	Q [l/s]	pcs.	Q2*n [l/s]
Washbasin	0,2	28	1,12
WC	0,15	20	0,45
Bath	0,3	18	1,62
Dish washer	0,2	18	0,72
Sink	0,2	18	0,72
Washing machine	0,2	18	0,72

total	5,35

Total for a residential building A,B: 2x5,35=10,7 l/s

$Q_v = \sqrt{10{,}7} = 3{,}27\ l/s$

$$Q = \frac{\pi d^2}{4} v \ \Rightarrow d = \sqrt{\frac{4Q}{\pi v}}$$

Where

d diameter (real)

DN diameter nominal

v connection piping velocity 2,5 m/s

$d = \sqrt{\frac{4Q}{\pi v}} = \sqrt{\frac{4 * 3{,}27 * 10^{-3}}{\pi * 2{,}5}} = 0{,}04m$

→ **Design DN50**

4 Heating

The heat source for domestic hot water and heating preparation is a pressure-independent compact heat exchanger plant in the technical room. The station is connected to the central heat supply. The heating system will be secured by safety valves and an automatic expansion wessel. The hot water circulation will have a temperature gradient 65/45°

The floor convectors and radiators will be placed under the windows.

5 Ventilation

The ventilation of the flats is provided by mechanical equal pressure ventilation with heat recovery system. The heat recovery unit is placed in the ventilation room in the basement of the building. The ventilation unit will supply heated outdoor air to the living rooms and remove waste air. The living room door will have a gap under the door. Supply and exhaust pipes of ventilation pipe from the air handling units will be led to the ventilated rooms and will have a noise insulating ducts to prevent the noise spread. The kitchen hood vertical pipe will end above the roof of the building. Ducts that are passing through a fire section will be fire insulated. Regulation of the air output of the assembly ventilation units is ensured by controller. The exhaust air is blown over the roof of the building. The ventilation of the storage and technical rooms and will be provided with using a fresh air. Ventilation of the garage area, bicycles and pram storages are ensured by under pressure ventilation. Exhaust air will be removed by fans. The kitchen will be equipped with recirculating range hood.

6 Electricity

The electricity will be designed according to the requirements of the building. The electricity shaft will be in the corridor shaft.

7 Standard norms and literature

[1] ČSN 75 6760 - Internal sewage

[2] ČSN 75 5455 - Calculation of internal water mains

[3] ČSN 73 0540 – Tepelná ochrana budov

[4] ČSN EN 806-1 (736660) Indoor plumbing for the supply of water intended for human consumption

8 List of drawings

1. Situation 1:250
2. Drainage, heating system, water supply - 2nd Underground floor 1:50
3. Drainage, heating system, water supply - 1st Underground floor 1:50
4. Drainage, heating system, water supply - 1st floor 1:50
5. Ventilation system - 2nd Underground floor 1:50
6. Ventilation system – 1st Underground floor 1:50
7. Ventilation system – 1st Underground floor 1:50

Table for simplified heat load calculation

Room name	living room and kitchen	Room number	A.102.2	Floor	1st floor	Building	
Design internal temperature Θ	20 [°C]	Design external temperature Θ_e	-12 [°C]	Air specific heat c_p	0,28	Wh/kg K	
Minimum air exchange rate n_{min}	0,5 [h^{-1}]	Internal room volume V_m	109,9604 [m^3]	Air density ϱ	1,2	kg/m^3	
Lowest hygienic air amount, permanent flow $V_{min,i}$	60 [$m^3 \cdot h^{-1}$]	Supply air temperature Θ_{sup}	-12 [°C]	Note			

Transmission heat loss

Building element (construction) EW -external wall, W - external window, ED - external door, IW - internal wall, ID - internal door, F - floor, C- ceiling, R - roof	Length	Width or height	Area $A = x.y$	Number of holes (W,D)	Area of all the holes	Area without holes $Ak = A - A_o$	Heat loss coefficient (incl. thermal bridges)	Temperature behind the construction (building element)	Temp. Red. coefficient $b_u = \frac{\theta i - \theta u,k}{\theta i - \theta e}$	Transmission heat loss coefficient $H_{T,k} = A_k . U_k . b_u$	Heat loss
	x	y	A	o	Ao	A_k	U_k	$\Theta_{u,k}$	$b_{u,k}$	$H_{T,k}$	
	m	m	m^2	-	m^2	m^2	$W.m^{-2}K^{-1}$	°C	-	$W. K^{-1}$	W
EW1	14,54	2,68	38,97	4	18,28	20,69	0,30	-12,0	1,0	6,21	
W1	2,00	2,30	4,60	1	4,60	4,60	1,50	-12,0	1,0	6,90	
W2	3,60	1,90	6,84	1	6,84	6,84	1,50	-12,0	1,0	10,26	
W3	1,50	1,90	2,85	1	2,85	2,85	1,50	-12,0	1,0	4,28	
W4	2,10	1,90	3,99	1	3,99	3,99	1,50	-12,0	1,0	5,99	
ID1	0,80	1,97	1,58	1	1,58	1,58	3,50	20,0	0,0	0,00	
IW1	5,00	2,68	13,40	0	0,00	13,40	2,70	20,0	0,0	0,00	
IW2	5,30	2,68	14,20	1	1,58	12,62	2,70	20,0	0,0	0,00	
F	-	-	41,03	0	0,00	41,03	0,40	5,0	0,5	7,69	
Total transmission heat loss coefficient $H_T = \Sigma H_{T,k}$										**41,32**	$\Phi_T = H_T . (\Theta_i - \Theta_e)$ **1322**

