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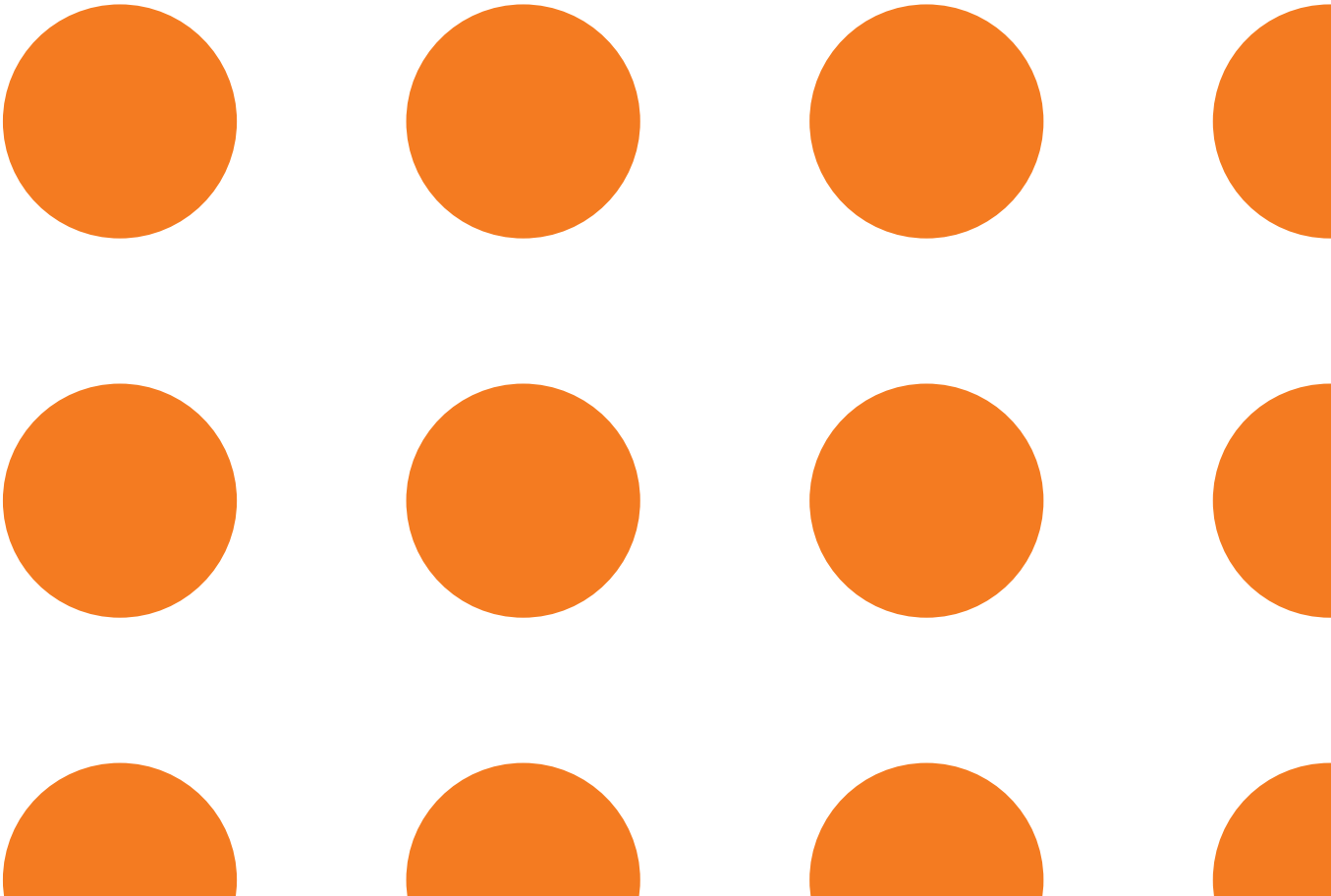
COMPLEX THERMAL-TECHNICAL ANALYSIS OF THE DETACHED PANEL APARTMENT HOUSE OF TYPE B 70 IN ORIGINAL STATE (PART 2)



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CONTENTS

Used Symbols and Units

A	Area of building construction	m^2
A_b	Total floor area of building	m^2
A_e	Total area of heat-exchanging envelope of building	m^2
b_x	Reduction factor	-
B	Characteristic number of building	$Pa^{0,67}$
D	Number of climatic day-degrees	K.day
f_{Rsi}	Temperature factor	-
h_k	Average construction height of storeys	m
H	Heat transfer coefficient of building	W/K
H_{tr}	Transmission heat loss coefficient	W/K
H_{ve}	Ventilation heat loss coefficient	W/K
k	Ratio of internal and external volume	-
l	Length of detail	m
n	Air change rate	1/h
q_i	Heat power of internal heat sources	W/m^2
$Q_{H,nd}$	Energy need for heating	kWh/a
$Q_{H,nd1}$	Specific energy need for heating	$kWh/(m^3.a)$
$Q_{H,nd2}$	Specific energy need for heating	$kWh/(m^2.a)$
$Q_{H,nd,N1}$	Standard specific energy need	$kWh/(m^3.a)$
$Q_{H,nd,N2}$	Standard specific energy need	$kWh/(m^2.a)$
Q_{ep}	Energy need for heating for proving the meeting the requirement on energy economy of building	$kWh/(m^2.a)$
$Q_{ep,N}$	Standard value of energy need for heating for reaching the energy economy of building	$kWh/(m^2.a)$
R_g	Thermal resistance of closed air gap	$m^2.K/W$
R_{se}	Surface resistance of heat transfer on external side of a construction	$m^2.K/W$
R_{si}	Surface resistance of heat transfer on internal side of a construction	$m^2.K/W$
t	Length of duration of calculation period	day
U	Thermal transmittance	$W/(m^2.K)$
U_{em}	Average thermal transmittance	$W/(m^2.K)$

$U_{em,N}$	Standard value of average thermal transmittance	W/(m^2.K)
V_b	Volume of the heated space of building	m^3
ΔH_{tm}	Heat loss coefficient including the influence of thermal bridges	W/K
ΔU	Increase of thermal transmittance due to thermal bridges .	W/(m^2.K)
$\Delta\theta_{si}$	Safety value of surface temperature.....	K
θ_e	Calculating external air temperature.....	°C
θ_i	Calculating internal air temperature.....	°C
θ_{si}	Internal surface temperature.....	°C
$\theta_{si,80}$	Critical surface temperature for growth of moulds	°C
λ	Thermal conductivity coefficient	W/(m.K)
Σ	Sum	-
φ_e	Relative humidity of external air	%
φ_i	Relative humidity of internal air	%
ψ	Linear thermal transmittance	W/(m.K)

Introduction

Panel apartment buildings and problems which relate to their renovation are becoming more and more current topic, nowadays. The emphasis is put on a quality of housing but also on decreasing the energy need for heating. This relates to ensuring miminum heat losses through envelope constructions of the building. That is possible to reach only by quality additional thermal insulation and renovation of envelope constructions. An important factor for achieving lower energy need for heating and healthy indoor environment without a risk of growth of moulds is a correct solution of thermal bridges.

The publication presents issues of thermal-technical evaluation of detached panel apartment house of structural system B 70 in its original state which was built in the seventies and eighties of the twentieth century. The aim of team of authors was comprehensively calculate and analyse thermal-technical properties of this building. This publication is a sequel of the professional handbook titled Complex Thermal-Technical Analysis of the Detached Panel Apartment House of type B 70 in Original State (Part 1). This, second part consists of 4 chapters. In Chapter 1 is a description of the building. The chapter 2 is aimed to evaluation of another 26 details from the viewpoint of hygienic criterion and calculation of linear themal transmittance for each detail. The Chapter 3 deals with a calculation of increase of thermal transmittance due to thermal bridges ΔU and Chapter 4 contains a calculation and comparison of energy need for heating.

The calculation and evaluation of envelope constructions and first 24 selected details of the building are given in the publication titled Complex Thermal-Technical Analysis of the Detached Panel Apartment House of type B70 in Original State (Part1).

The publication is written in a clearly arranged tabular way, in form of professional handbook. It has no ambition to be a textbook, but only a handbook. It is intended not only for students of faculties of civil engineering and faculties of architecture, but also for the professional and general public. It can be used also as a tool when renovating buildings built in this type of structural system.

The basic prerequisite for using this handbook is at least a minimum knowledge of building thermal technology and thermal protection of buildings.

Team of authors

1 Evaluated Building

Table 1.1 – Floor plan of detached house of structural system B 70

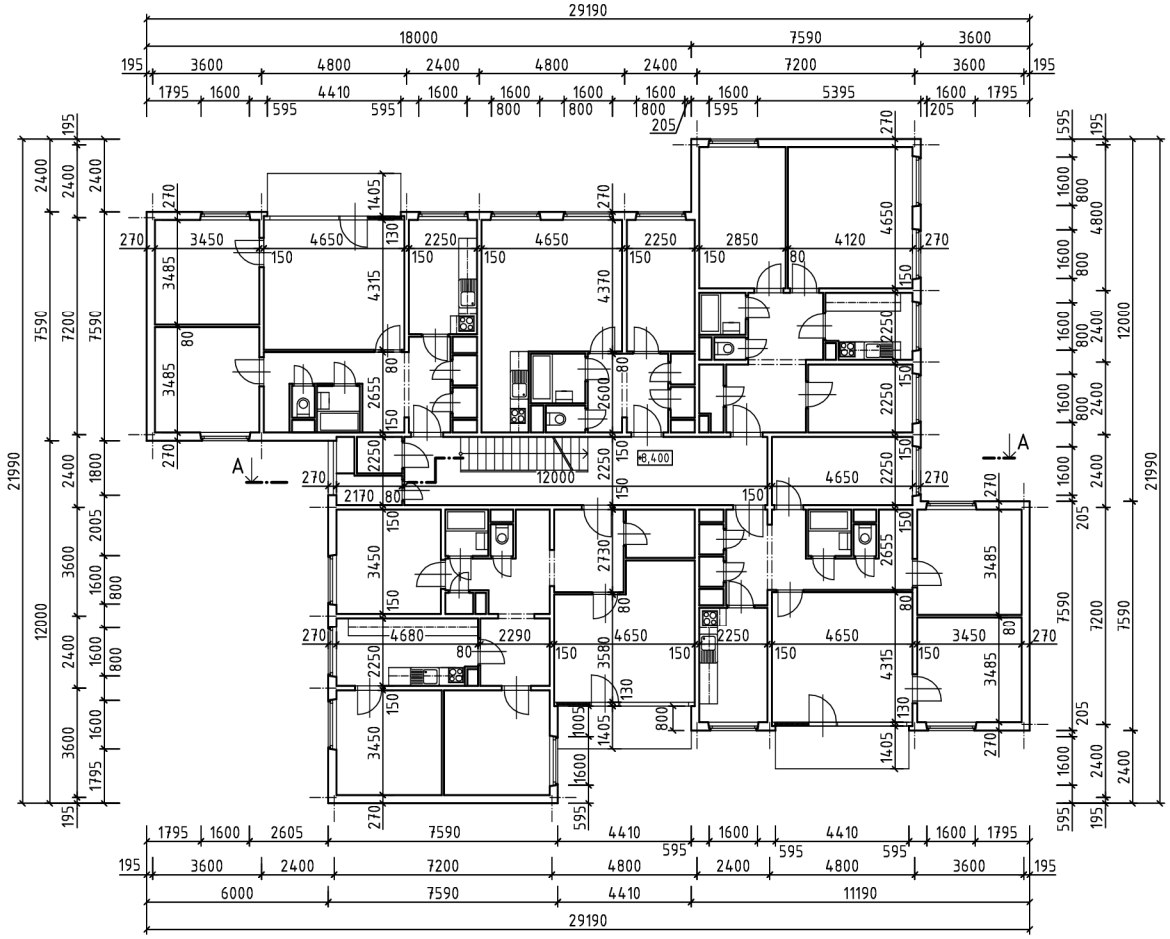
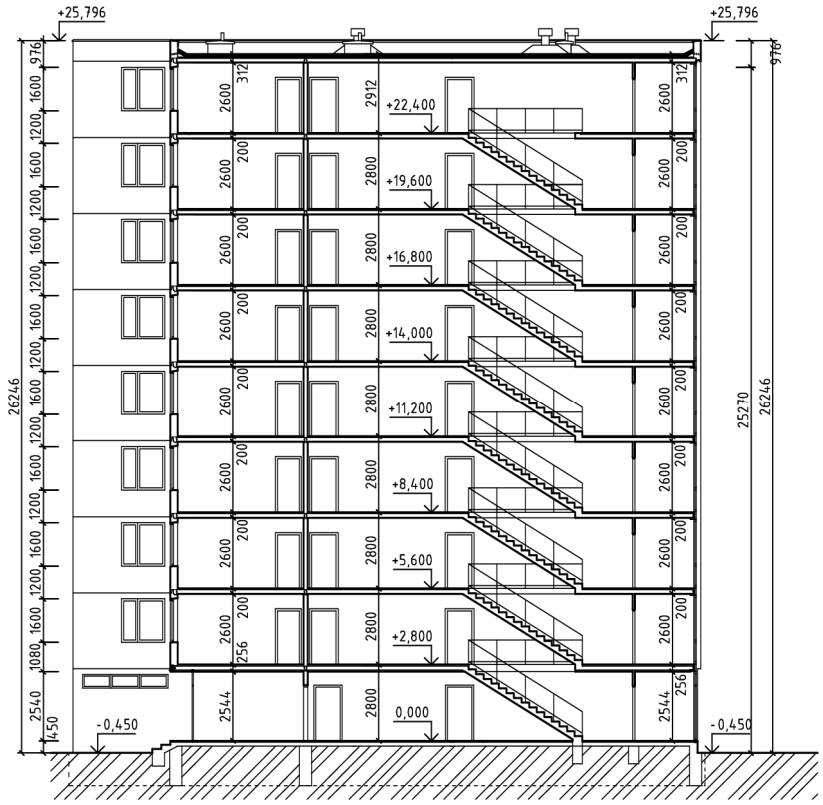
Structural system B 70 - detached house
Floor plan

Description of the evaluated building
The evaluated apartment house is built in the structural system B 70. It is a detached house. It has 8 living floors with flats and an entrance floor. The module of load-bearing walls is 2400, 3600 and 4800 mm. The construction height is 2800 mm. The building has a flat roof. External wall panels consist of reinforced concrete load-bearing wall with the thickness of 150 mm, polystyrene foam boards of 60 mm and reinforced concrete membrane of 60 mm. The thickness of internal load-bearing reinforced concrete walls and ceiling panels is 150 mm. The building has wooden windows with double glazing and steel windows in the staircasse space.

Table 1.2 – Cross-section and front view of detached house of structural system B 70

Structural system B 70 - detached house
Cross-section

Front view


2 Evaluation of Hygienic Criterion and Calculation of the Linear Thermal Transmittance of Selected Details of the Building

Table 4.25.1 – Marking of the position of detail in the building – detail 25

DETAIL 25
Floor plan

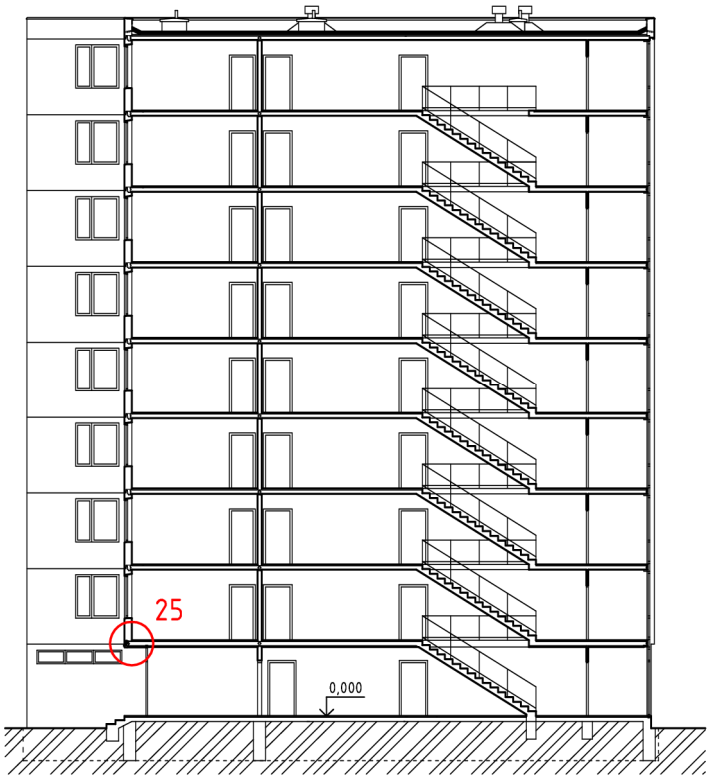
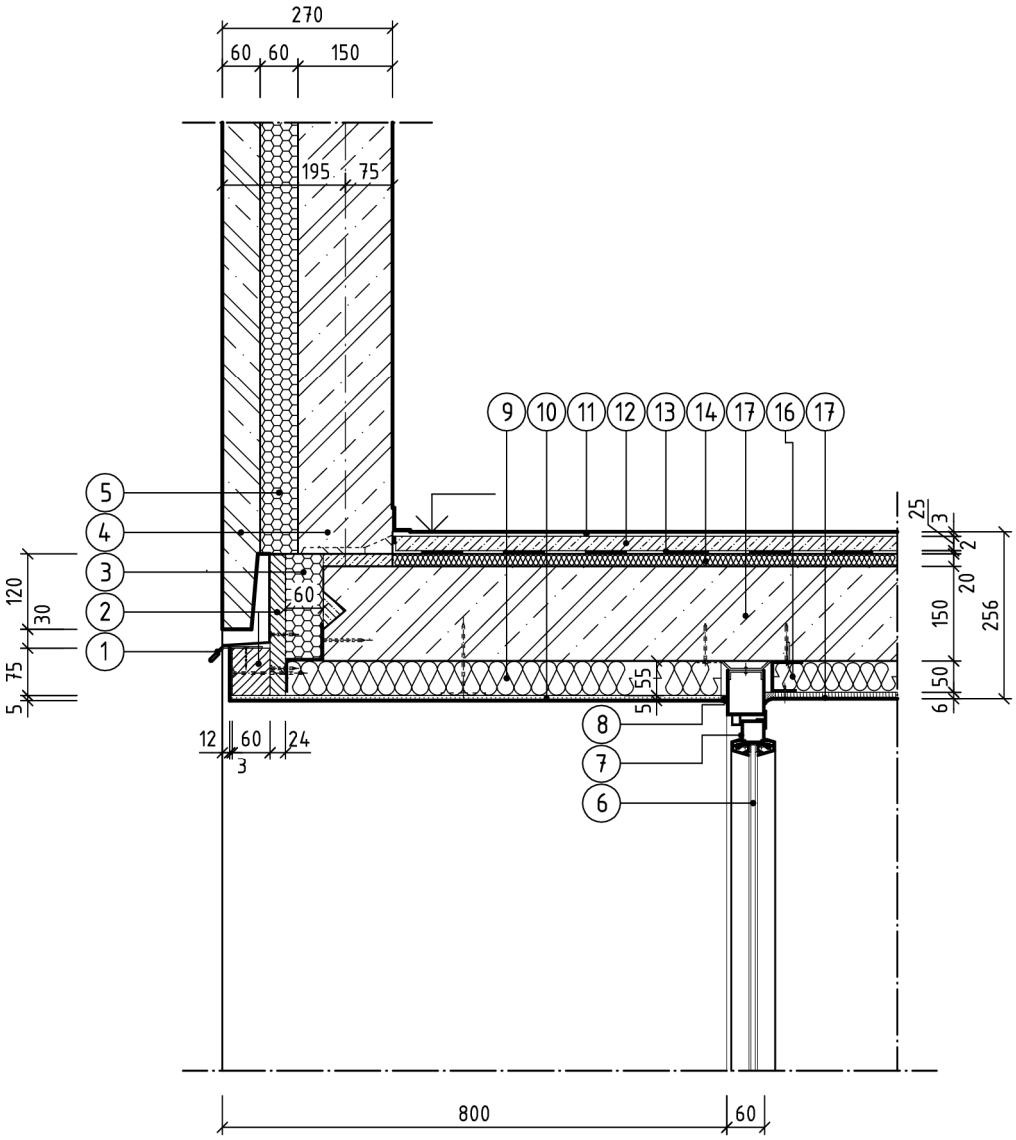
Section A-A


Table 4.25.2 – Structural composition of detail 25

DETAIL 25



Legend:

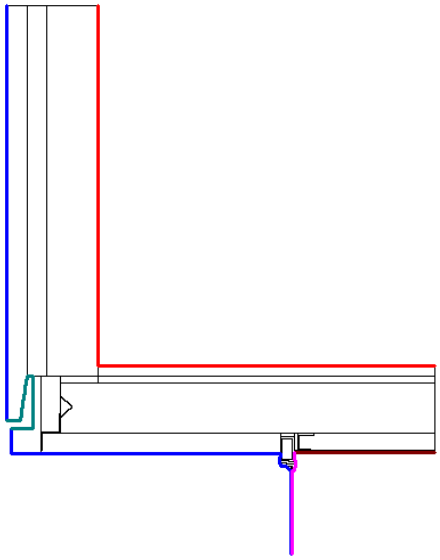
1. Galvanized sheet metal (not considered in model)
2. Wooden board and balk (λ = 0.18 W/(m.K))
3. Polystyrene foam (λ = 0.044 W/(m.K))
4. Reinforced concrete (λ = 1.58 W/(m.K))
5. Polystyrene foam (λ = 0.07 W/(m.K))
6. PVC + adhesive (λ = 0.16 W/(m.K))
7. Cement coating (λ = 1.02 W/(m.K))
8. Tar paper (λ = 0.21 W/(m.K))
9. Boards LIGNOPOR (λ = 0.047 W/(m.K))
10. Plaster UNIFAS (λ = 0.99 W/(m.K))
11. PVC + adhesive (λ = 0.16 W/(m.K))
12. Cement coating (λ = 1.16 W/(m.K))
13. Tar paper (λ = 0.21 W/(m.K))
14. Boards FIBREX (λ = 0.052 W/(m.K))
15. Reinforc. concrete ceiling panel (λ = 1.58 W/(m.K))
16. Basalt felt (λ = 0.06 W/(m.K))
17. Particle boards (λ = 0.22 W/(m.K))

$U_{wall,1}$ = 0.862 W/(m^2.K) **$U_{ceiling}$ = 0.522 W/(m^2.K)** **U_{floor} = 0.566 W/(m^2.K)**

Table 4.25.3 – Boundary conditions for a calculation detail 25

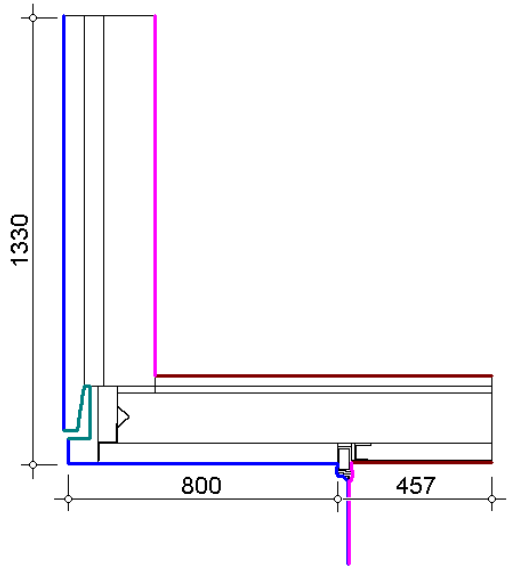
DETAIL 25

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior	Bound. condit. for unheated space
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W R_{se} = 0.08 m^2.K/W	θ_e = 2.5 °C φ_e = 60 % R_{se} = 0.17 m^2.K/W R_{se} = 0.13 m^2.K/W