Ventilation heat loss

Ventilation air amount $V_i = max(V_m .n; V_{min,i})$	**60**	[$m^3.h^{-1}$]	Total ventilation heat loss coefficient $H_V = V_i . c_P . ϱ .(\Theta_i - \Theta_{sup})/(\Theta_i - \Theta_e)$	**20,16**	$\Phi_V = H_V . (\Theta_i - \Theta_e)$	**645**

Total heat loss = Total design heat load $\Phi = \Phi_T + \Phi_V$ [W] **1967**

ISAN THERMO FRT 0065 0250 trench heater with forced convection
length 2500mm width 250mm
2061W

Table for simplified heat load calculation

Room name	bedroom	Room number	A.102.3	Floor	1st floor	Building	
Design internal temperature Θ_i	20 [°C]	Design external temperature Θ_e	-12 [°C]	Air specific heat c_p	0,28 Wh/kg K		
Minimum air exchange rate n_{min}	0,5 $[h^{-1}]$	Internal room volume V_m	42,746 $[m^3]$	Air density ϱ	1,2 kg/m^3		
Lowest hygienic air amount, permanent flow $V_{min,i}$	30 $[m^3 \cdot h^{-1}]$	Supply air temperature Θ_{sup}	-12 [°C]	Note			

Transmission heat loss

Building element (construction): EW - external wall, W - external window, ED - external door, IW - internal wall, ID - internal door, F - floor, C- ceiling, R - roof	Length	Width or height	Area $A = x.y$	Number of holes (W,D)	Area of all the holes	Area without holes $Ak = A - A_o$	Heat loss coefficient (incl. thermal bridges)	Temperature behind the construction (building element)	Temp. Red. coefficient $b_u = \frac{\theta i - \theta u,k}{\theta i - \theta e}$	Transmission heat loss coefficient $H_{T,k} = A_k . U_k . b_u$	Heat loss
	x	y	A	o	Ao	A_k	U_k	$\Theta_{u,k}$	$b_{u,k}$	$H_{T,k}$	
	m	m	m^2	-	m^2	m^2	$W.m^{-2}K^{-1}$	°C	-	$W. K^{-1}$	W
EW1	4,36	2,68	11,68	1	3,99	7,69	0,30	-12,0	1,0	2,31	
W1	2,10	1,90	3,99	1	3,99	3,99	1,50	-12,0	1,0	5,99	
ID	0,80	1,97	1,58	1	1,58	1,58	3,50	20,0	0,0	0,00	
F	-	-	41,03	0	0,00	41,03	0,40	5,0	0,5	7,69	
Total transmission heat loss coefficient $H_T = \Sigma H_{T,k}$										**15,99**	$\Phi_T = H_T . (\Theta_i - \Theta_e)$ **512**

Ventilation heat loss

Ventilation air amount $V_i = max(V_m .n; V_{min,i})$	**30**	$[m^3.h^{-1}]$	Total ventilation heat loss coefficient $H_V = V_i . c_P . ϱ .(\Theta_i - \Theta_{sup})/(\Theta_i - \Theta_e)$	**10,08**	$\Phi_V = H_V . (\Theta_i - \Theta_e)$	**323**
Total heat loss = Total design heat load $\Phi = \Phi_T + \Phi_V$ [W]						**834**

RADIK 11 VK Steel panel radiator
1400x400mm
991W

Table for simplified heat load calculation

Room name	bathroom	Room number	A.102.4	Floor	1st floor	Building	
Design internal temperature Θ_i	24 [°C]	Design external temperature Θ_e	-12 [°C]	Air specific heat c_p	0,28	Wh/kg K	
Minimum air exchange rate n_{min}	1,5 $[h^{-1}]$	Internal room volume V_m	42,746 $[m^3]$	Air density ϱ	1,2	kg/m^3	
Lowest hygienic air amount, permanent flow $V_{min,i}$	15 $[m^3 \cdot h^{-1}]$	Supply air temperature Θ_{sup}	15 [°C]	Note			

Transmission heat loss

Building element (construction)	Length	Width or height	Area $A = x.y$	Number of holes (W,D)	Area of all the holes	Area without holes $Ak = A - A_o$	Heat loss coefficient (incl. thermal bridges)	Temperature behind the construction (building element)	Temp. Red. coefficient $b_u = \frac{\theta i - \theta u,k}{\theta i - \theta e}$	Transmission heat loss coefficient $H_{T,k} = A_k . U_k . b_u$	Heat loss
EW - external wall W - external window ED - external door IW - internal wall ID - internal door F - floor C- ceiling R - roof	x	y	A	o	Ao	A_k	U_k	$\Theta_{u,k}$	$b_{u,k}$	$H_{T,k}$	
	m	m	m^2	-	m^2	m^2	$W.m^{-2}K^{-1}$	°C	-	$W. K^{-1}$	W
IW1	2,80	2,68	7,50	0	0,00	7,50	2,70	20,0	0,1	2,25	
IW2	1,90	2,68	5,09	1	1,58	1,58	2,70	20,0	0,1	0,47	
IW3	2,80	2,68	7,50	0	0,00	7,50	2,70	20,0	0,1	2,25	
ID	0,80	1,97	1,58	0	1,58	1,58	3,50	20,0	0,1	0,61	
F	-	-	41,03	0	0,00	41,03	0,40	5,0	0,5	8,66	
Total transmission heat loss coefficient $H_T = \Sigma H_{T,k}$										**14,25**	$\Phi_T = H_T . (\Theta_i - \Theta_e)$ **513**

Ventilation heat loss

Ventilation air amount $V_i = max(V_m .n; V_{min,i})$	**21,373**	$[m^3.h^{-1}]$	Total ventilation heat loss coefficient $H_V = V_i . c_P . ϱ .(\Theta_i - \Theta_{sup})/(\Theta_i - \Theta_e)$	**1,80**	$\Phi_V = H_V . (\Theta_i - \Theta_e)$	**65**

Total heat loss = Total design heat load $\Phi = \Phi_T + \Phi_V$ [W] **578**

towel rail radiator KORALUX LINEAR MAX-M
900x750mm
600W

CZECH TECHNICAL UNIVERSITY IN PRAGUE

FACULTY OF CIVIL ENGINEERING

K124 DEPARTMENT OF ARCHITECTURAL ENGINEERING

Project documentation of a residential building - Chodov

TECHNICAL REPORT

FIRE SAFETY PART

Author: Bc. Akbota Baibatyrova

Consulted with: Ing. Malila Noori, Ph.D.

CONTENT:

1 General information

The new residential buildings is build in Prague, Chodov. There will be two buidlings “A” and “B” with shared two underground floors. Each building has its own main entrance from the East side. The buidling is located in parcels n.174 and 176.

Building A has 2 underground floors, 4 upper ground floors. There are 5 apartments on the 1-3rd floors and 3 apartments on the 4th floor. In total there are 18 apartments in each building (A,B). Apartments range from 1+KK to 4+KK. On the 1st underground floor there are 40 parking spaces, on the 2nd underground floor 40 storage rooms, 2 UPS rooms, 2 air handling unit rooms and technical room. The 4th floor roof is designed as green roof.

The 1 ground floor level ±0,000 is 296,300 m a.s.l. Height of the floors is 3m, total height of the building is 15,28m. A barrier-free solution is ensured by a walk-through lift and access to the building is designed in accordance with the Decree No. 398/2009 Coll.[2]. There are 2 disabled parking spaces available on 1st underground floor (in total 40 parking spaces). The parking entry is from the East.

The vertical load bearing structures of the underground floors are made of reinforced concrete. The perimeter wall of the 2nd underground floor is 300mm, inner load bearing wall is 250mm. The 1st underground floor perimeter wall is 250mm thick, inner vertical load bearing wall 200-250mm and load bearing columns 250x850mm. The reinforced concrete perimeter wall of the 1st -4th floors is 250mm thick, 5th floor is 200mm. Load bearing inner walls of the upper ground floors are 200-250mm thick.