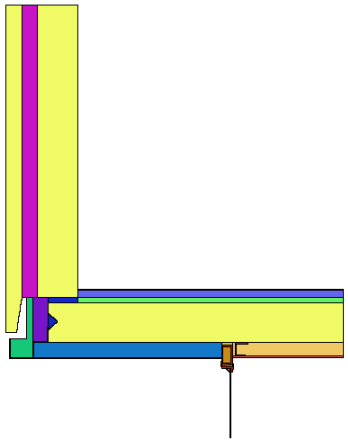
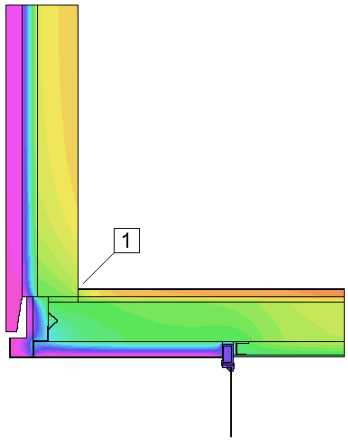
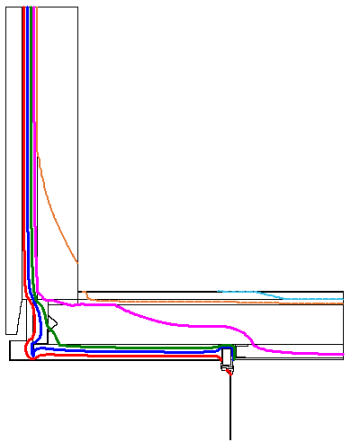
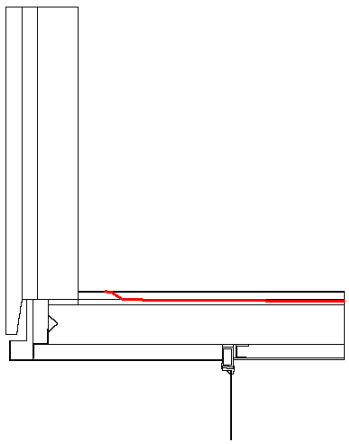
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior	Bound. condit. for unheated space
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.17 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W R_{se} = 0.08 m^2.K/W	θ_e = 2.5 °C φ_e = 60 % R_{se} = 0.17 m^2.K/W R_{se} = 0.13 m^2.K/W

Table 4.25.4 – Thermal-technical evaluation of detail 25

DETAIL 25

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 0.220 W/(m.K) λ = 0.060 W/(m.K) λ = 1.580 W/(m.K) λ = 0.052 W/(m.K) λ = 0.210 W/(m.K) λ = 1.160 W/(m.K) λ = 0.160 W/(m.K) λ = 50.00 W/(m.K) λ = 0.500 W/(m.K) λ = 0.050 W/(m.K) λ = 1.000 W/(m.K) λ = 0.990 W/(m.K) λ = 0.047 W/(m.K) λ = 1.360 W/(m.K) λ = 0.044 W/(m.K) λ = 0.070 W/(m.K) λ = 0.180 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
 -10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	 13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 7.94 °C	-	θ_{si} = 7.94 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
			NOTE: For more than two boundary conditions it is not possible to use the temperature factor. In calculation of ψ the value b_x is used.	
Lin. thermal transmittance	ψ = 2.61151 - 0.862 × 1.330 - 0.522 × 0.800 - 0.566 × 0.457 × 0.5 = 0.918 W/(m.K)			

Table 4.26.1 – Marking of the position of detail in the building – detail 26

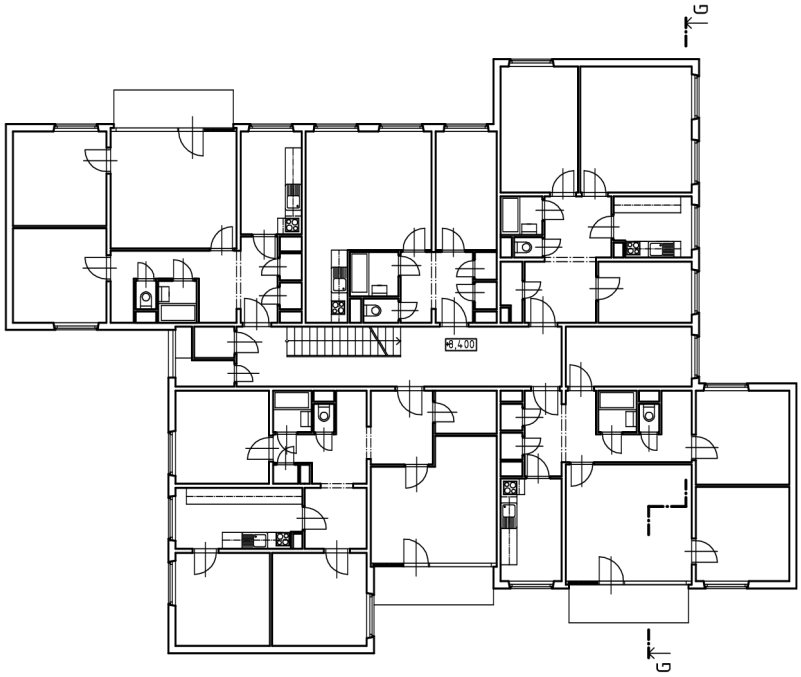
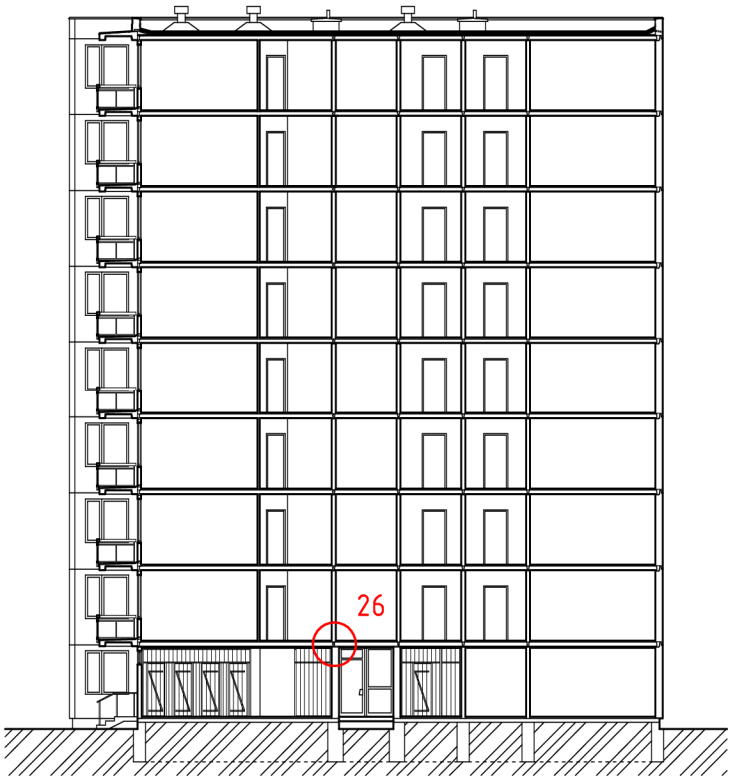
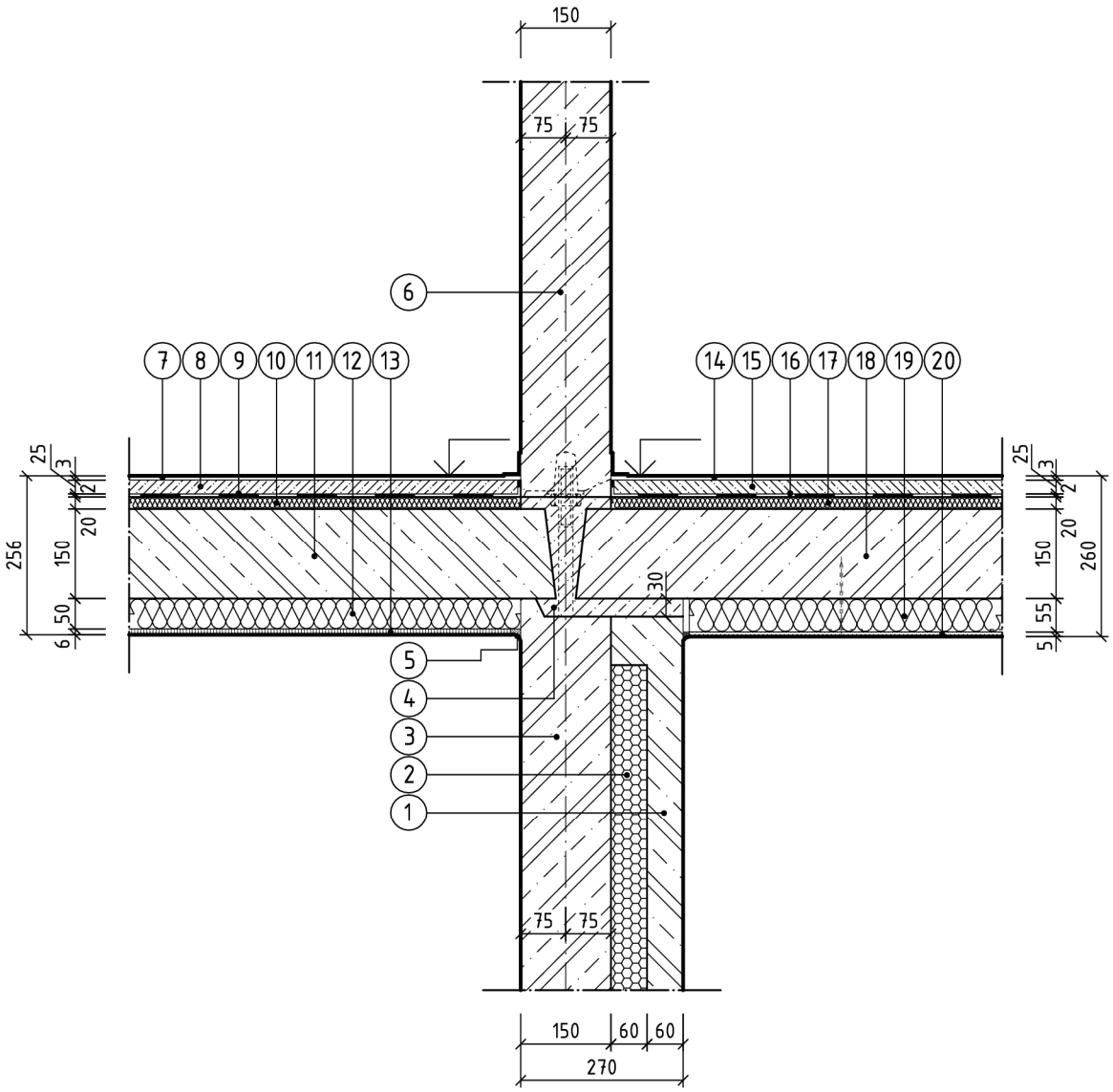
DETAIL 26
Floor plan

Section G-G


Table 4.26.2 – Structural composition of detail 26

DETAIL 26



Legend:

1. Reinforced concrete (λ = 1.58 W/(m.K))
2. Polystyrene foam (λ = 0.07 W/(m.K))
3. Reinforced concrete (λ = 1.58 W/(m.K))
4. Concrete grout (λ = 1.36 W/(m.K))
5. Sealant (λ = 0.22 W/(m.K))
6. Reinforced concrete (λ = 1.34 W/(m.K))
7. PVC + adhesive (λ = 0.16 W/(m.K))
8. Cement coating (λ = 1.02 W/(m.K))
9. Tar paper (λ = 0.21 W/(m.K))
10. Boards FIBREX (λ = 0.05 W/(m.K))
11. Reinforc. concrete ceiling panel (λ = 1.34 W/(m.K))
12. Basalt felt (λ = 0.06 W/(m.K))
13. Particle boards (λ = 0.22 W/(m.K))
14. PVC + adhesive (λ = 0.16 W/(m.K))
15. Cement coating (λ = 1.16 W/(m.K))
16. Tar paper (λ = 0.21 W/(m.K))
17. Boards FIBREX (λ = 0.052 W/(m.K))
18. Reinforc. concrete ceiling panel (λ = 1.58 W/(m.K))
19. Boards LIGNOPOR (λ = 0.047 W/(m.K))
20. Plaster UNIFAS (λ = 0.99 W/(m.K))

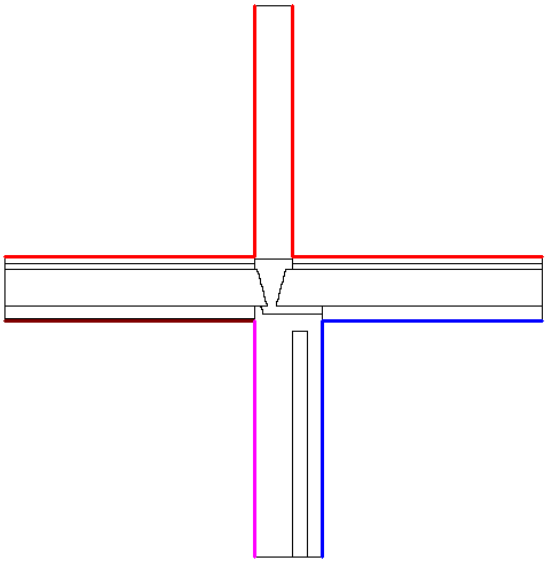
U_{floor} = 0.566 W/(m^2.K)

$U_{ceiling}$ = 0.522 W/(m^2.K)

Table 4.26.3 – Boundary conditions for a calculation detail 26

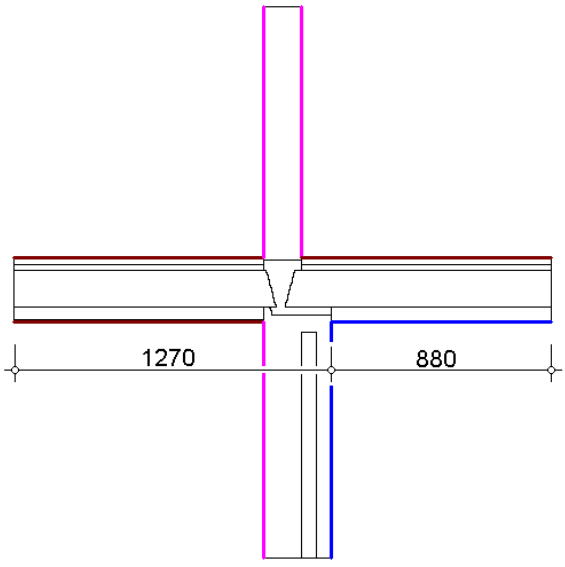
DETAIL 26

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior	Bound. condit. for unheated space
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W	θ_e = 2.5 °C φ_e = 60 % R_{se} = 0.17 m^2.K/W R_{se} = 0.13 m^2.K/W

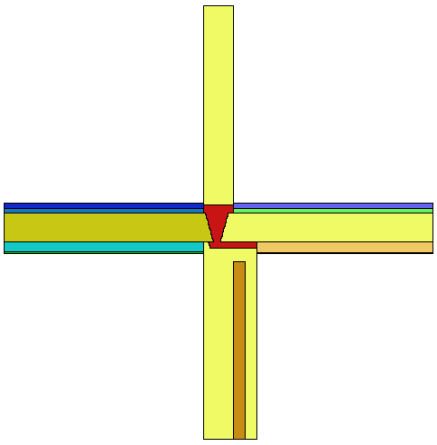
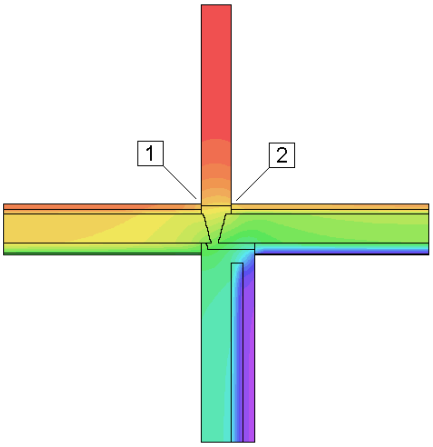
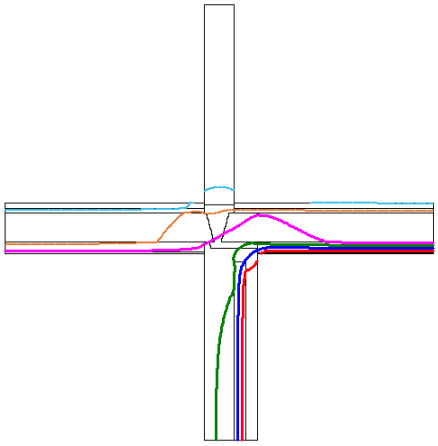
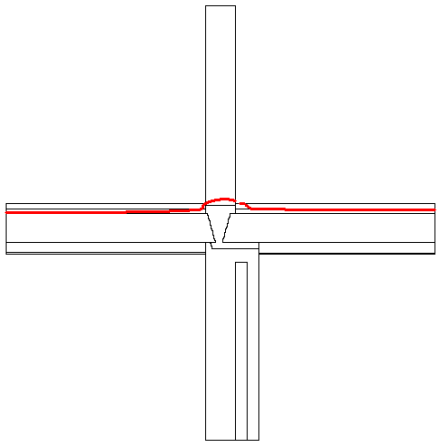
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior	Bound. condit. for unheated space
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.17 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W	θ_e = 2.5 °C φ_e = 60 % R_{se} = 0.17 m^2.K/W R_{se} = 0.13 m^2.K/W

Table 4.26.4 – Thermal-technical evaluation of detail 26

DETAIL 26

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 0.990 W/(m.K) λ = 0.047 W/(m.K) λ = 1.580 W/(m.K) λ = 0.052 W/(m.K) λ = 0.210 W/(m.K) λ = 1.160 W/(m.K) λ = 0.160 W/(m.K) λ = 1.360 W/(m.K) λ = 0.070 W/(m.K) λ = 1.340 W/(m.K) λ = 0.220 W/(m.K) λ = 0.060 W/(m.K) λ = 0.050 W/(m.K) λ = 1.020 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 13.21 °C	-	θ_{si} = 12.51 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 12.51 °C	-	**NOTE:** For more than two boundary conditions it is not possible to use the temperature factor. In calculation of ψ the value b_x is used.	
Linear thermal transmittance			ψ = 1.28959 - 0.522 × 0.880 - 0.566 × 1.270 × 0.5 = 0.471 W/(m.K)	

Table 4.27.1 – Marking of the position of detail in the building – detail 27

DETAIL 27
Floor plan

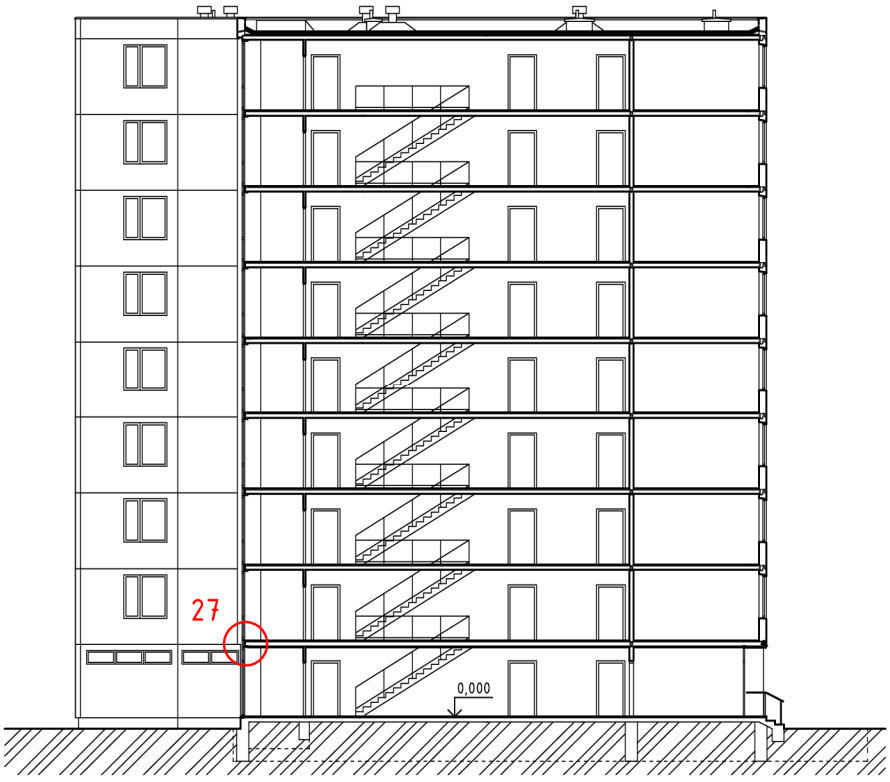
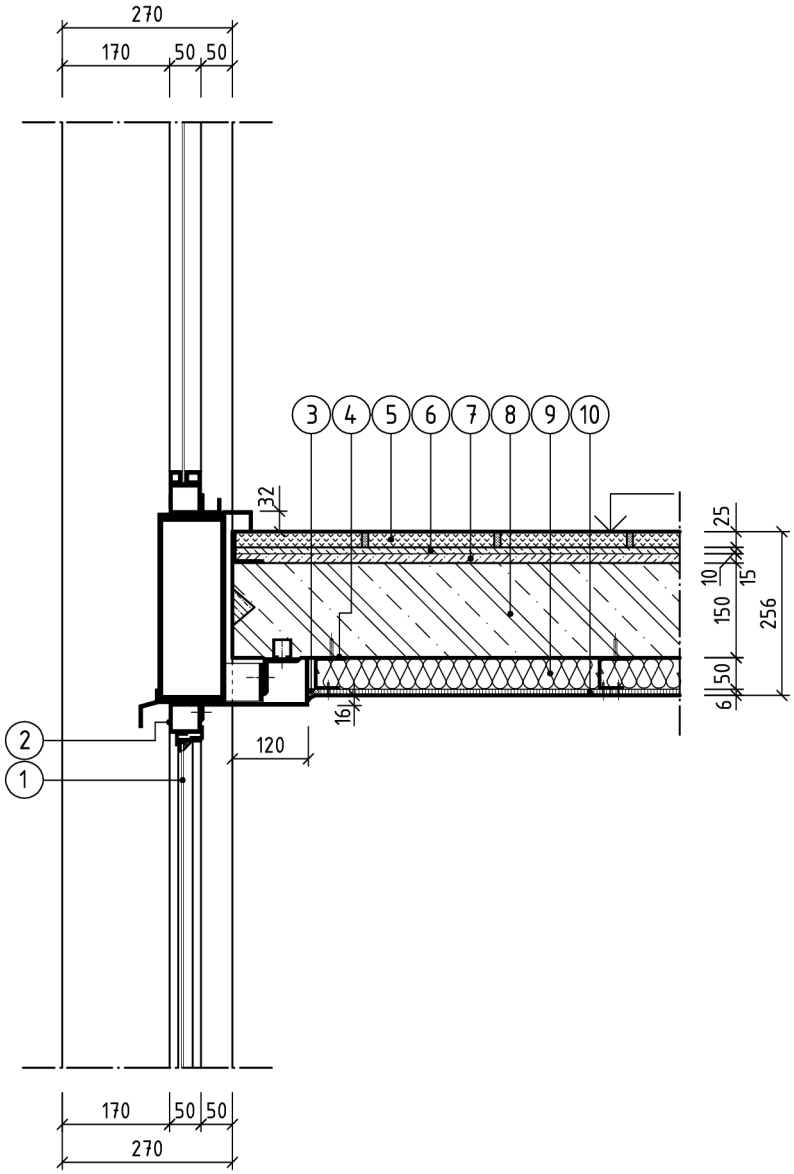
Section I-I


Table 4.27.2 – Structural composition of detail 27

DETAIL 27



Legend:

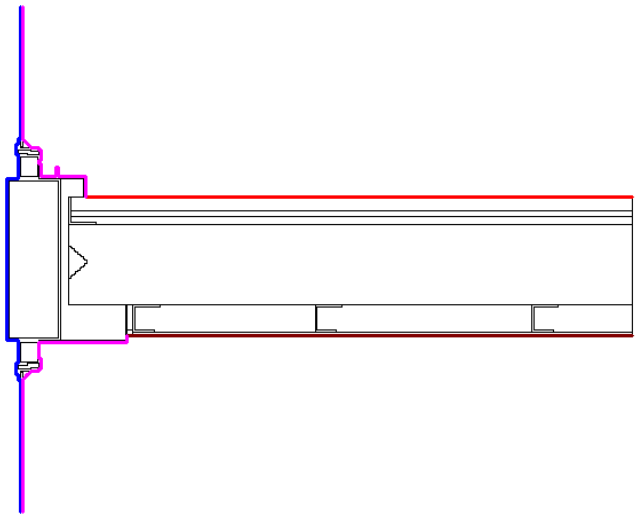
1. Glass 4 mm (λ = 1.00 W/(m.K))
2. Steel window (λ = 50 W/(m.K), λ = 0.5 W/(m.K))
3. Sealant (λ = 0.22 W/(m.K))
4. Steel profile (λ = 40.0 W/(m.K))
5. Ceramic floor tiling (λ = 1.01 W/(m.K))
6. Cement mortar (λ = 1.02 W/(m.K))
7. Concrete coating (λ = 1.05 W/(m.K))
8. Reinforc. concrete ceiling panel (λ = 1.34 W/(m.K))
9. Basalt felt (λ = 0.06 W/(m.K))
10. Particle boards (λ = 0.22 W/(m.K))

$U_{wall,1}$ = 0.862 W/(m^2.K) **$U_{window,\ steel}$ = 6.238 W/(m^2.K)** **U_{floor} = 0.566 W/(m^2.K)**

Table 4.27.3 – Boundary conditions for a calculation detail 27

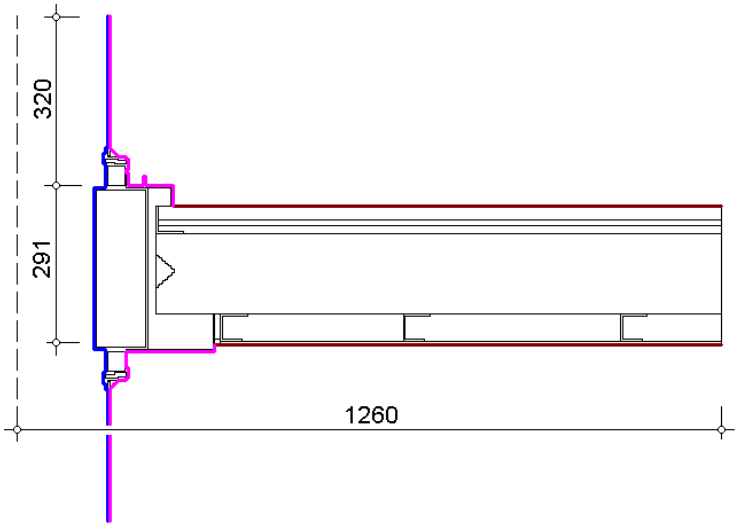
DETAIL 27

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior	Bound. condit. for unheated space
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W	θ_e = 2.5 °C φ_e = 60 % R_{se} = 0.17 m^2.K/W R_{se} = 0.13 m^2.K/W

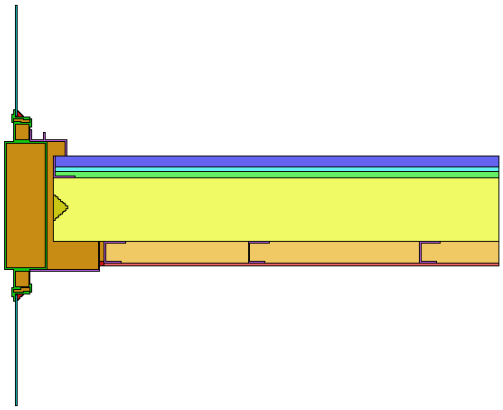
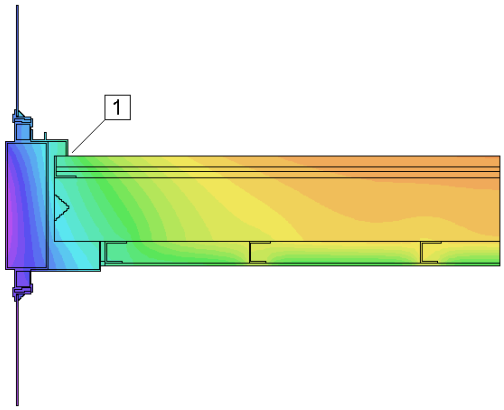
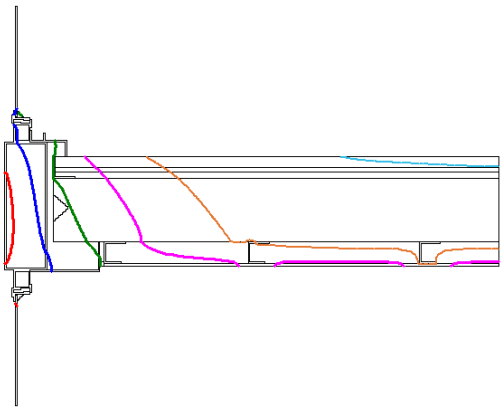
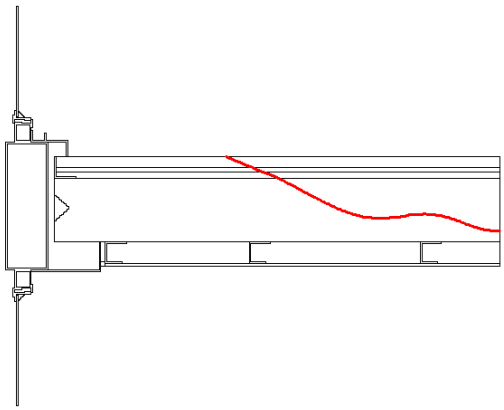
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior	Bound. condit. for unheated space
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.17 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W	θ_e = 2.5 °C φ_e = 60 % R_{se} = 0.17 m^2.K/W R_{se} = 0.13 m^2.K/W

Table 4.27.4 – Thermal-technical evaluation of detail 27

DETAIL 27

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 0.220 W/(m.K) λ = 0.060 W/(m.K) λ = 1.340 W/(m.K) λ = 1.050 W/(m.K) λ = 1.020 W/(m.K) λ = 1.010 W/(m.K) λ = 40.00 W/(m.K) λ = 0.220 W/(m.K) λ = 0.500 W/(m.K) λ = 1.360 W/(m.K) λ = 50.00 W/(m.K) λ = 1.000 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 1.63 °C	-	θ_{si} = 1.63 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
			NOTE: For more than two boundary conditions it is not possible to use the temperature factor. In calculation of ψ the value b_x is used.	
Linear thermal transmittance			ψ = 3.61199 - 0.862 × 0.291 - 6.238 × 0.320 - 0.566 × 1.260 × 0.5 ψ = 1.008 W/(m.K)	

Table 2.28.1 – Marking of the position of detail in the building – detail 28

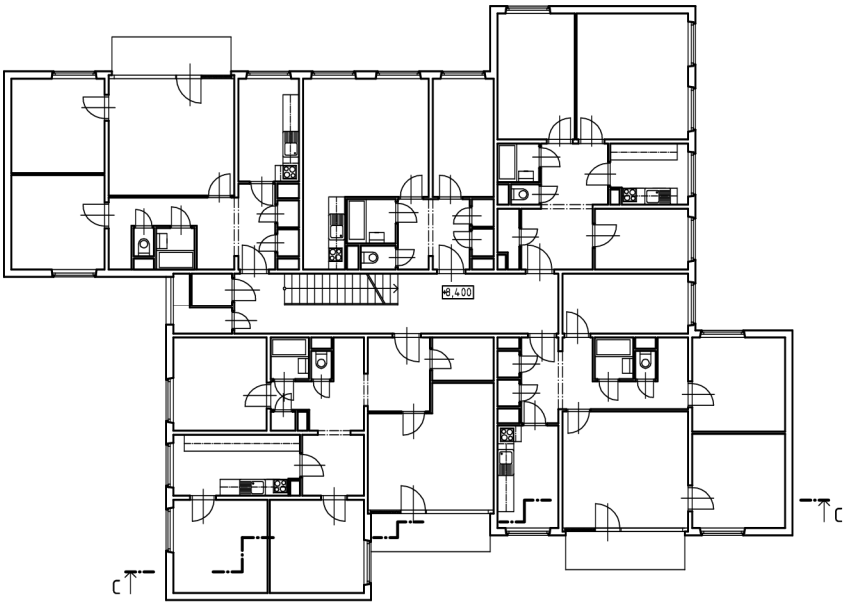
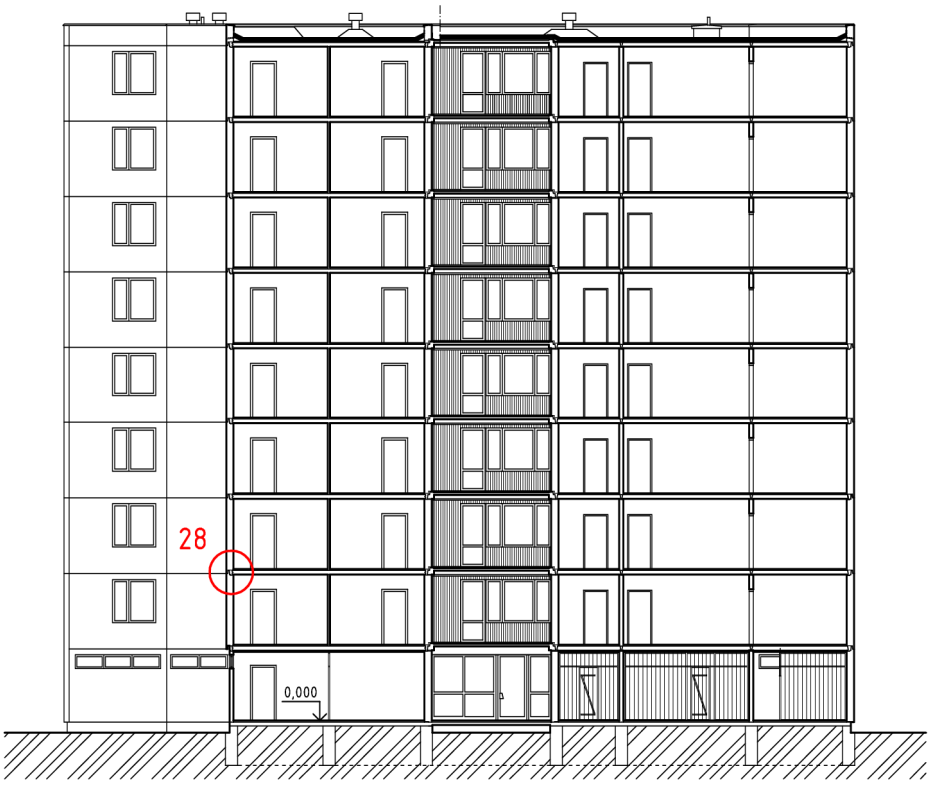
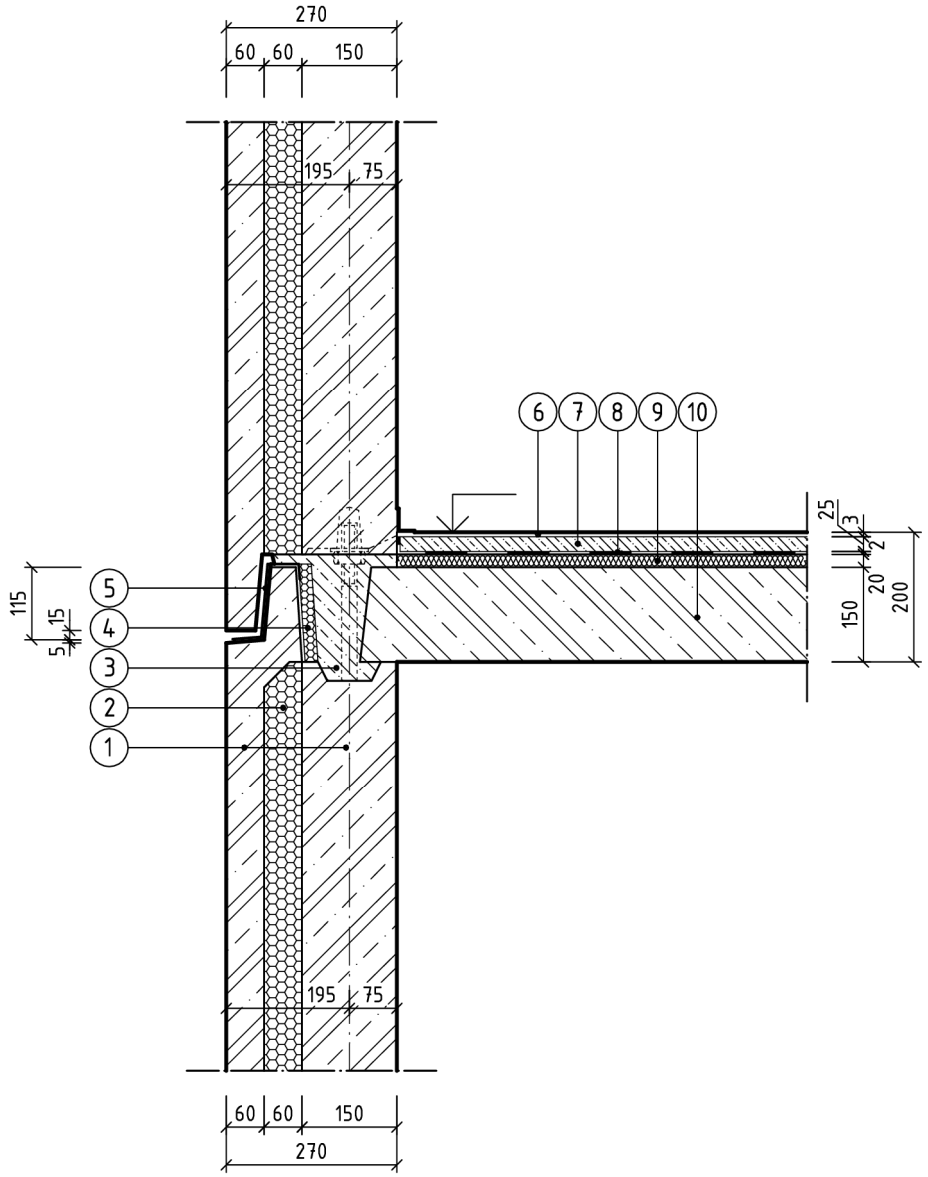
DETAIL 28
Floor plan

Section C-C


Table 2.28.2 – Structural composition of detail 28

DETAIL 28



Legend:

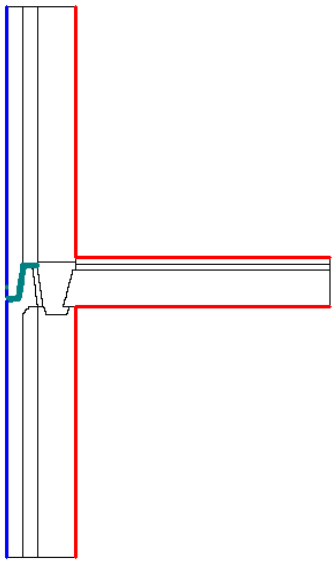
1. Reinforced concrete (λ = 1.58 W/(m.K))
2. Polystyrene foam (λ = 0.07 W/(m.K))
3. Concrete grout (λ = 1.36 W/(m.K))
4. Polystyrene foam th. 20 mm (λ = 0.044 W/(m.K))
5. Galvanized sheet metal (not considered in model)
6. PVC + adhesive (λ = 0.16 W/(m.K))
7. Cement coating (λ = 1.02 W/(m.K))
8. Tar paper (λ = 0.21 W/(m.K))
9. Boards FIBREX (λ = 0.05 W/(m.K))
10. Reinforced concrete ceiling panel (λ = 1.34 W/(m.K))

$U_{wall,1}$ = 0.862 W/(m^2.K)

Table 2.28.3 – Boundary conditions for a calculation of detail 28

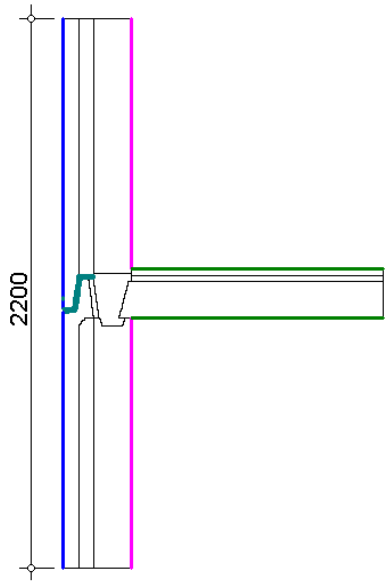
DETAIL 28

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W R_{se} = 0.08 m^2.K/W

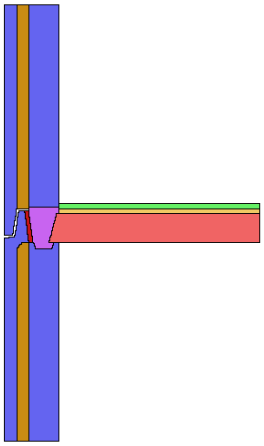
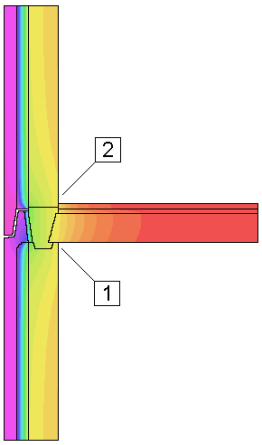
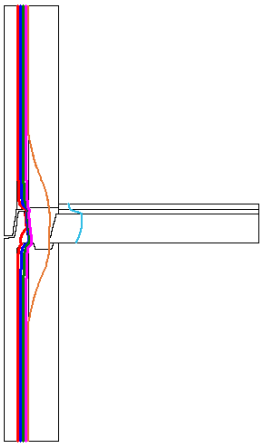
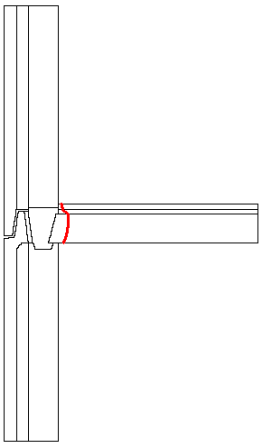
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W R_{se} = 0.08 m^2.K/W

Table 2.28.4 – Thermal-technical evaluation of detail 28

DETAIL 28

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.340 W/(m.K) λ = 0.050 W/(m.K) λ = 0.021 W/(m.K) λ = 1.020 W/(m.K) λ = 0.160 W/(m.K) λ = 1.580 W/(m.K) λ = 1.360 W/(m.K) λ = 0.044 W/(m.K) λ = 0.070 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 11.19 °C	f_{Rsi}= 0.748	θ_{si} = 11.19 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 11.36 °C	f_{Rsi}= 0.753	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance			ψ = 1.94343 - 0.862 × 2.200 = 0.314 W/(m.K)	

Table 2.29.1 – Marking of the position of detail in the building – detail 29

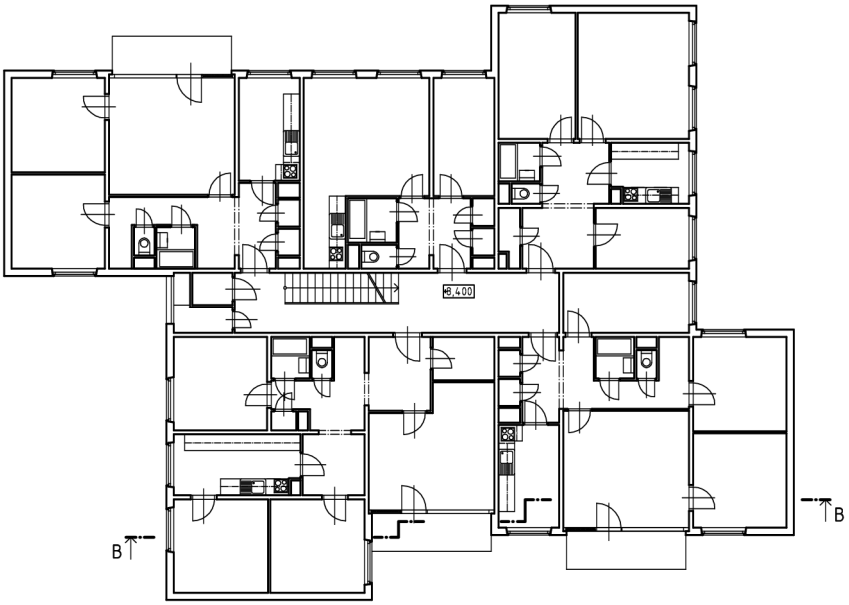
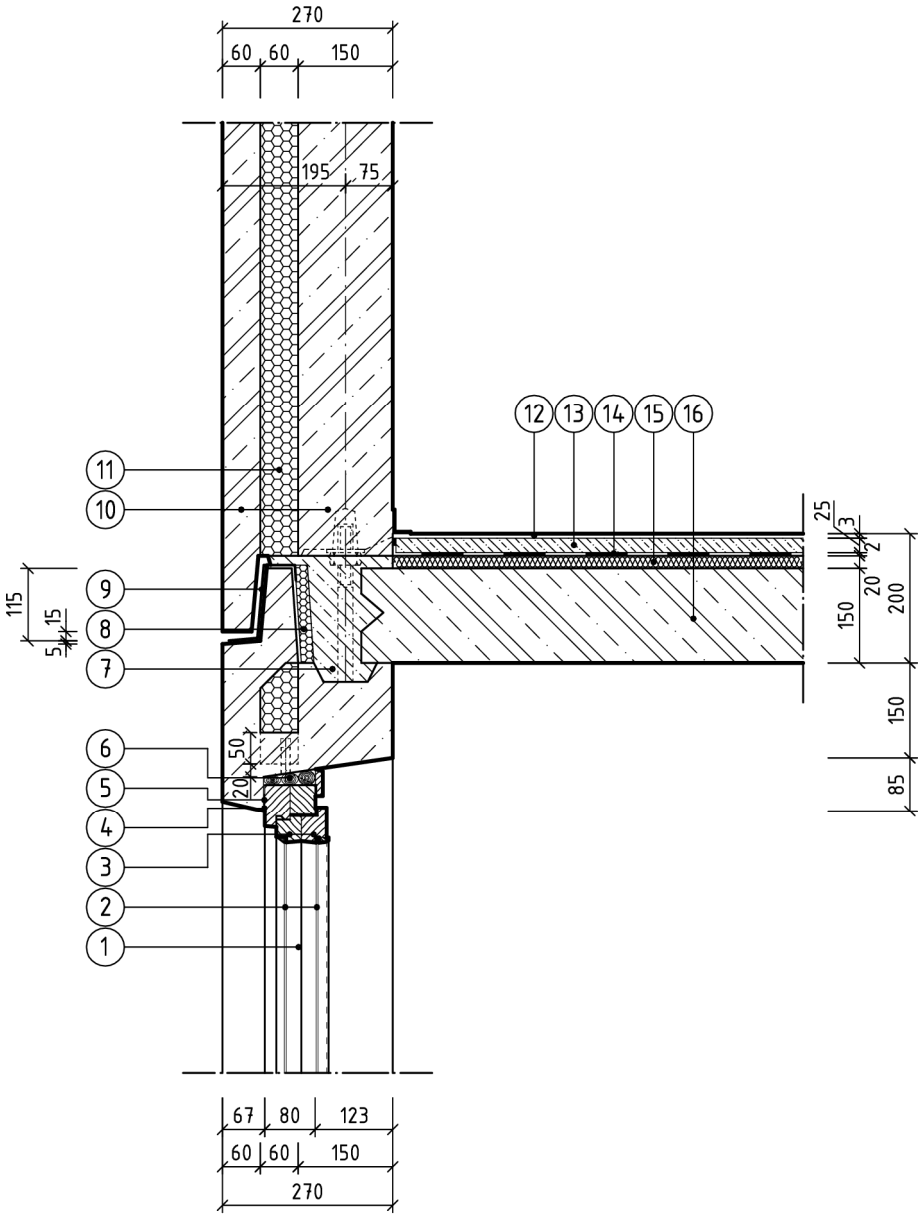
DETAIL 29
Floor plan