2 Abbreviations, nomenclature

d Separation Distance

FC Fire Compartment

FIRG Functionally Integrated Room Groups

FPA Fire Protected Area

FUA Fire Unprotected Area

FRG Fire Resistance Grade

FR Fire Resistance

PEW Protective Escape Way

3 Fire safety characteristics

Fire height of the underground floor is h=-6 m

Fire height of the building is h=9m

Vertical and horizontal structures have DP1 type

The construction system of the building is incombustible

Based on ČSN 73 0833 the building is solved as OB2. Parking area is considered as industrial based on norms ČSN 73 0804 [2].

The building is equipped with an evacuation elevator, emergency lighting, UPS, acoustic sirens, smoke detectors and window opening device.

4 Fire compartments

FC	**Purpose**
SE	Evacuation elevator shaft
IS	Installation shaft
P02.01/N05	PEW A
P02.02/N05	PEW A
P02.03	A.H.U. room
P02.04	UPS Uninterruptible Power Supply room
P02.05	Storage rooms
P02.06	UPS room
P02.07	A.H.U. room
P02.08	Technical room
P01.03	Stroller room
P01.04	Janitorial room
P01.05	Garage area
P01.06	Garage area
P01.07	Stroller room
P01.08	Janitorial room
N01.01-N01.05	Apartments
N02.01-N01.05	Apartments
N03.01-N01.05	Apartments
N04.01-N01.03	Apartments

4.1 Fire risk and fire resistance grade

The fire compartment for an apartment unit based on ČSN 73 0833 [3] can be considered that the coefficients a_n=1, b=1, c=1, p_s=10 kg/m^2, p_n=40 kg/m^2, factored fire load p_v=45 kg/m^2

Apartment fire load p_v=45kg/m^2 **III.FRG**

Technical room fire load **II.FRG**

FC P02.04 - Technical room

S [m2]	an	pn [kg/m2]	as	ps [kg/m2]	a	b	c	pv [kg/m2]	FRG
46,44	0,5	5	0,9	2	0,6	1,7	1	7,31	**II. FRG**

Storage rooms fire grade p_v=45kg/m^2 **III.FRG**

Janitorial room p_v=45kg/m^2 **III.FRG**

Stroller room fire load p_v=15kg/m^2 **I.FRG**

Staircase is ventilated PEW A **III.FRG**

Elevator shafts **II.FRG**

Installation shafts **II.FRG**

A.H.U. room **II.FRG**

FC P02.03 - A.H.U. ROOM

S [m2]	an	pn [kg/m2]	as	ps [kg/m2]	a	b	c	pv [kg/m2]	FRG
49,13	0,9	15	0,9	2	0,9	1,7	1	26,01	**II. FRG**

UPS room **II.FRG**

FC P02.04 - UPS ROOM

S [m2]	an	pn [kg/m2]	as	ps [kg/m2]	a	b	c	pv [kg/m2]	FRG
15,86	0,9	10	0,9	2	0,9	1,7	1	18,36	**II. FRG**

The parking space is divided into two compartments (23 in the first compartment and 17 in the other). The garage is not suitable for gas-fueled vehicles. At the garage entrance will be a sign to prohibit the LPG/CNG cars.

Each garage compartment will have **II.FRG**

5 Fire resistance

The fire resistance of the structures will meet the requirements according to tab. 12 ČSN 73 0802 [7].

Perimeter wall axis distance 25mm thickness reinforced concrete 250mm – REI 90 DP1 > 45

Fire dividing walls between apartments RC 200mm – REW 90 DP1 > 45

Underground RC sloup R 30 DP1 > 15

RC slab axis distance 25mm thickness 250mm REI 90 DP1 > 60 DP1

RC slab axis distance 25mm thickness 220mm REI 60 DP1 > 45

Partition walls Porotherm 11,5 EI 180 DP1

Gypsum board on the ceiling EI 30 DP1

Thermal insulation of underground perimeter wall DP1

Entrance doors to apartments EI 30 DP3 SC

Fire door from PEW to garage area EI 30 SC C DP1

Fire roller shutter in garage EW 30 DP1

Fire door to a technical room EI 30 DP3 SC

Fire door to storage area EI 30 DP3 SC

Fire door to stroller room EI 30 DP3 SC

Fire door to janitorial room EI 30 DP3 SC

Thermal insulation of ground floor perimeter wall is mineral wool

6 Protected escape way

The main entrance of the both buildings (A,B) is at the staircase landing. Evacuation of people from the building is ensured by a staircase area connecting all floors of the building, which is designed as a protected escape way type A with mechanical ventilation with $10xh^{-1}$. The air outlet is in the highest point of the escape route with automatic opening. The air supply will be ensured for at least 10 minutes. The ventilation will be automatic and also equipped with remote control with switch buttons on each floor along with smoke detectors. Escape routes staircase flights have width at least 1,10m, door width at least 0,9m.