Section B-B


Table 2.29.2 – Structural composition of detail 29

DETAIL 29



Legend:

1. Closed air gap 37 mm (λ = 0.204 W/(m.K))
2. Glass 3 mm (λ = 1.00 W/(m.K))
3. Wooden double glazed window (λ = 0.18 W/(m.K))
4. Sealant (λ = 0.22 W/(m.K))
5. Microporous rubber (λ = 0.06 W/(m.K))
6. Seal - glass wool (λ = 0.07 W/(m.K))
7. Concrete grout (λ = 1.36 W/(m.K))
8. Polystyrene foam th. 20 mm (λ = 0.044 W/(m.K))
9. Galvanized sheet metal (not considered in model)
10. Reinforced concrete (λ = 1.58 W/(m.K))
11. Polystyrene foam (λ = 0.07 W/(m.K))
12. PVC + adhesive (λ = 0.16 W/(m.K))
13. Cement coating (λ = 1.02 W/(m.K))
14. Tar paper (λ = 0.21 W/(m.K))
15. Boards FIBREX (λ = 0.05 W/(m.K))
16. Reinforced concrete ceiling panel (λ = 1.34 W/(m.K))

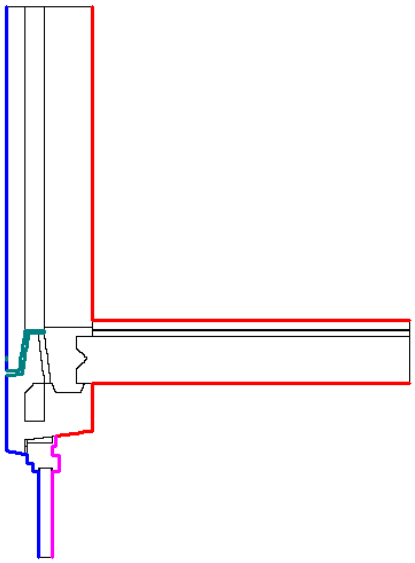
$U_{wall,1}$ = 0.862 W/(m^2.K)

$U_{window,\ wooden}$ = 2.579 W/(m^2.K)

Table 2.29.3 – Boundary conditions for a calculation of detail 29

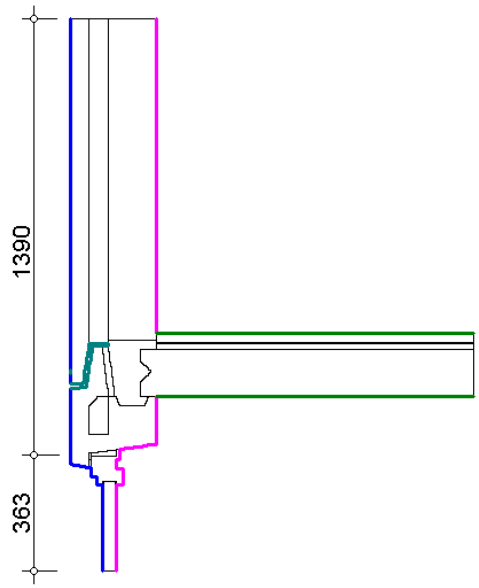
DETAIL 29

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W R_{se} = 0.08 m^2.K/W

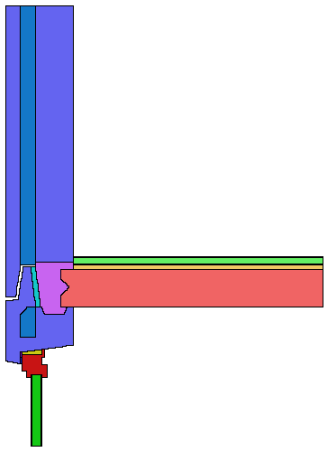
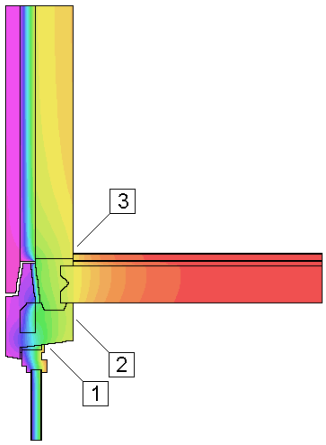
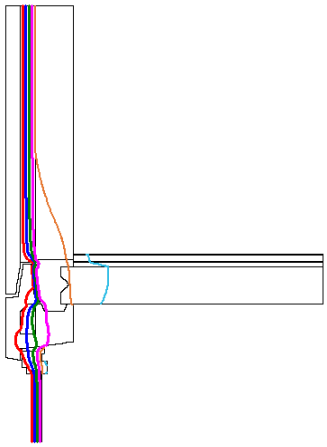
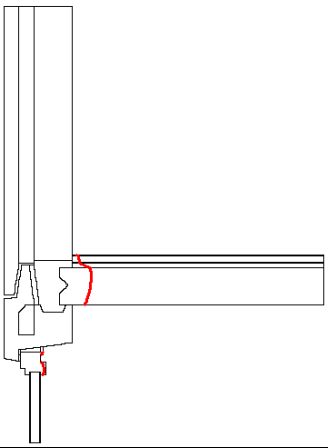
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W R_{se} = 0.08 m^2.K/W

Table 2.29.4 – Thermal-technical evaluation of detail 29

DETAIL 29

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.340 W/(m.K) λ = 0.050 W/(m.K) λ = 0.210 W/(m.K) λ = 1.020 W/(m.K) λ = 0.160 W/(m.K) λ = 1.580 W/(m.K) λ = 1.360 W/(m.K) λ = 0.180 W/(m.K) λ = 1.000 W/(m.K) λ = 0.070 W/(m.K) λ = 0.204 W/(m.K) λ = 0.044 W/(m.K) λ = 0.070 W/(m.K) λ = 0.220 W/(m.K) λ = 0.060 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 4.42 °C	f_{Rsi}= 0.555	θ_{si} = 4.42 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 9.06 °C	f_{Rsi}= 0.687	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
3	θ_{si} = 10.85 °C	f_{Rsi}= 0.739		
Linear thermal transmittance			ψ = 2.75578 - 0.862 × 1.390 - 2.579 × 0.363 = 0.621 W/(m.K)	

Table 2.30.1 – Marking of the position of detail in the building – detail 30

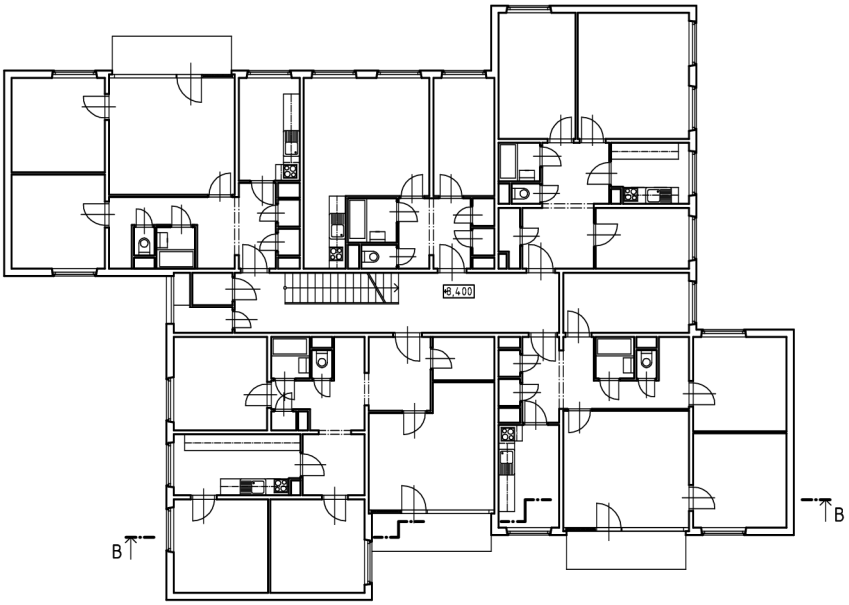
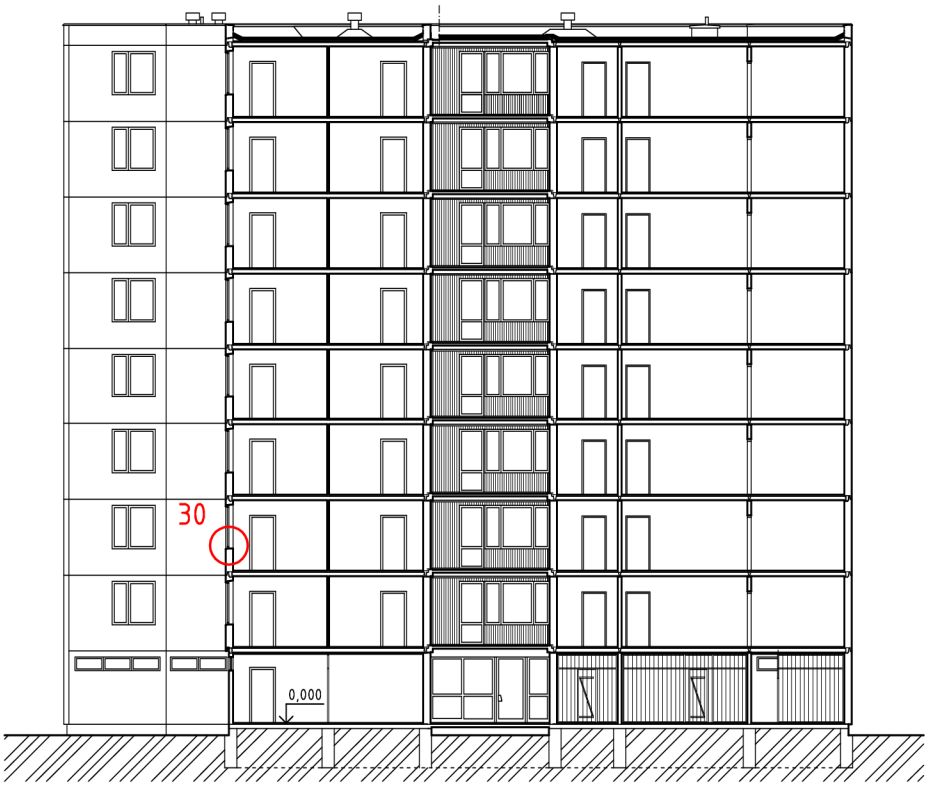
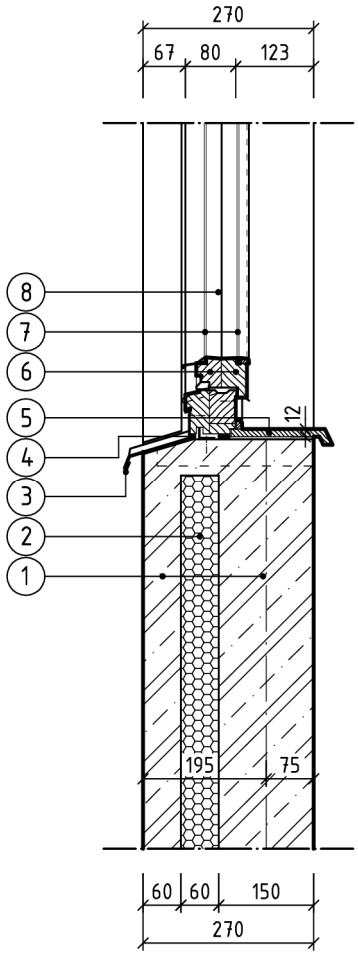
DETAIL 30
Floor plan

Section B-B


Table 2.30.2 – Structural composition of detail 30

DETAIL 30



Legend:

1. Reinforced concrete (λ = 1.58 W/(m.K))
2. Polystyrene foam (λ = 0.07 W/(m.K))
3. Sheet metal covering (not considered in model)
4. Seal - glass wool (λ = 0.07 W/(m.K))
5. Internal window sill (λ = 0.18 W/(m.K))
6. Wooden double glazed window (λ = 0.18 W/(m.K))
7. Glass 3 mm (λ = 1.00 W/(m.K))
8. Closed air gap 37 mm (λ = 0.204 W/(m.K))

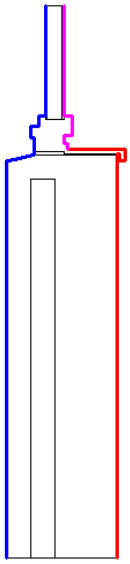
$U_{wall,1}$ = 0.862 W/(m^2.K)

$U_{window,\ wooden}$ = 2.579 W/(m^2.K)

Table 2.30.3 – Boundary conditions for a calculation of detail 30

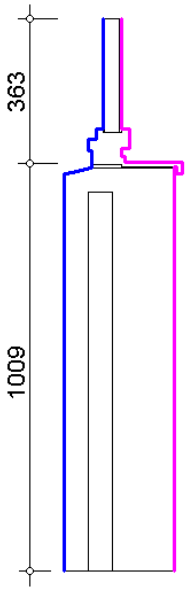
DETAIL 30

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

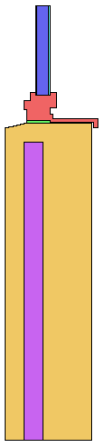
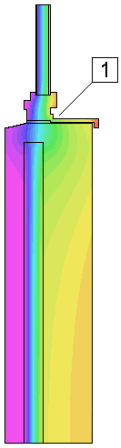
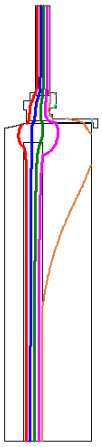
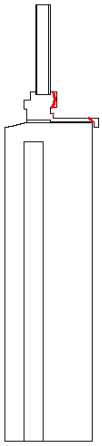
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.30.4 – Thermal-technical evaluation of detail 30

DETAIL 30

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 0.180 W/(m.K) λ = 1.580 W/(m.K) λ = 1.160 W/(m.K) λ = 0.070 W/(m.K) λ = 1.000 W/(m.K) λ = 0.204 W/(m.K) λ = 0.070 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
 -10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	 13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 8.16 °C	f_{Rsi}= 0.662	θ_{si} = 8.16 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
			$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance			ψ = 2.16985 - 0.862 × 1.009 - 2.579 × 0.363 = 0.364 W/(m.K)	

Table 2.31.1 – Marking of the position of detail in the building – detail 31

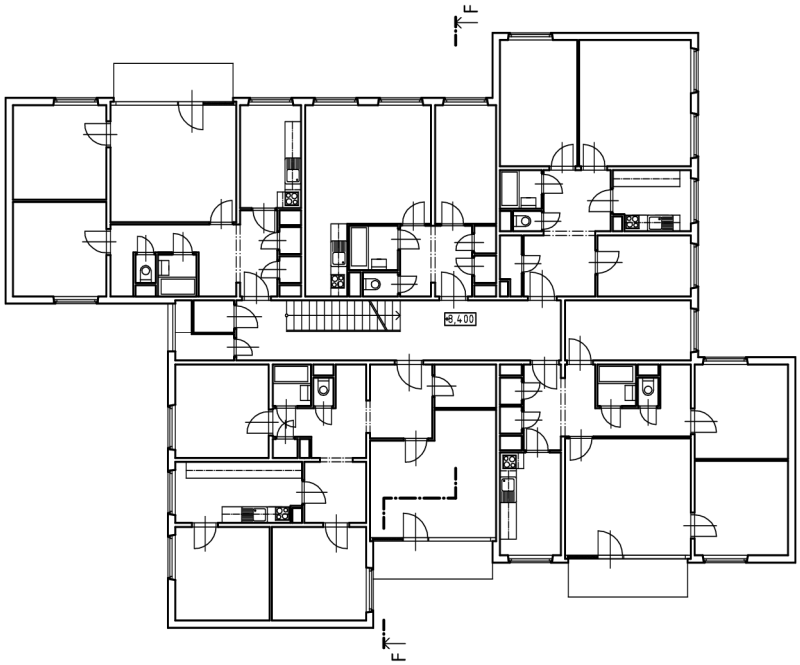
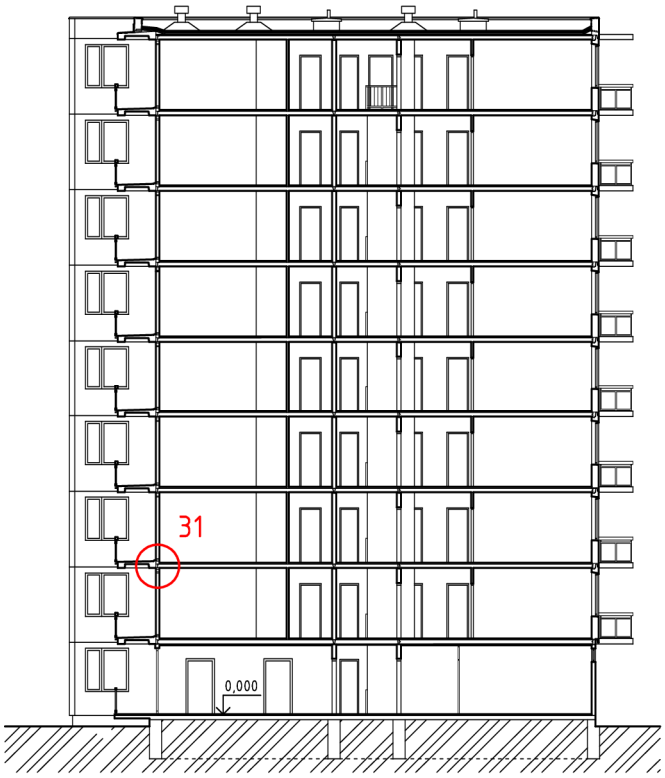
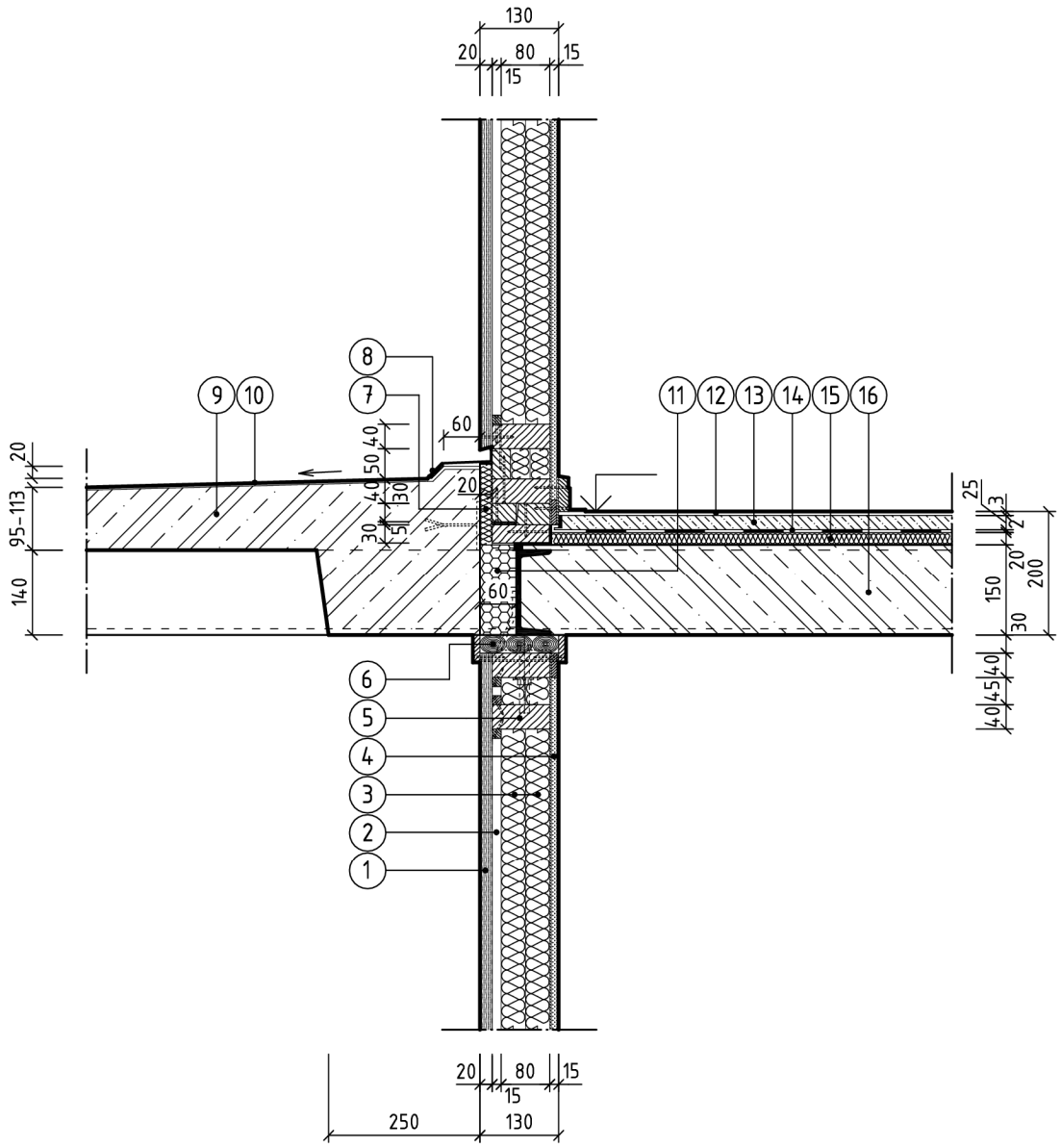
DETAIL 31
Floor plan

Section F-F


Table 2.31.2 – Structural composition of detail 31

DETAIL 31



Legend:

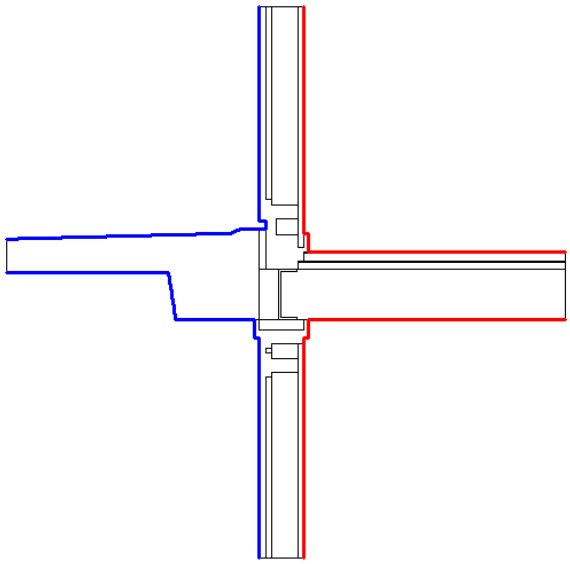
1. Batten siding (λ = 0.18 W/(m.K))
2. Closed air gap (λ = 0.09 W/(m.K))
3. Basalt wool (λ = 0.07 W/(m.K))
4. Particle board (λ = 0.11 W/(m.K))
5. Wooden frame (λ = 0.18 W/(m.K))
6. Seal - glass wool (λ = 0.07 W/(m.K))
7. Polystyrene foam th. 20 mm (λ = 0.044 W/(m.K))
8. Galvanized sheet metal (not considered in model)
9. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))
10. Coating (not considered in model)
11. Polystyrene foam (λ = 0.044 W/(m.K))
12. PVC + adhesive (λ = 0.16 W/(m.K))
13. Cement coating (λ = 1.02 W/(m.K))
14. Tar paper (λ = 0.21 W/(m.K))
15. Boards FIBREX (λ = 0.05 W/(m.K))
16. Reinforced concrete ceiling panel (λ = 1.34W/(m.K))

$U_{wall,2}$ = 0.579 W/(m^2.K)

Table 2.31.3 – Boundary conditions for a calculation of detail 31

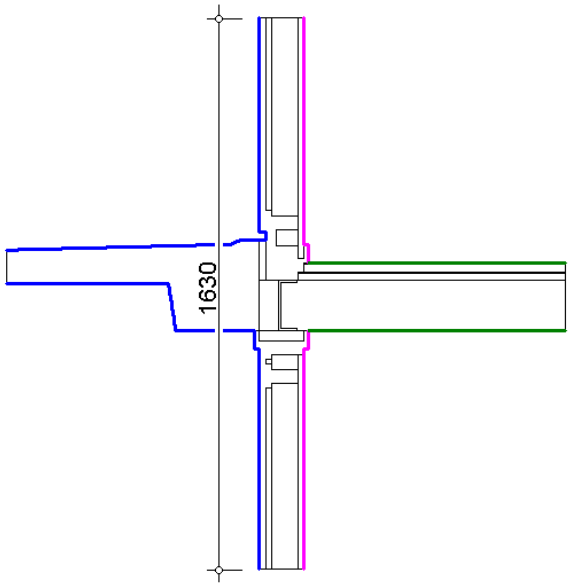
DETAIL 31

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

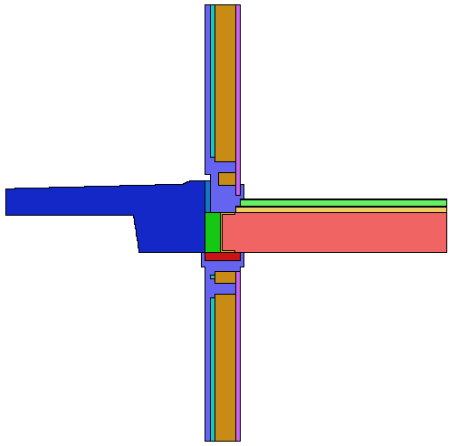
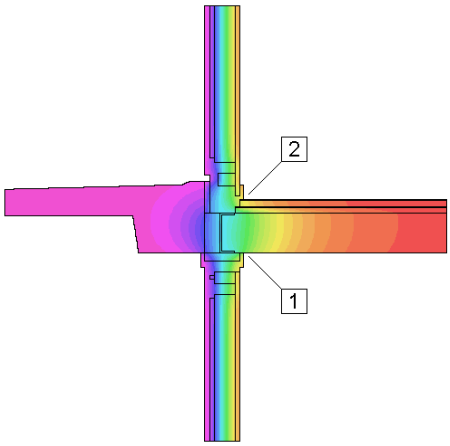
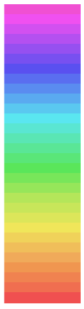
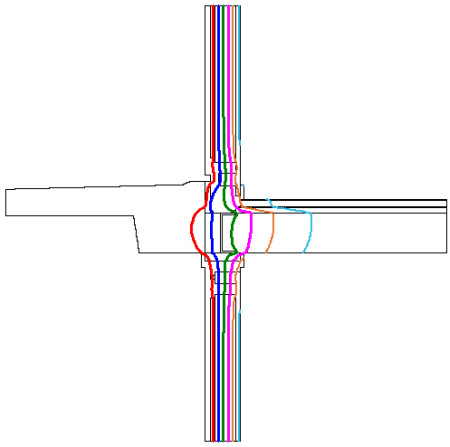
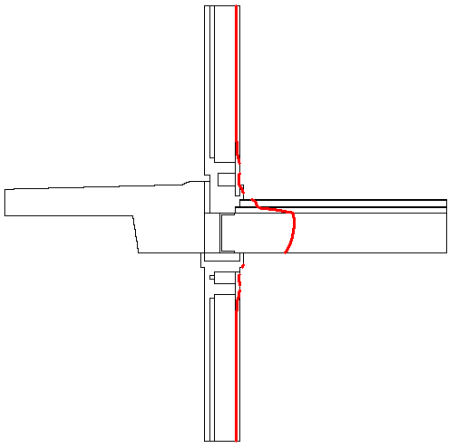
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.31.4 – Thermal-technical evaluation of detail 31

DETAIL 31

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.340 W/(m.K) λ = 0.050 W/(m.K) λ = 0.210 W/(m.K) λ = 1.020 W/(m.K) λ = 0.160 W/(m.K) λ = 0.180 W/(m.K) λ = 0.110 W/(m.K) λ = 0.070 W/(m.K) λ = 0.070 W/(m.K) λ = 40.00 W/(m.K) λ = 1.360 W/(m.K) λ = 0.090 W/(m.K) λ = 0.044 W/(m.K) λ = 1.580 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 4.44 °C	f_{Rsi}= 0.555	θ_{si} = 4.44 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 11.51 °C	f_{Rsi}= 0.757	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance			ψ = 1.57654 - 0.579 × 1.630 = 0.633 W/(m.K)	

Table 2.32.1 – Marking of the position of detail in the building – detail 32

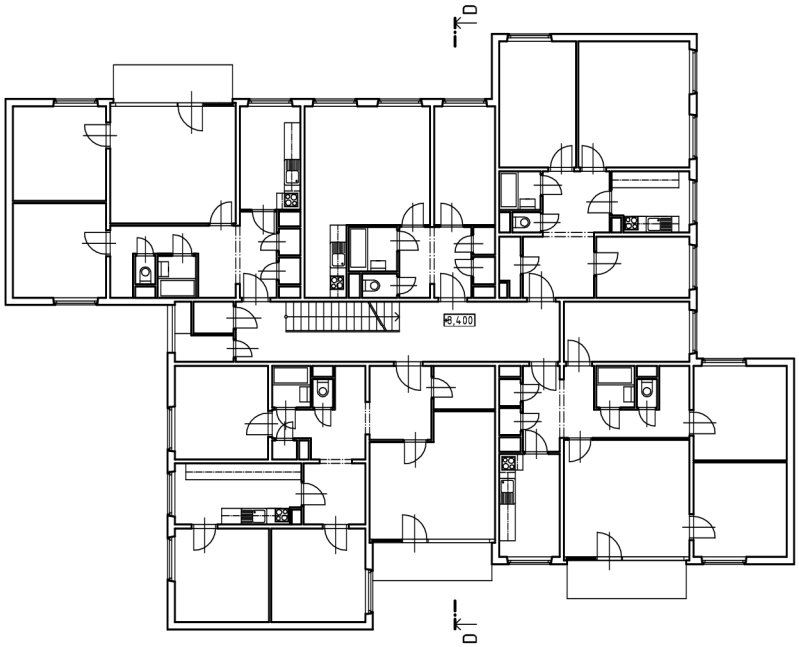
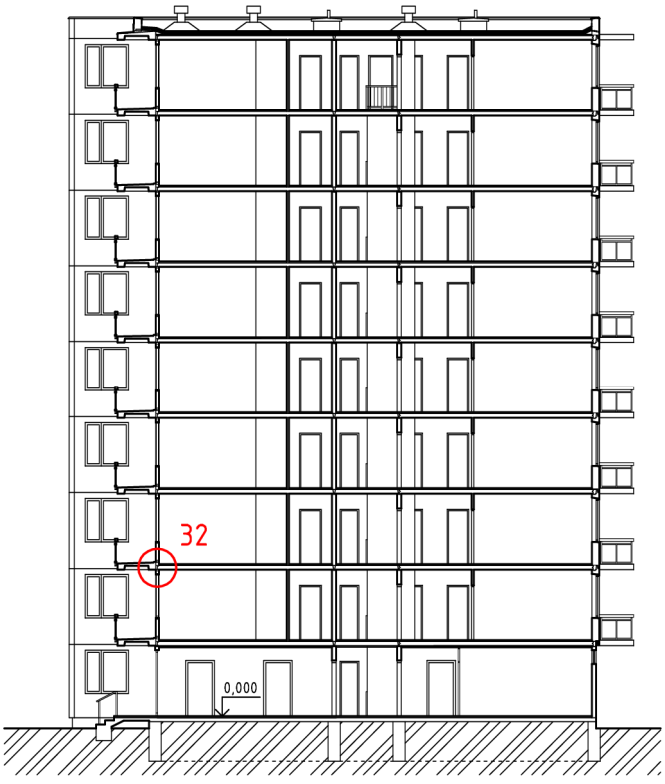
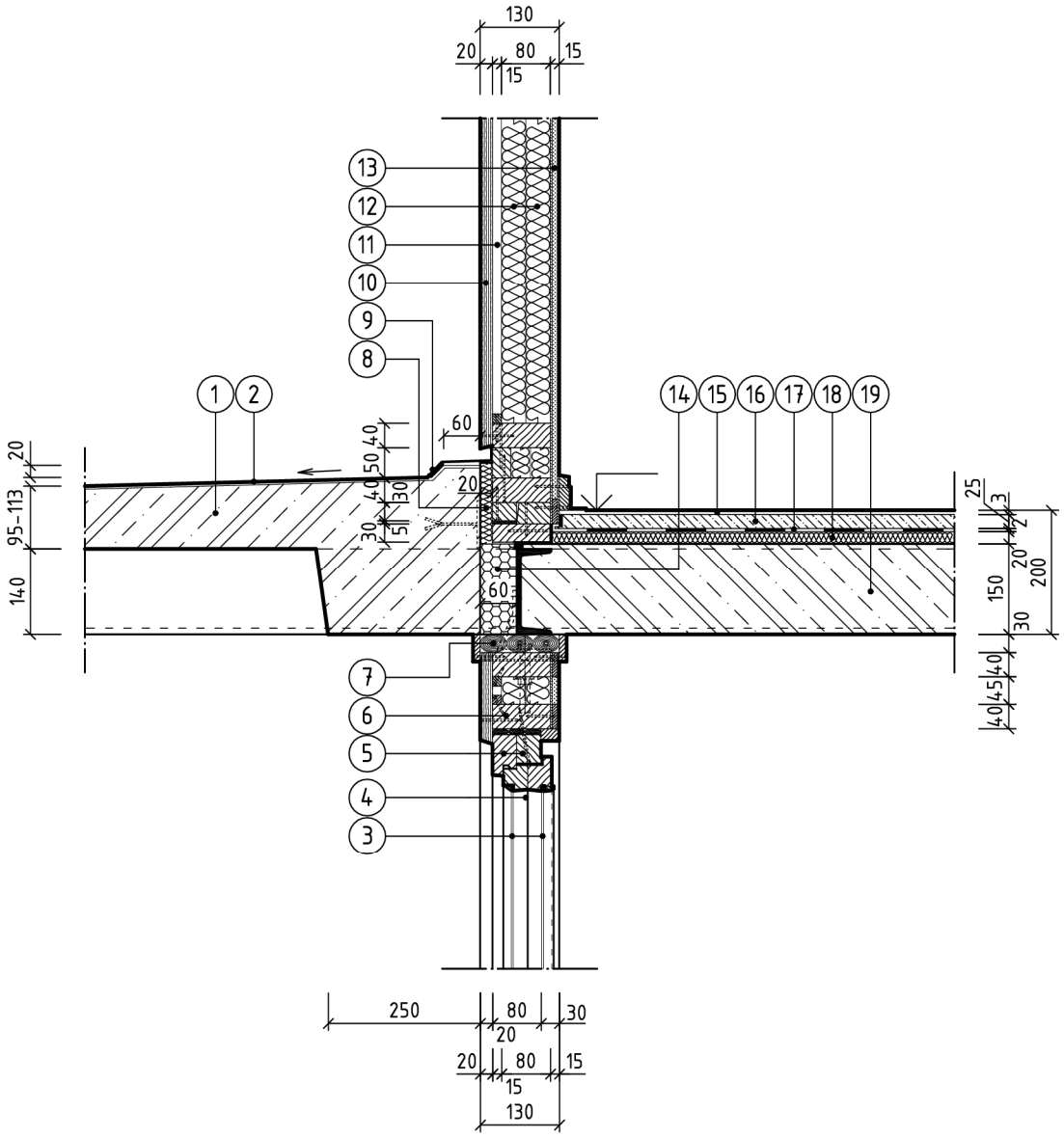
DETAIL 32
Floor plan

Section D-D


Table 2.32.2 – Structural composition of detail 32

DETAIL 32



Legend:

1. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))
2. Coating (not considered in model)
3. Glass 3 mm (λ = 1.00 W/(m.K))
4. Closed air gap 37 mm (λ = 0.204 W/(m.K))
5. Wooden double glazed window (λ = 0.18 W/(m.K))
6. Wooden frame (λ = 0.18 W/(m.K))
7. Seal - glass wool (λ = 0.07 W/(m.K))
8. Polystyrene foam thickn. 20 mm (λ = 0.044 W/(m.K))
9. Galvanized sheet metal (not considered in model)
10. Batten siding (λ = 0.18 W/(m.K))
11. Closed air gap (λ = 0.09 W/(m.K))
12. Basalt wool (λ = 0.07 W/(m.K))
13. Particle board (λ = 0.11 W/(m.K))
14. Polystyrene foam (λ = 0.044 W/(m.K))
15. PVC + adhesive (λ = 0.16 W/(m.K))
16. Cement coating (λ = 1.02 W/(m.K))
17. Tar paper (λ = 0.21 W/(m.K))
18. Boards FIBREX (λ = 0.05 W/(m.K))
19. Reinforc. concrete ceiling panel (λ = 1.34 W/(m.K))

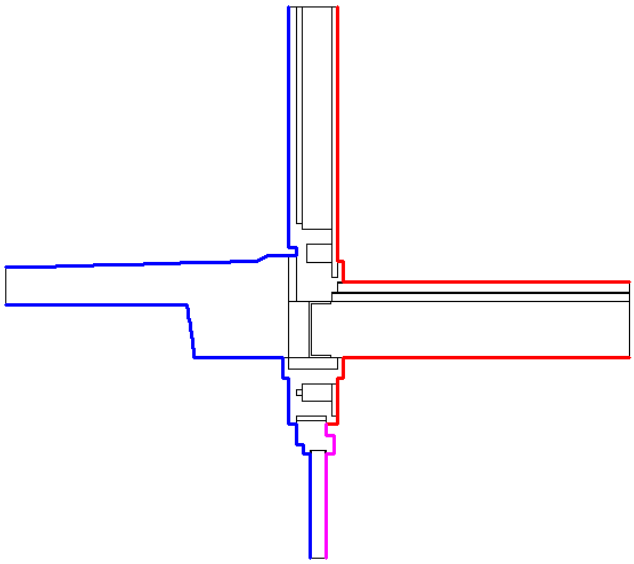
$U_{wall,2}$ = 0.579 W/(m^2.K)

$U_{window,\ wooden}$ = 2.579 W/(m^2.K)

Table 2.32.3 – Boundary conditions for a calculation of detail 32

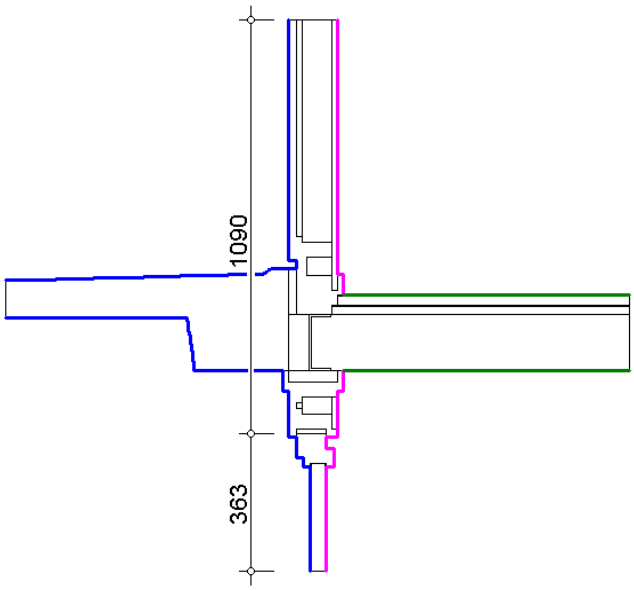
DETAIL 32

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

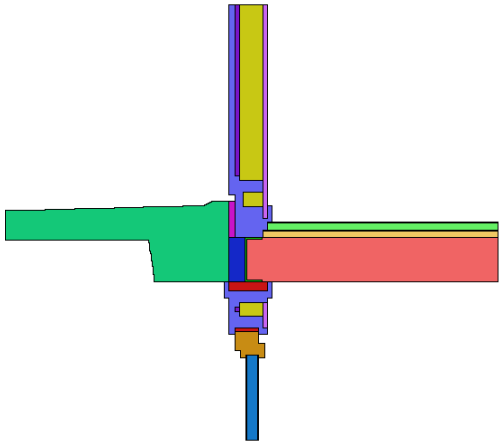
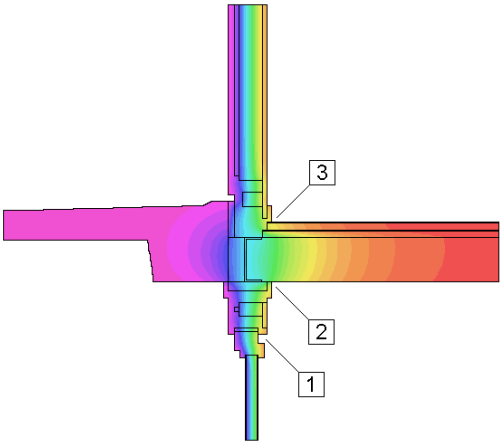
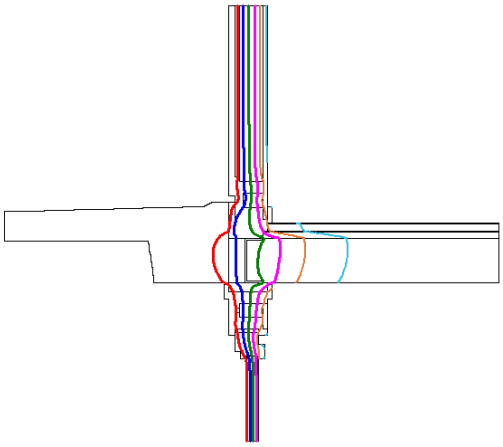
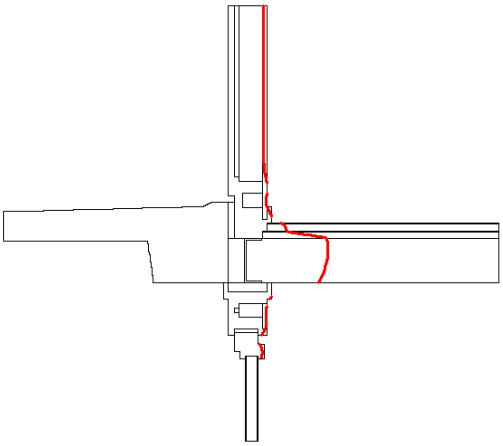
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.32.4 – Thermal-technical evaluation of detail 32

DETAIL 32

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.340 W/(m.K) λ = 0.050 W/(m.K) λ = 0.210 W/(m.K) λ = 1.020 W/(m.K) λ = 0.160 W/(m.K) λ = 0.180 W/(m.K) λ = 0.110 W/(m.K) λ = 0.070 W/(m.K) λ = 0.180 W/(m.K) λ = 0.070 W/(m.K) λ = 40.00 W/(m.K) λ = 1.000 W/(m.K) λ = 0.204 W/(m.K) λ = 1.360 W/(m.K) λ = 0.090 W/(m.K) λ = 0.044 W/(m.K) λ = 1.580 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 10.63 °C	f_{Rsi}= 0.732	θ_{si} = 4.46 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 4.46 °C	f_{Rsi}= 0.556	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
3	θ_{si} = 11.54 °C	f_{Rsi}= 0.758		
Linear thermal transmittance			ψ = 2.20362 - 0.579 × 1.090 - 2.579 × 0.363 = 0.636 W/(m.K)	