Overall, there are 77 people for each escape route PEW A.

designed values				CSN 73 0818		
FC	Function	Area [m2]	No.of peole	m2/person	Coef.	No. of people
P02.05	Storage area	59,29	-	10	-	6
P01.05,06	Garage		20 cars	0.5	-	10
1NP	Apartmetns		11		1,5	17
2NP	Apartmetns		11		1,5	17
3NP	Apartmetns		11		1,5	17
4NP	Apartmetns		8		1,5	12
					TOTAL	**77**

7 Separation distances

	SOUTH		WEST			NORTH		EAST	
2nd floor	N02.01	N02.02	NO2.02	N02.03	N02.04	N02.04	N02.05	N02.05	N02.01
S_{po} [m2]	11,64	11,64	6,84	12,35	9,12	10,79	12,74	6,27	6,84
S_p [m2]	24,33	24,33	15,40	20,02	23,63	21,41	26,13	17,51	15,40
Po [%]	47,85	47,85	44,41	61,70	38,60	50,43	48,74	35,80	44,41
p_v [kg/m2]	45,00		45,00			45,00		45,00	
l [m]	8,75	8,75	5,54	7,20	8,50	7,70	9,40	6,30	5,54
h_u [m]	2,78	2,78	2,78	2,78	2,78	2,78	2,78	2,78	2,78
d [m]	3,41	3,41	2,47	3,87	2,56	3,38	3,5	2,47	2,47

	SOUTH	WEST		NORTH		EAST	
4th floor	N04.01	NO4.01	N04.02	N04.02	N04.03	N04.01	N02.03
S_{po} [m2]	12,54	12,04	13,30	5,35	10,70	12,71	10,70
S_p [m2]	33,00	25,03	36,03	10,45	22,83	23,93	27,91
Po [%]	38,00	48,12	36,92	51,22	46,90	53,13	38,35
p_v [kg/m2]	45,00	45,00		45,00		45,00	
l [m]	12,00	9,10	13,10	3,80	8,30	8,70	10,15
h_u [m]	2,75	2,75	2,75	2,75	2,75	2,75	2,75
d [m]	2,76	3,41	3,41	3,09	3,38	3,41	3,09

p0=(Sp0/Sp) *100 [%]

The lowest value: p0 = 40 %

l - length of external wall [m]

hu - height of external wall [m]

Sp0- size of fire opened area in assessed FC [m2]

The fire dangerous space will not cross the fire exposed areas of neighboring buildings. The fire dangerous space of the building extends beyond the borders at the West. The owner of the neighboring plot will be informed, and his consent is required.

8 Firefighting equipment

The outer hydrant located near the main road (approx. 19m from the building) can be used for fire water. Every floor of the building will be equipped with fire hydrant. The length of fire hose with valve is 30m.

Fire extinguishers are hanged-up on the wall where it’s visible, so the height of the handle is max 1,5m above the flooring. Once a year periodical control of the fire extinguisher and once per four years control of vessels is provided. The pipeline will be from non-flammable material and protected from freeze because of the unheated basement.

According to ČSN 730802, Article 12.2.2, an access road is at least a one-lane road with width at least 3 m.

Due to the fire height h < 22.5 m, it is not necessary to establish internal emergency routes of the buildings.

Each floor of the PEW, common areas and the parking area will be equipped with emergency lighting. Emergency lighting must meet the required emergency lighting time for at least 60 minutes. Emergency lighting will be connected to the UPS of the building. Escape routes will be marked with signs. Each apartment will be equipped with automatic smoke detectors in the corridor. Elevator cabin on the outside and the inside will have a “Evacuation Elevator” safety sign.

9 Standard norms and literature

[1] ČSN 73 0872 Požární bezpečnost staveb – Ochrana staveb proti šíření požáru vzduchotechnickým zařízením

[2] ČSN 73 0804 Fire protection of buildings. Industrial buildings

[3] ČSN 73 0833 Fire protection of buildings. Buildings for dwelling and lodging

[4] ČSN 73 0818 Fire safety of buildings Occupation of buildings

[5] ČSN 73 0821 ed. 2 Požární bezpečnost staveb – Požární odolnost stavebních konstrukcí (2007/05)

[6] ČSN 73 0873 Požární bezpečnost staveb – Zásobování požární vodou (2003)

[7] ČSN 73 0802 Fire protection of buildings. Non industrial buildings

10 List of drawings

1. Situation 1:250
2. Fire safety – 2nd underground floor
3. Fire safety – 1st underground floor
4. Fire safety – 1st floor
5. Fire safety – 4th floor