Table 2.33.1 – Marking of the position of detail in the building – detail 33

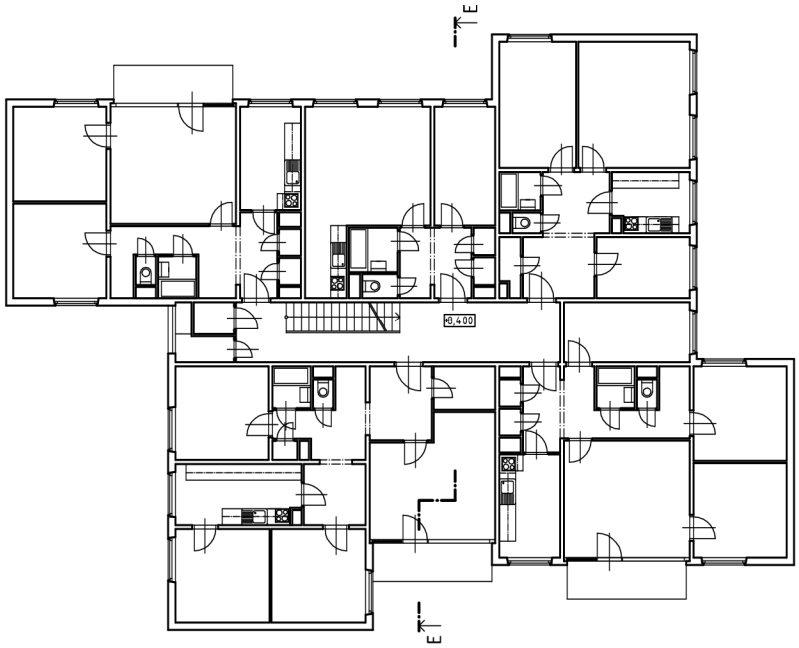
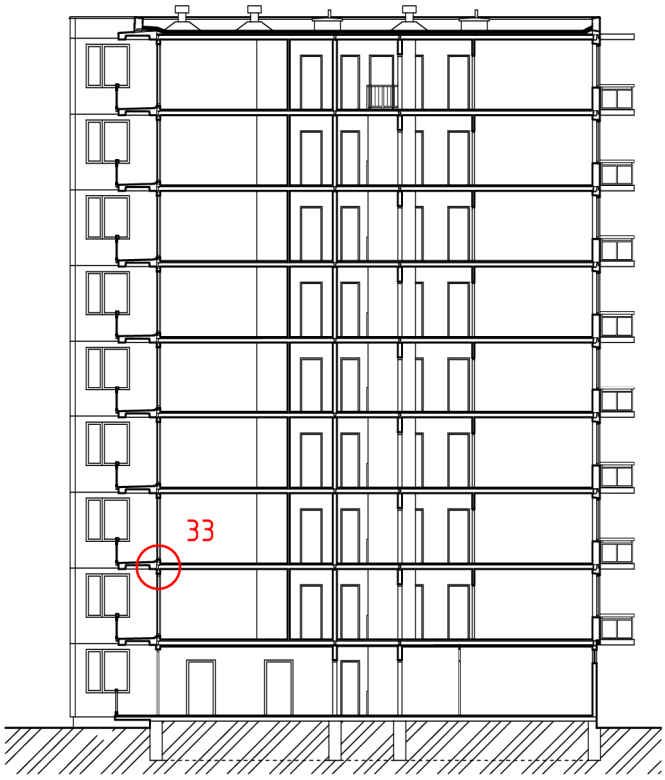
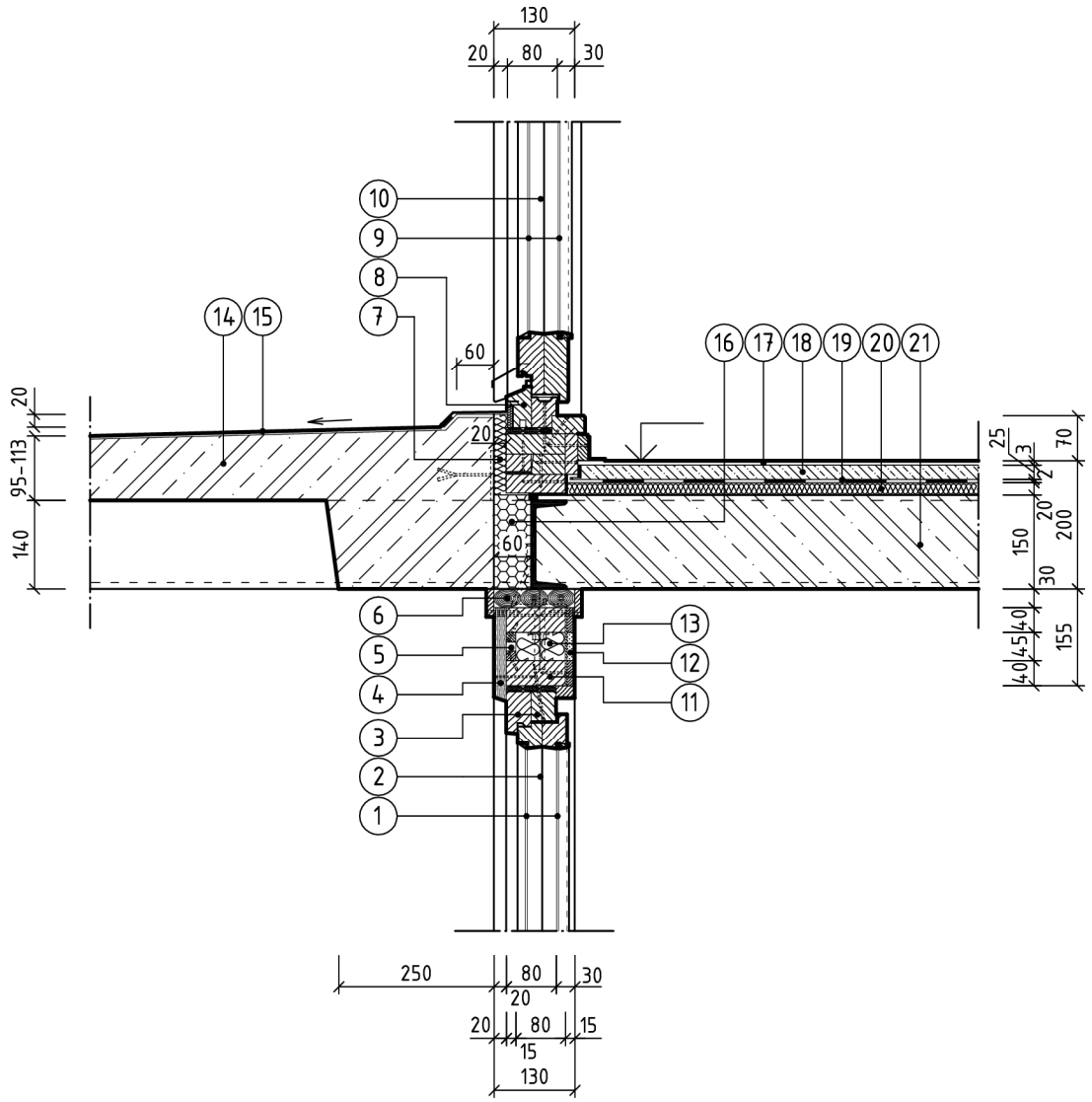
DETAIL 33
Floor plan

Section E-E


Table 2.33.2 – Structural composition of detail 33

DETAIL 33



Legend:

1. Glass 3 mm (λ = 1.00 W/(m.K))
2. Closed air gap 37 mm (λ = 0.204 W/(m.K))
3. Wooden double glazed window (λ = 0.18 W/(m.K))
4. Batten siding (λ = 0.18 W/(m.K))
5. Closed air gap (λ = 0.09 W/(m.K))
6. Seal - glass wool (λ = 0.07 W/(m.K))
7. Polystyrene foam thick. 20 mm (λ = 0.044 W/(m.K))
8. Wood. loggia double glazed door (λ = 0.18 W/(m.K))
9. Glass 3 mm (λ = 1.00 W/(m.K))
10. Closed air gap 37 mm (λ = 0.204 W/(m.K))
11. Wooden frame (λ = 0.18 W/(m.K))
12. Particle board (λ = 0.11 W/(m.K))
13. Basalt wool (λ = 0.07 W/(m.K))
14. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))
15. Coating (not considered in model)
16. Polystyrene foam (λ = 0.044 W/(m.K))
17. PVC + adhesive (λ = 0.16 W/(m.K))
18. Cement coating (λ = 1.02 W/(m.K))
19. Tar paper (λ = 0.21 W/(m.K))
20. Boards FIBREX (λ = 0.05 W/(m.K))
21. Reinforc. concrete ceiling panel (λ = 1.34 W/(m.K))

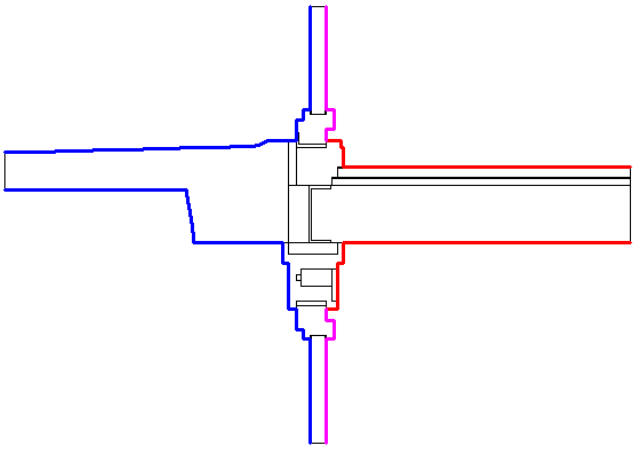
$U_{wall,2}$ = 0.579 W/(m^2.K)

$U_{window,\ wooden}$ = 2.579 W/(m^2.K)

Table 2.33.3 – Boundary conditions for a calculation of detail 33

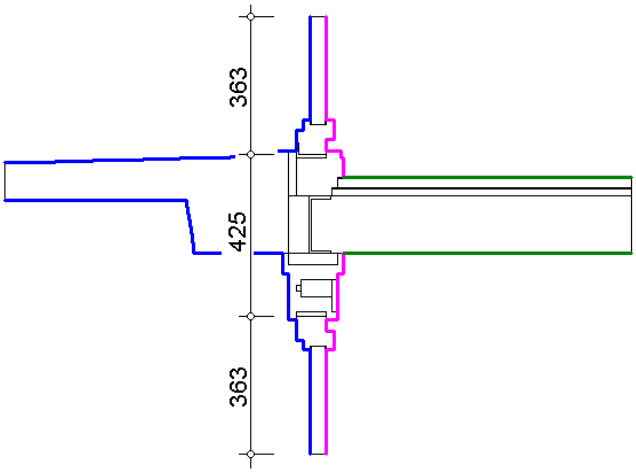
DETAIL 33

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

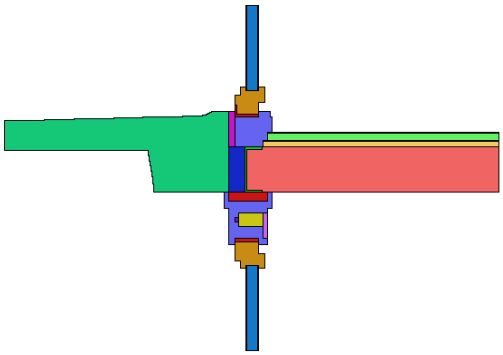
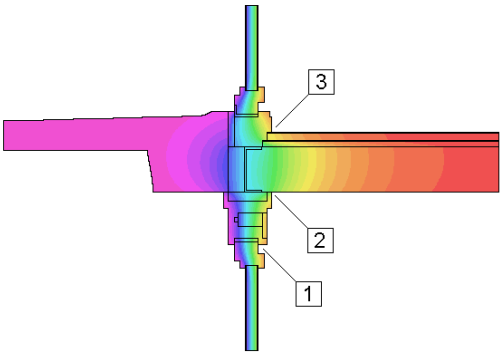
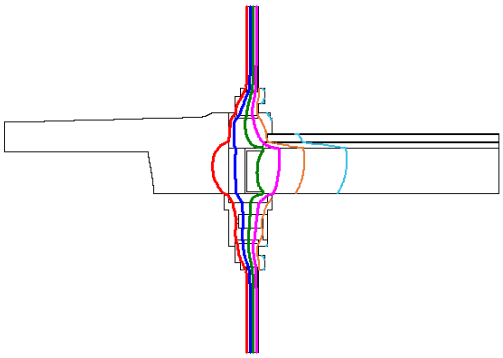
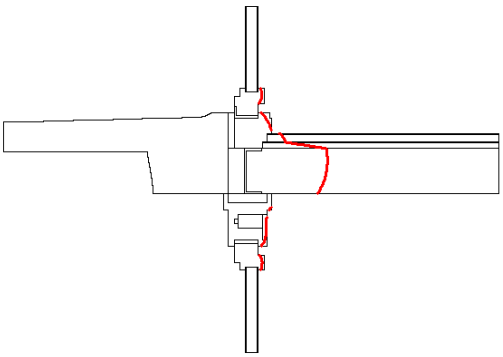
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.33.4 – Thermal-technical evaluation of detail 33

DETAIL 33

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.340 W/(m.K) λ = 0.050 W/(m.K) λ = 0.210 W/(m.K) λ = 1.020 W/(m.K) λ = 0.160 W/(m.K) λ = 0.180 W/(m.K) λ = 0.110 W/(m.K) λ = 0.070 W/(m.K) λ = 0.180 W/(m.K) λ = 0.070 W/(m.K) λ = 40.00 W/(m.K) λ = 1.000 W/(m.K) λ = 0.204 W/(m.K) λ = 1.360 W/(m.K) λ = 0.090 W/(m.K) λ = 0.044 W/(m.K) λ = 1.580 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 10.60 °C	f_{Rsi}= 0.731	θ_{si} = 4.57 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 4.57 °C	f_{Rsi}= 0.559	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
3	θ_{si} = 11.96 °C	f_{Rsi}= 0.770		
Linear thermal transmittance	ψ = 2.72075 - 0.579 × 0.425 - 2.579 × (0.363 + 0.363) = 0.602 W/(m.K)			

Table 2.34.1 – Marking of the position of detail in the building – detail 34

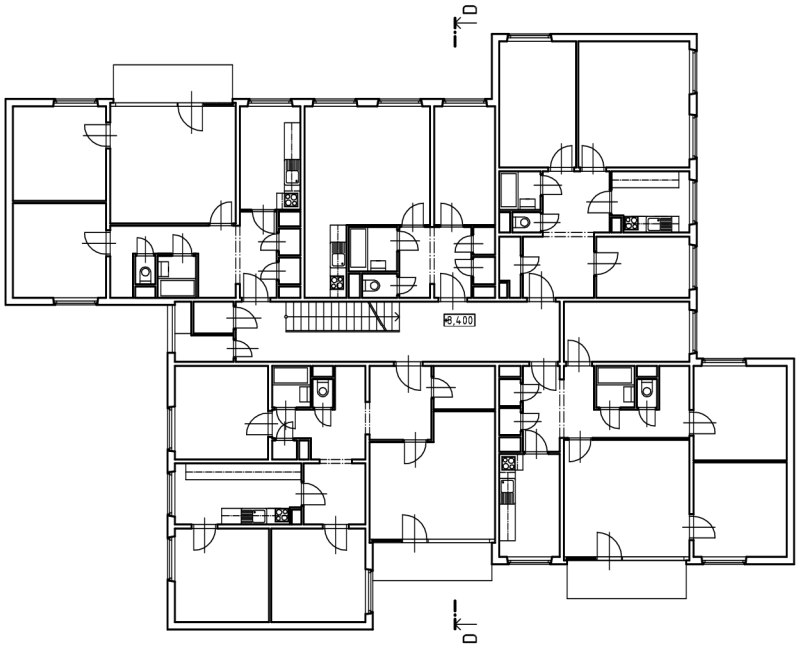
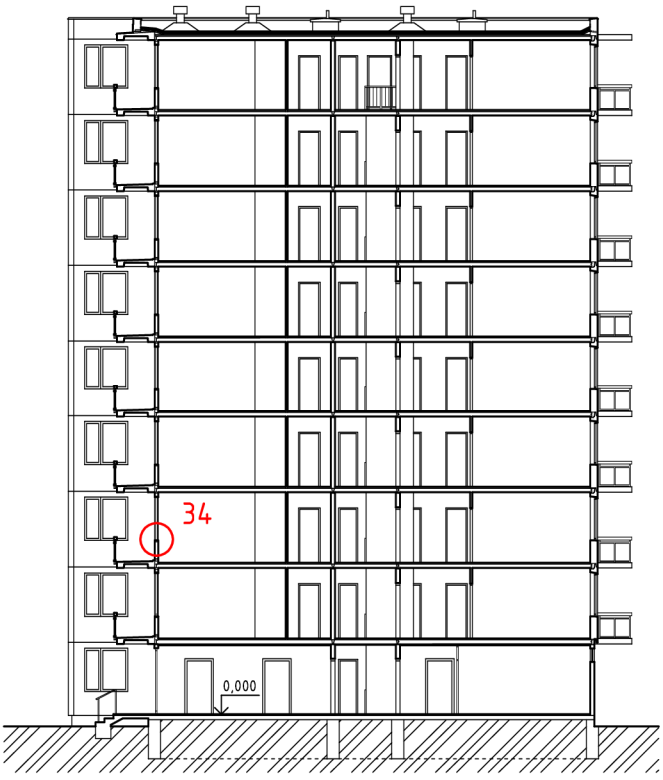
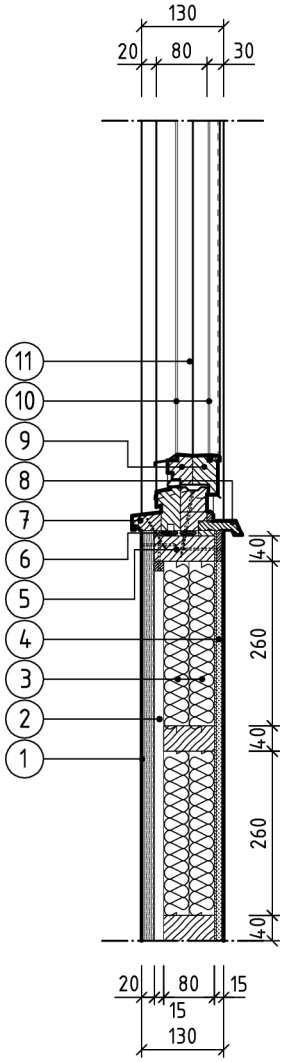
DETAIL 34
Floor plan

Section D-D


Table 2.34.2 – Structural composition of detail 34

DETAIL 34



Legend:

1. Batten siding (λ = 0.18 W/(m.K))
2. Closed air gap (λ = 0.09 W/(m.K))
3. Basalt wool (λ = 0.07 W/(m.K))
4. Particle board (λ = 0.11 W/(m.K))
5. Wooden frame (λ = 0.18 W/(m.K))
6. Seal - glass wool (λ = 0.07 W/(m.K))
7. External window sill (λ = 0.18 W/(m.K))
8. Internal window sill (λ = 0.18 W/(m.K))
9. Wooden double glazed window (λ = 0.18 W/(m.K))
10. Glass 3 mm (λ = 1.00 W/(m.K))
11. Closed air gap 37 mm (λ = 0.204 W/(m.K))

$U_{wall,2}$ = 0.579 W/(m^2.K)

$U_{window,\ wooden}$ = 2.579 W/(m^2.K)

Table 2.34.3 – Boundary conditions for a calculation of detail 34

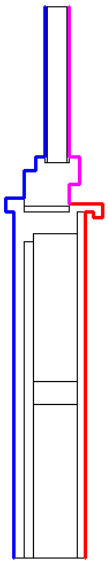
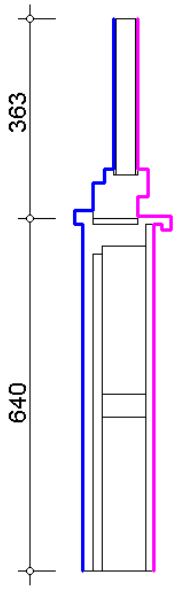
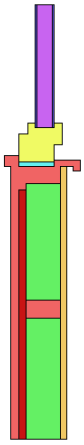
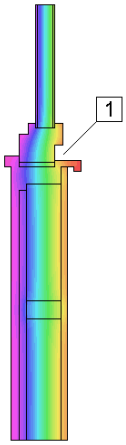
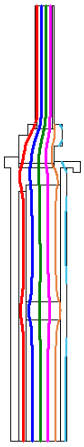
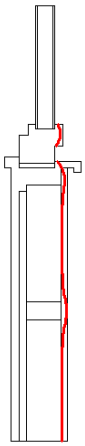
<table>
<tr><th colspan="2">DETAIL 34</th></tr>
<tr><th colspan="2">Boundary conditions for calculation of surface temperatures</th></tr>
<tr><td colspan="2">  </td></tr>
<tr><td>Boundary conditions for interior</td><td>Boundary conditions for exterior</td></tr>
<tr><td>θ_i = 20 °C
φ_i = 50 %
R_{si} = 0.25 m^2.K/W
R_{si} = 0.13 m^2.K/W</td><td>θ_e = -15 °C
φ_e = 84 %
R_{se} = 0.04 m^2.K/W</td></tr>
<tr><th colspan="2">Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance</th></tr>
<tr><td colspan="2"> 
</td></tr>
<tr><td>Boundary conditions for interior</td><td>Boundary conditions for exterior</td></tr>
<tr><td>θ_i = 20 °C
φ_i = 50 %
R_{si} = 0.13 m^2.K/W</td><td>θ_e = -15 °C
φ_e = 84 %
R_{se} = 0.04 m^2.K/W</td></tr>
</table>

Table 2.34.4 – Thermal-technical evaluation of detail 34

DETAIL 34

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 0.180 W/(m.K) λ = 0.110 W/(m.K) λ = 0.180 W/(m.K) λ = 0.070 W/(m.K) λ = 0.050 W/(m.K) λ = 1.000 W/(m.K) λ = 0.204 W/(m.K) λ = 0.090 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 11.23 °C	f_{Rsi}= 0.750	θ_{si} = 11.23 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
			$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance			ψ = 1.35362 - 0.579 × 0.640 - 2.579 × 0.363 = 0.047 W/(m.K)	

Table 2.35.1 – Marking of the position of detail in the building – detail 35

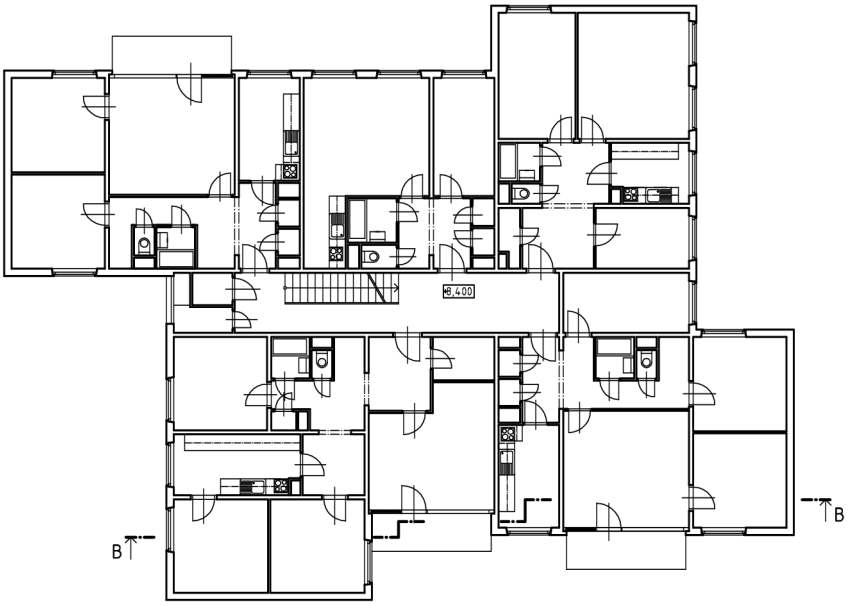
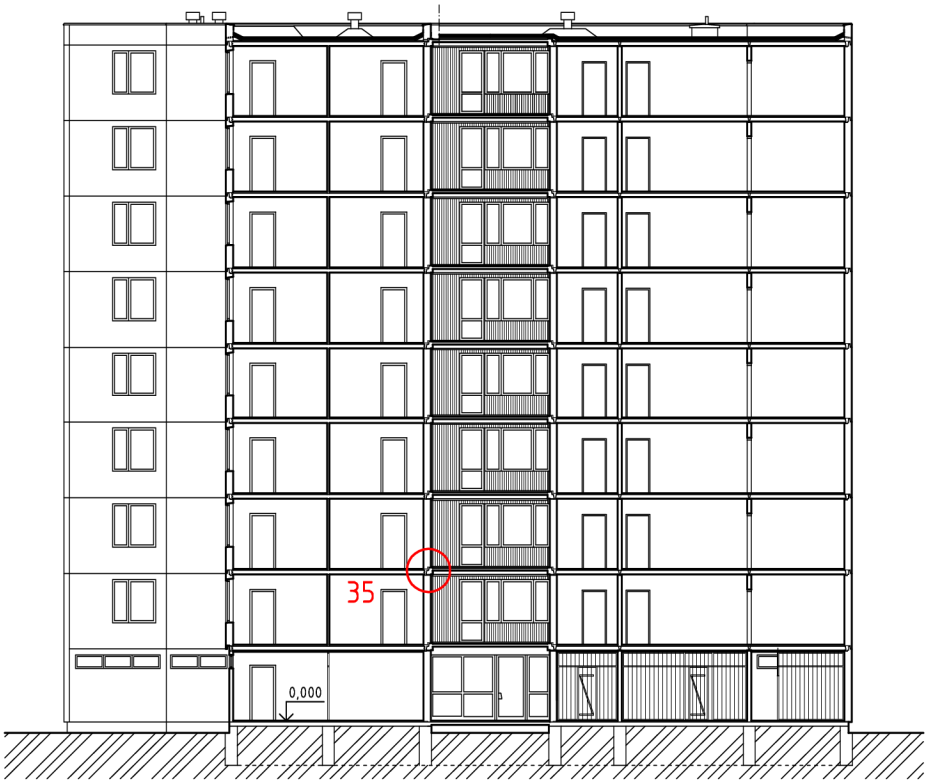
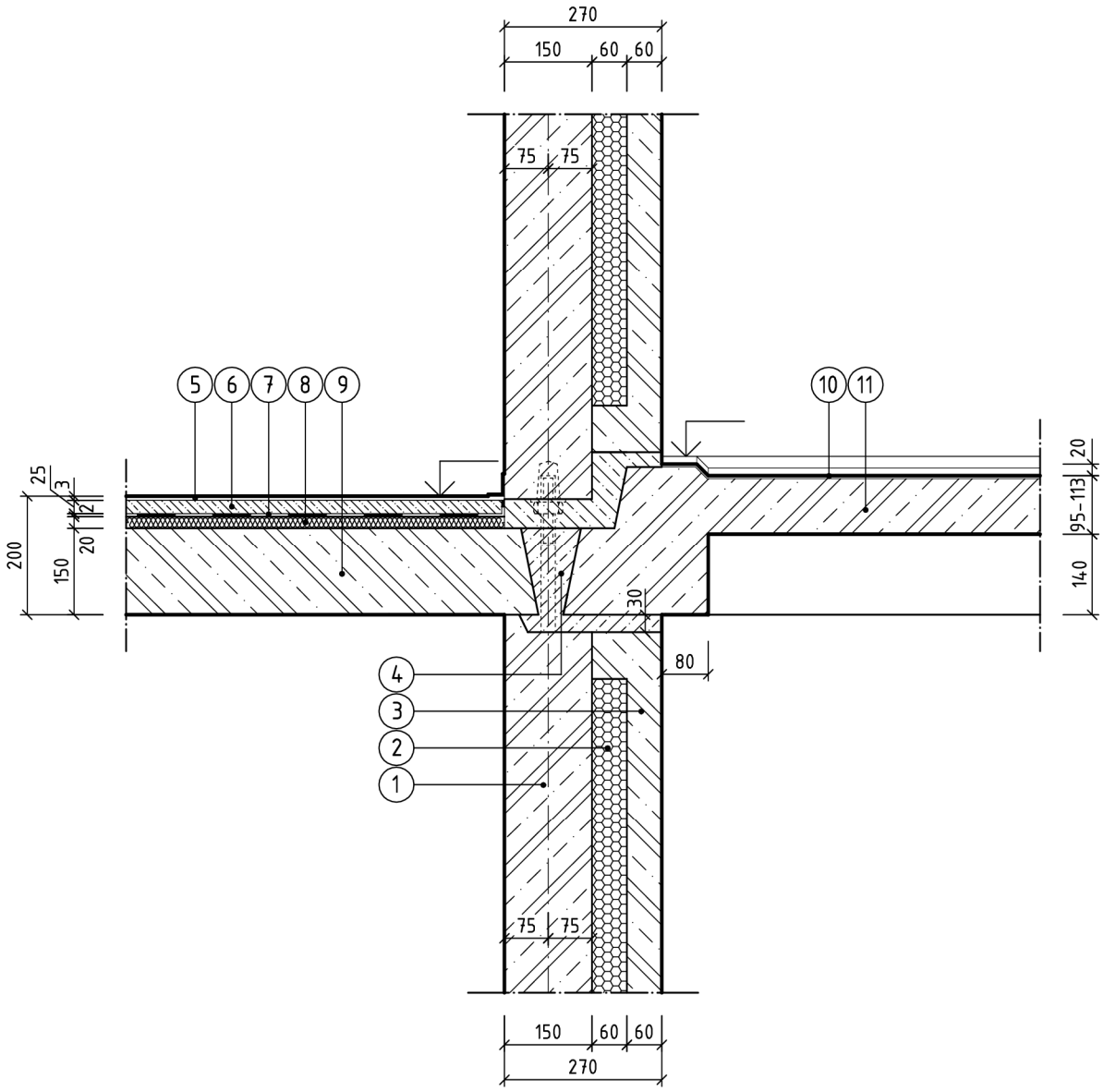
DETAIL 35
Floor plan

Section B-B


Table 2.35.2 – Structural composition of detail 35

DETAIL 35



Legend:

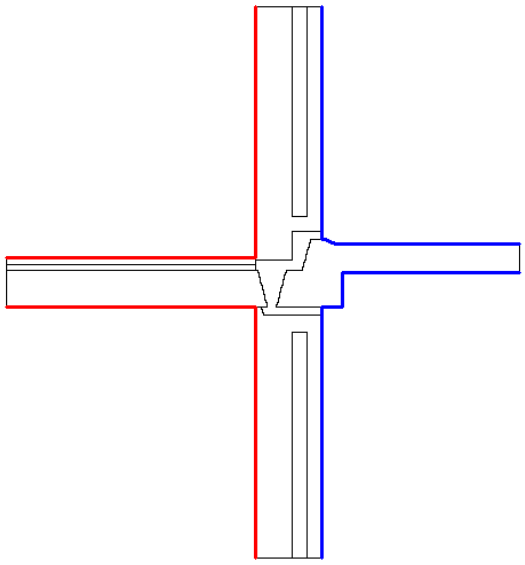
1. Reinforced concrete (λ = 1.58 W/(m.K))
2. Polystyrene foam (λ = 0.07 W/(m.K))
3. Reinforced concrete (λ = 1.58 W/(m.K))
4. Concrete grout (λ = 1.36 W/(m.K))
5. PVC + adhesive (λ = 0.16 W/(m.K))
6. Cement coating (λ = 1.02 W/(m.K))
7. Tar paper (λ = 0.21 W/(m.K))
8. Boards FIBREX (λ = 0.05 W/(m.K))
9. Reinforced concrete ceiling panel (λ = 1.34 W/(m.K))
10. Coating (not considered in model)
11. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))

$U_{wall,1}$ = 2.572 W/(m^2.K)

Table 2.35.3 – Boundary conditions for a calculation of detail 35

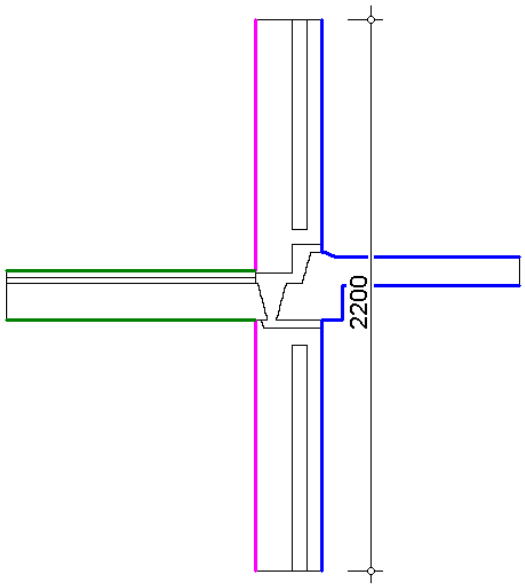
DETAIL 35

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

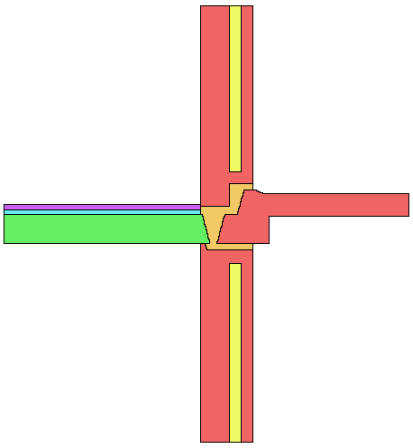
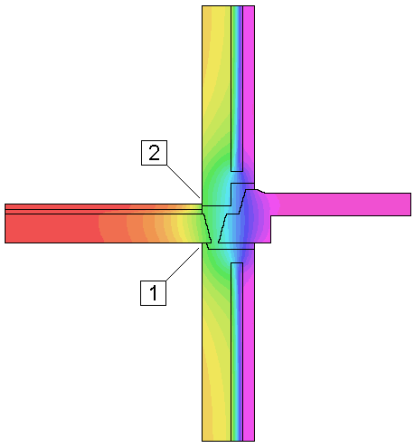
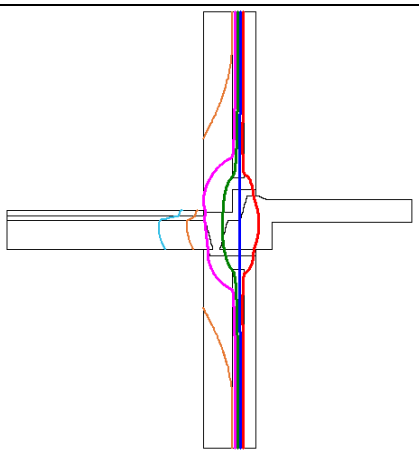
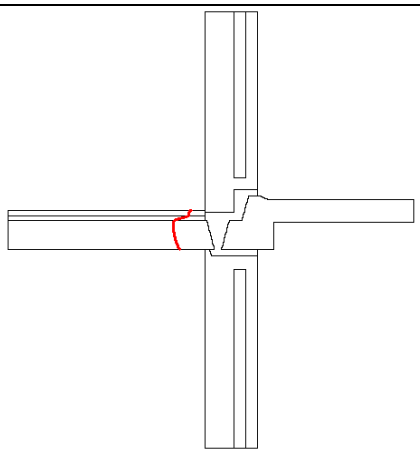
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.35.4 – Thermal-technical evaluation of detail 35

DETAIL 35

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 1.360 W/(m.K) λ = 0.070 W/(m.K) λ = 1.340 W/(m.K) λ = 0.050 W/(m.K) λ = 0.210 W/(m.K) λ = 1.020 W/(m.K) λ = 0.160 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 6.16 °C	f_{Rsi}= 0.605	θ_{si} = 5.06 °C < $\theta_{si,80} + \Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 5.06 °C	f_{Rsi}= 0.573	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance			ψ = 3.08705 - 0.862 × 2.200 = 1.191 W/(m.K)	

Table 2.36.1 – Marking of the position of detail in the building – detail 36

DETAIL 36
Floor plan

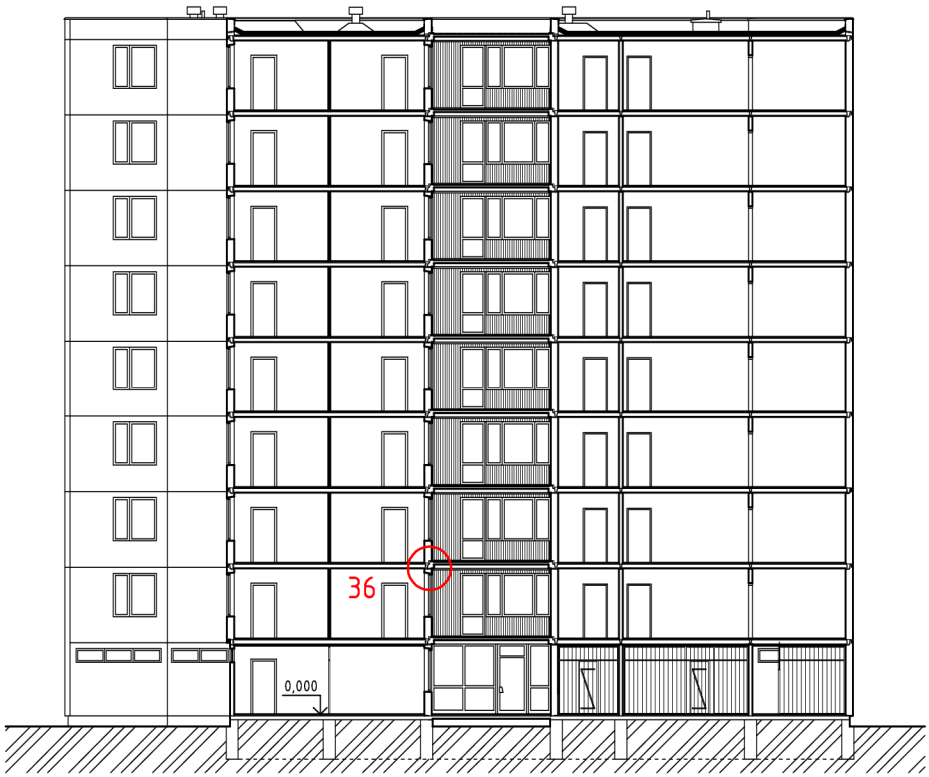
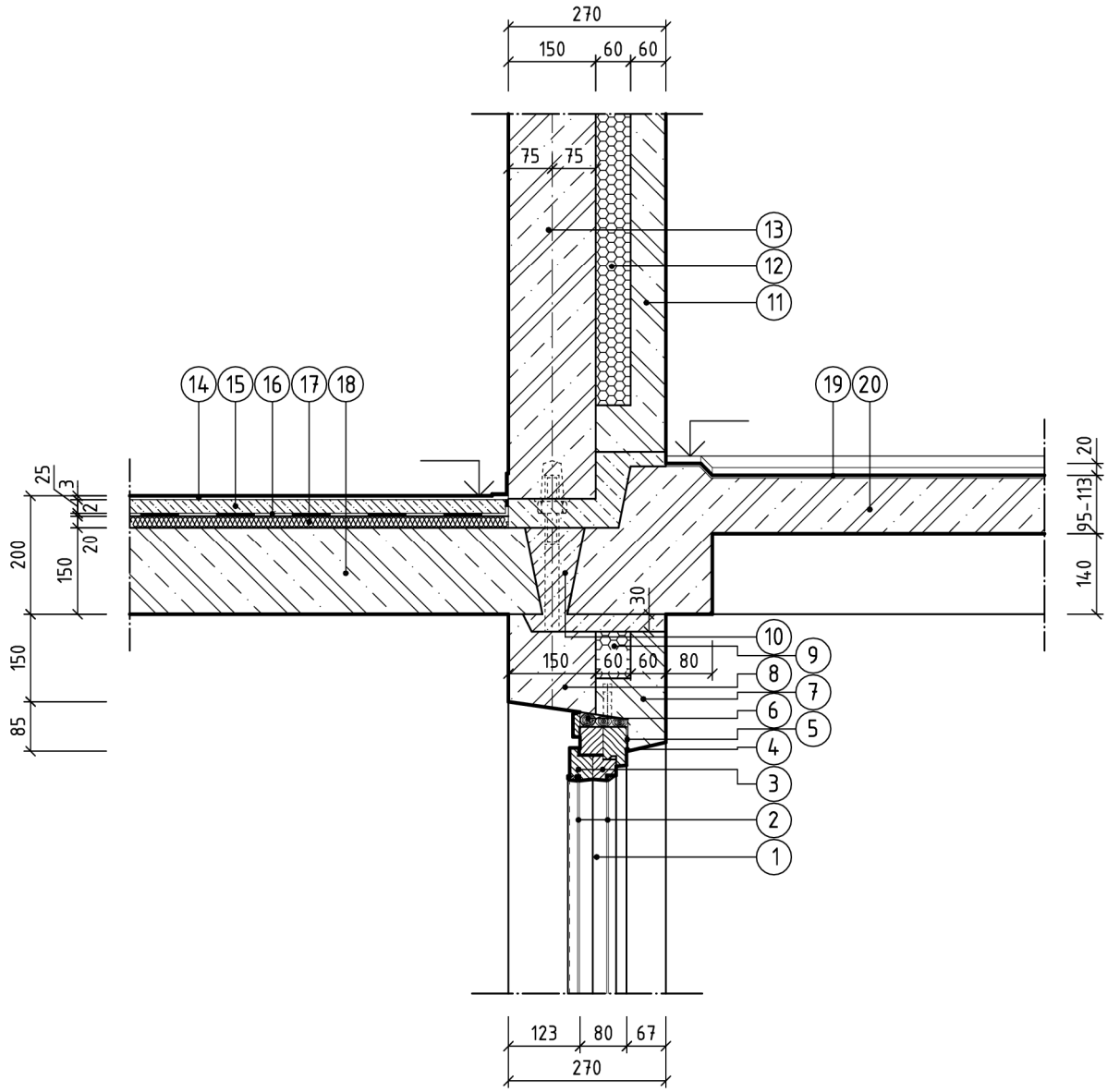
Section J-J


Table 2.36.2 – Structural composition of detail 36

DETAIL 36



Legend:

1. Closed air gap 37 mm (λ = 0.204 W/(m.K))
2. Glass 3 mm (λ = 1.00 W/(m.K))
3. Wooden window frame (λ = 0.18 W/(m.K))
4. Sealant (λ = 0.22 W/(m.K))
5. Microporous rubber (λ = 0.06 W/(m.K))
6. Seal - glass wool (λ = 0.07 W/(m.K))
7. Reinforced concrete (λ = 1.58 W/(m.K))
8. Reinforced concrete (λ = 1.58 W/(m.K))
9. Polystyrene foam (λ = 0.07 W/(m.K))
10. Concrete grout (λ = 1.36 W/(m.K))
11. Reinforced concrete (λ = 1.58 W/(m.K))
12. Polystyrene foam (λ = 0.07 W/(m.K))
13. Reinforced concrete (λ = 1.58 W/(m.K))
14. PVC + adhesive (λ = 0.16 W/(m.K))
15. Cement coating (λ = 1.02 W/(m.K))
16. Tar paper (λ = 0.21 W/(m.K))
17. Boards FIBREX (λ = 0.05 W/(m.K))
18. Reinforced concrete ceiling panel (λ = 1.34 W/(m.K))
19. Coating (not considered in model)
20. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))

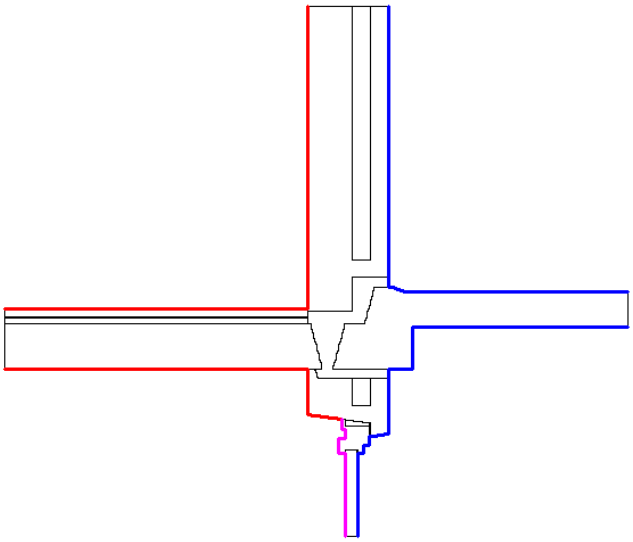
$U_{wall,1}$ = 0.862 W/(m^2.K)

$U_{window,\ wooden}$ = 2.579 W/(m^2.K)

Table 2.36.3 – Boundary conditions for a calculation of detail 36

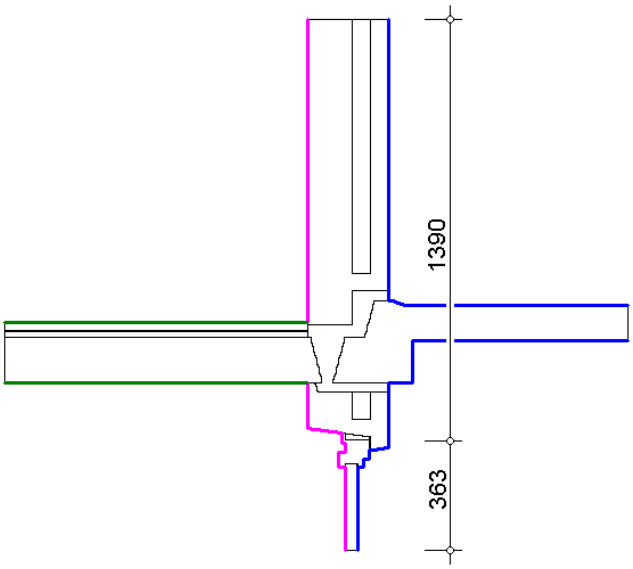
DETAIL 36

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

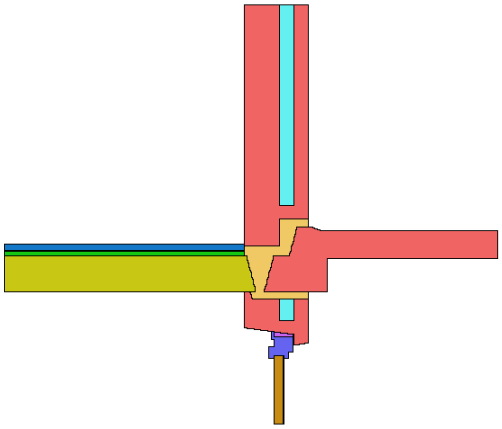
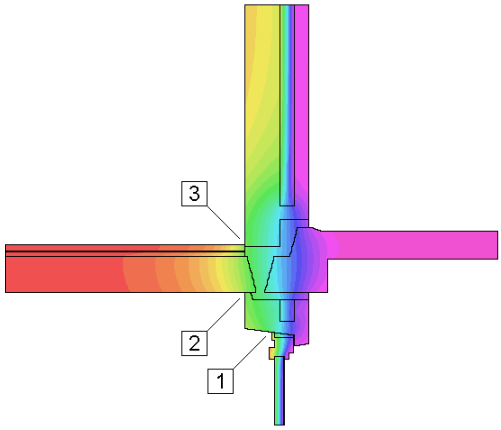
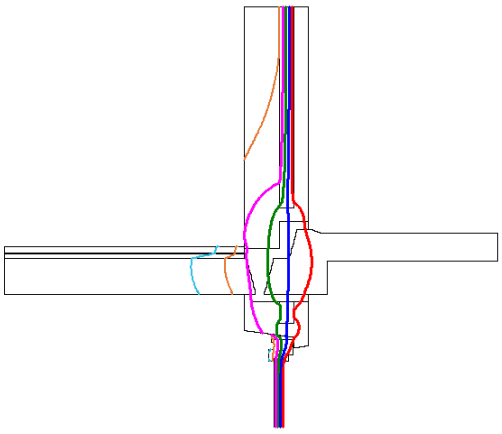
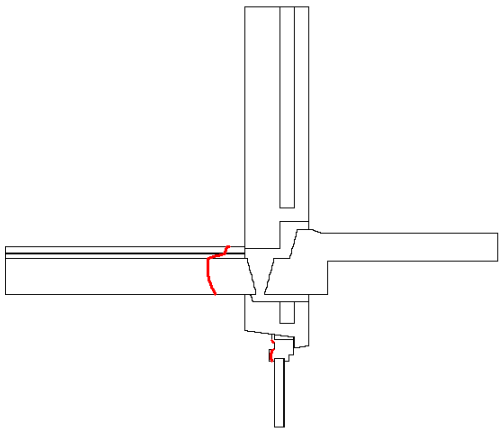
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.36.4 – Thermal-technical evaluation of detail 36

DETAIL 36

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 1.360 W/(m.K) λ = 0.220 W/(m.K) λ = 0.060 W/(m.K) λ = 0.070 W/(m.K) λ = 0.180 W/(m.K) λ = 0.070 W/(m.K) λ = 1.000 W/(m.K) λ = 0.204 W/(m.K) λ = 1.340 W/(m.K) λ = 0.050 W/(m.K) λ = 0.210 W/(m.K) λ = 1.020 W/(m.K) λ = 0.160 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 2.86 °C	f_{Rsi}= 0.510	θ_{si} = 2.86 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 6.75 °C	f_{Rsi}= 0.621	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
3	θ_{si} = 5.73 °C	f_{Rsi}= 0.592		
Linear thermal transmittance			ψ = 3.41724 - 0.862 × 1.390 - 2.579 × 0.363 = 1.283 W/(m.K)	

Table 2.37.1 – Marking of the position of detail in the building – detail 37

DETAIL 37
Floor plan

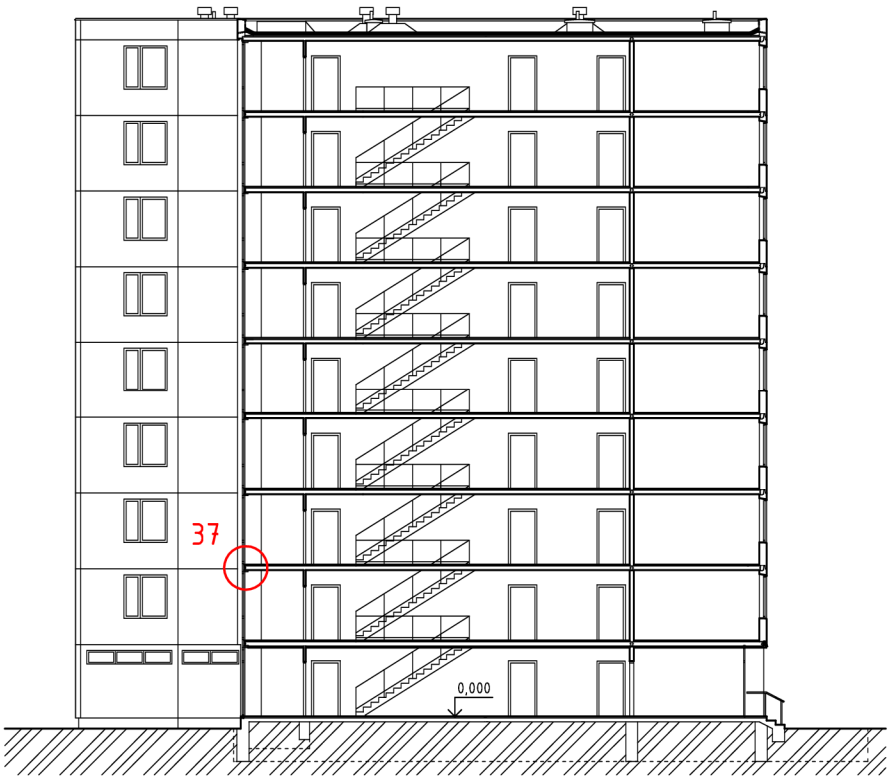
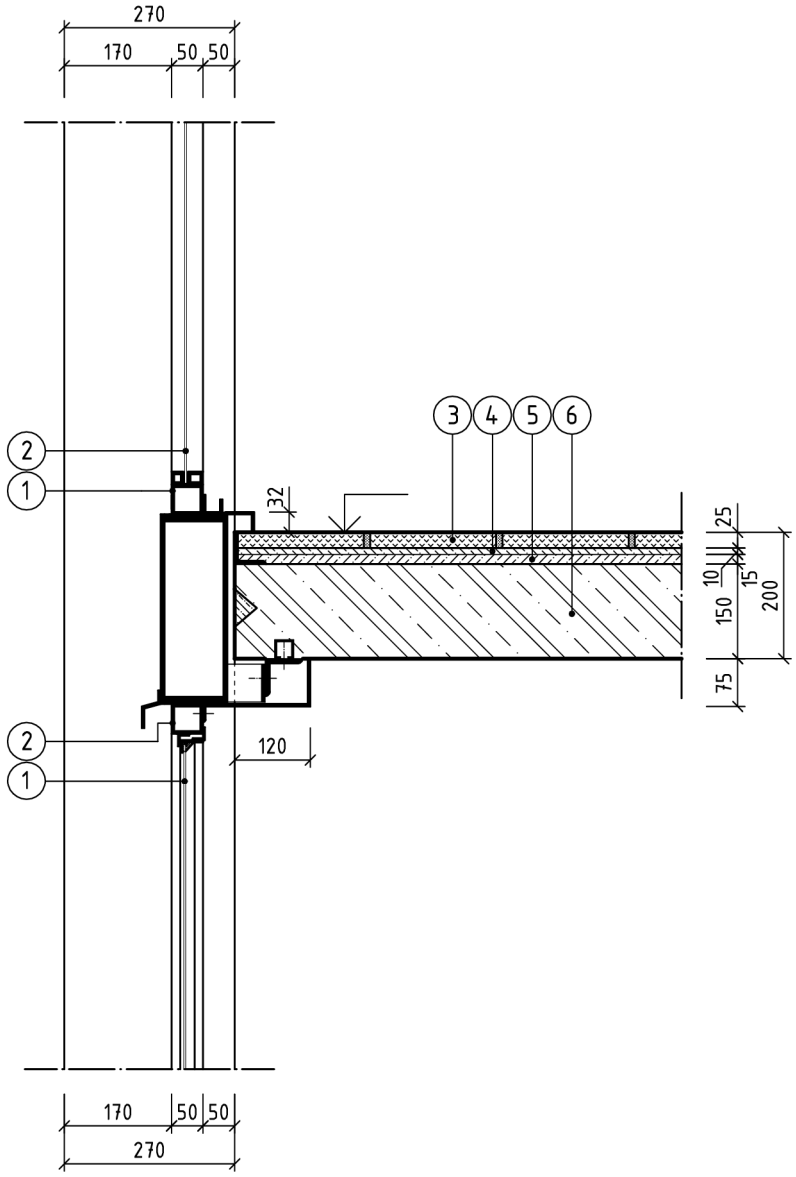
Section I-I


Table 2.37.2 – Structural composition of detail 37

DETAIL 37



Legend:

1. Glass 4 mm (λ = 1.00 W/(m.K))
2. Steel window (λ = 50 W/(m.K), λ = 0.5 W/(m.K))
3. Ceramic floor tiling (λ = 1.01 W/(m.K))
4. Cement mortar (λ = 1.02 W/(m.K))
5. Concrete coating (λ = 1.05 W/(m.K))
6. Reinforced concrete ceiling panel (λ = 1.34 W/(m.K))

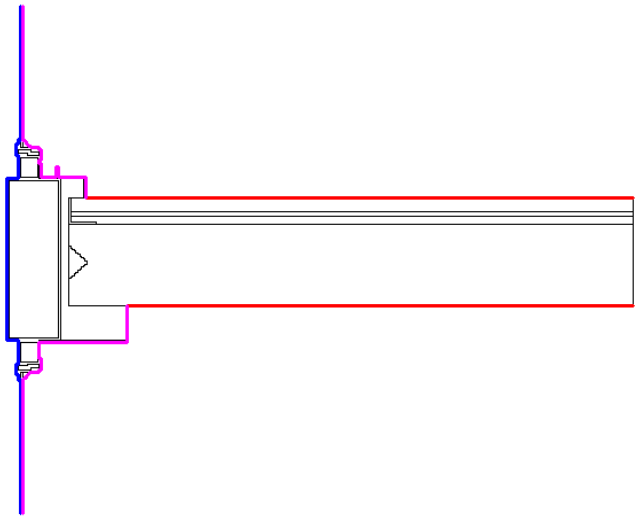
$U_{wall,1}$ = 0.862 W/(m^2.K)

$U_{window,\ steel}$ = 6.238 W/(m^2.K)

Table 2.37.3 – Boundary conditions for a calculation of detail 37

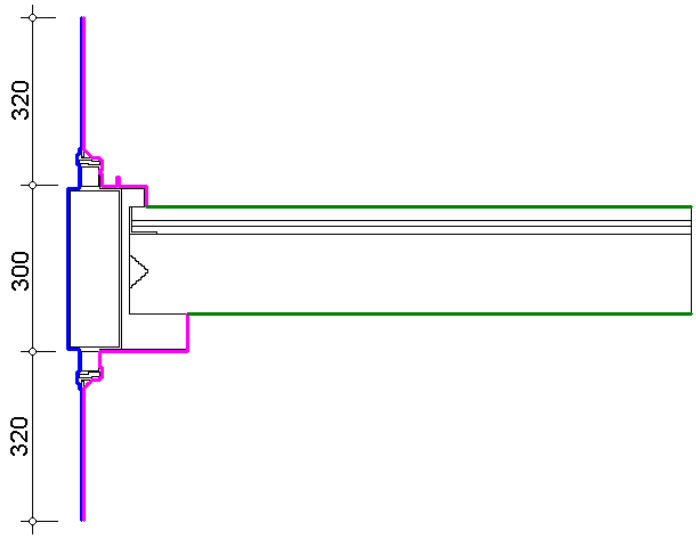
DETAIL 37

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

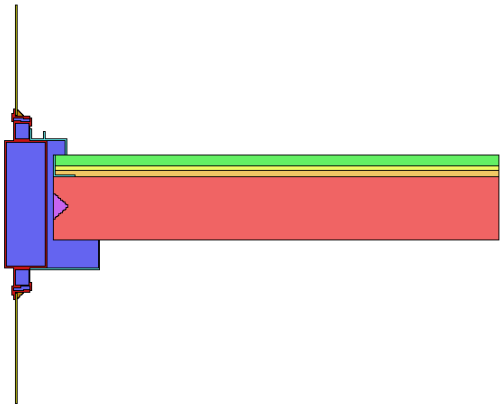
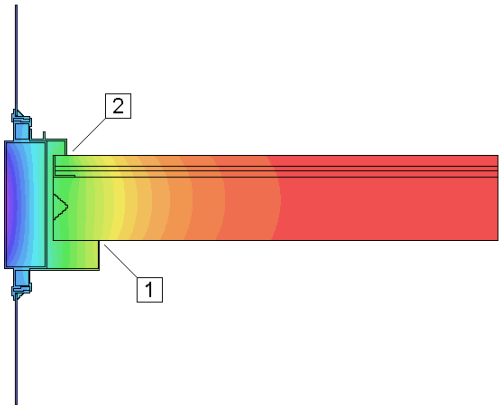
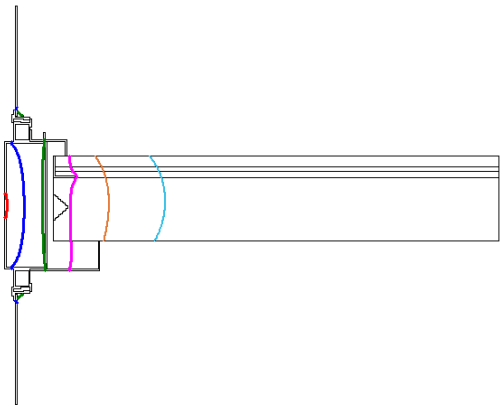
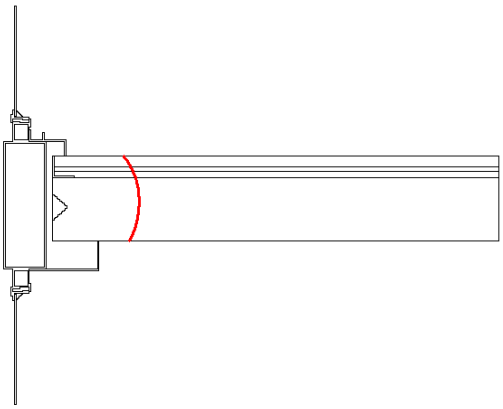
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.37.4 – Thermal-technical evaluation of detail 37

DETAIL 37

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.340 W/(m.K) λ = 1.050 W/(m.K) λ = 1.020 W/(m.K) λ = 1.010 W/(m.K) λ = 40.00 W/(m.K) λ = 0.500 W/(m.K) λ = 1.360 W/(m.K) λ = 50.00 W/(m.K) λ = 0.220 W/(m.K) λ = 1.000 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 9.12 °C	f_{Rsi}= 0.689	θ_{si} = 3.63 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 3.63 °C	f_{Rsi}= 0.532	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance	ψ = 5.89922 - 0.862 × 0.300 - 6.238 × (0.320 + 0.320) = 1.648 W/(m.K)			

Table 2.38.1 – Marking of the position of detail in the building – detail 38

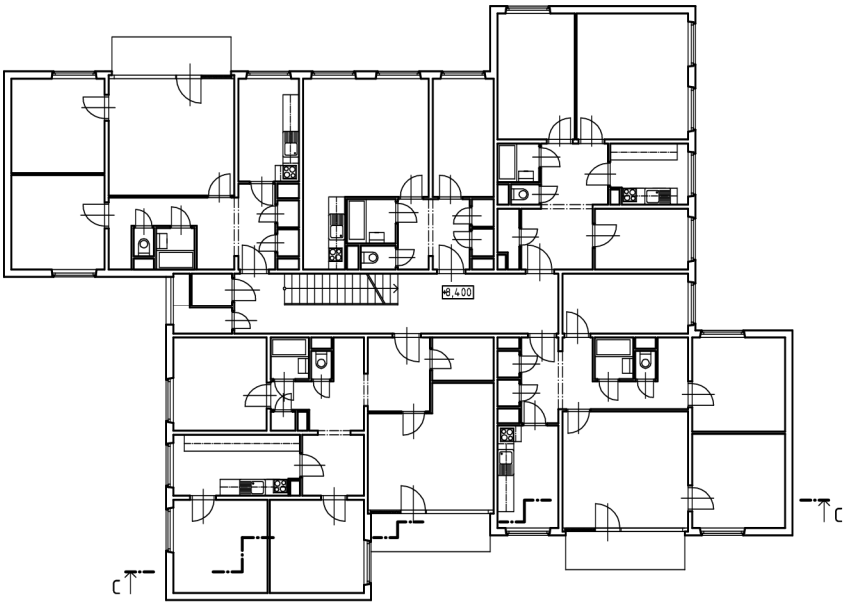
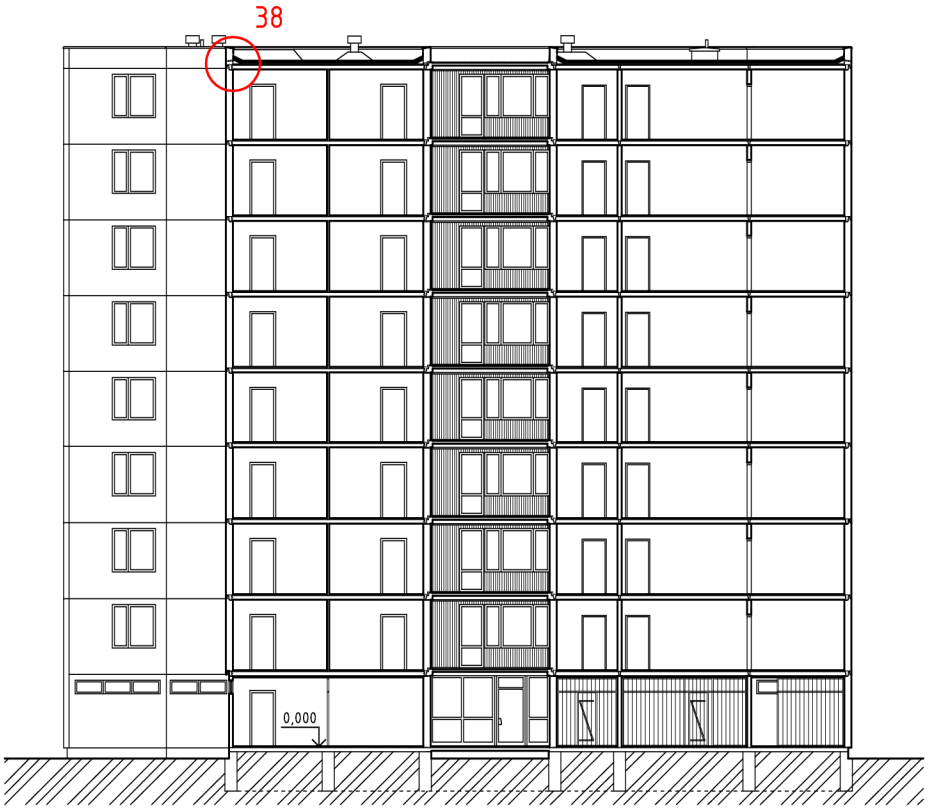
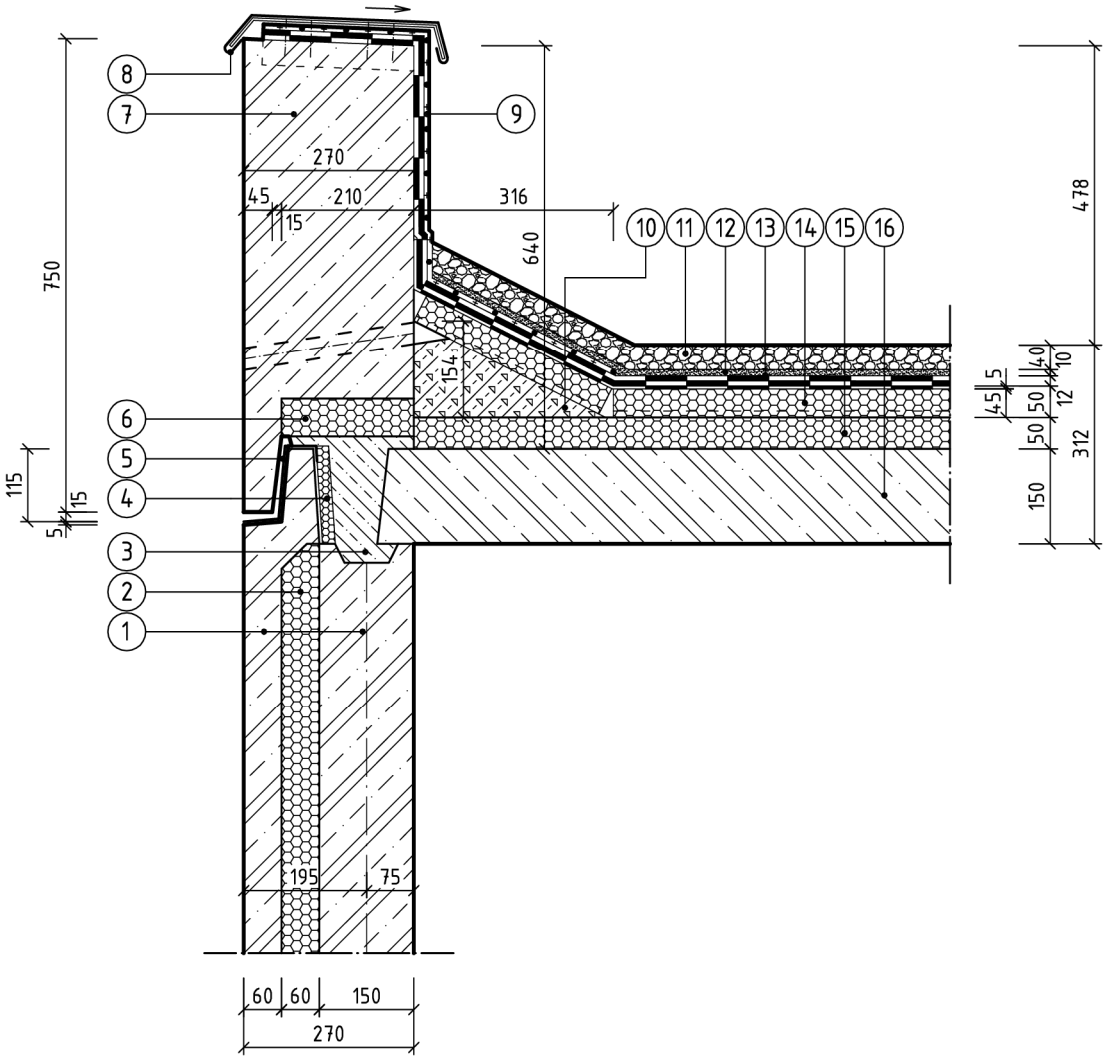
DETAIL 38
Floor plan

Section C-C


Table 2.38.2 – Structural composition of detail 38

DETAIL 38



Legend:

1. Reinforced concrete (λ = 1.58 W/(m.K))
2. Polystyrene foam (λ = 0.07 W/(m.K))
3. Concrete grout (λ = 1.36 W/(m.K))
4. Polystyrene foam thick. 20 mm (λ = 0.044 W/(m.K))
5. Galvanized sheet metal (not considered in model)
6. Polystyrene foam (λ = 0.044 W/(m.K))
7. Reinforced concrete attic panel (λ = 1.58 W/(m.K))
8. Sheet metal covering (not considered in model)
9. Waterproofing rubber foil (not considered in model)
10. Lightweight concrete (λ = 0.61 W/(m.K))
11. Gravel (λ = 0.75 W/(m.K))
12. Sand (λ = 0.95 W/(m.K))
13. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
14. Boards POLSID (λ = 0.044 W/(m.K))
15. Polystyrene foam (λ = 0.044 W/(m.K))
16. Reinforced concrete ceiling panel (λ = 1.58 W/(m.K))

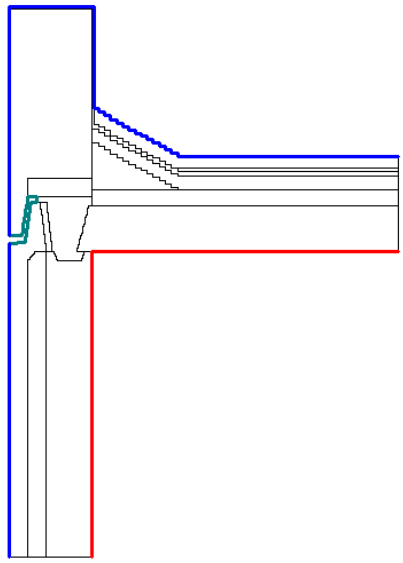
$U_{wall,1}$ = 0.862 W/(m^2.K)

U_{roof} = 0.394 W/(m^2.K)

Table 2.38.3 – Boundary conditions for a calculation of detail 38

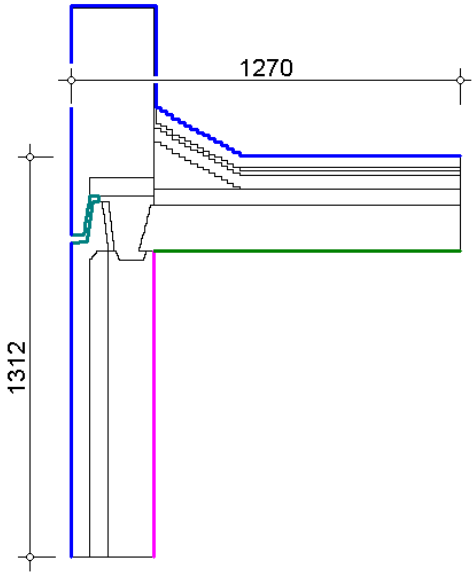
DETAIL 38

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W R_{se} = 0.08 m^2.K/W

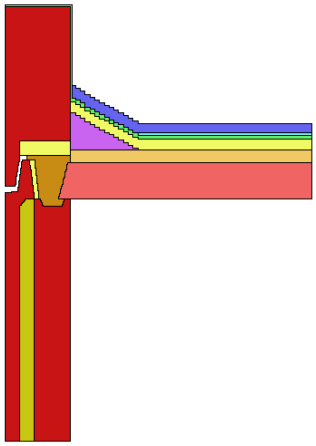
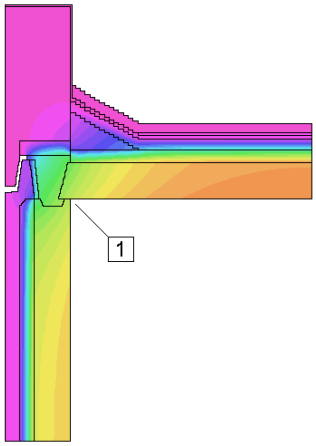
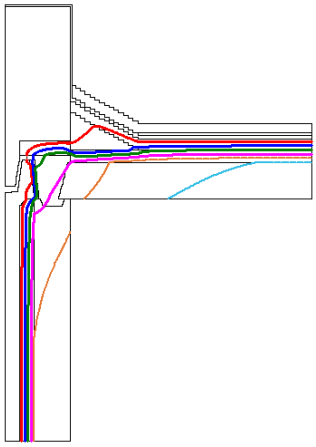
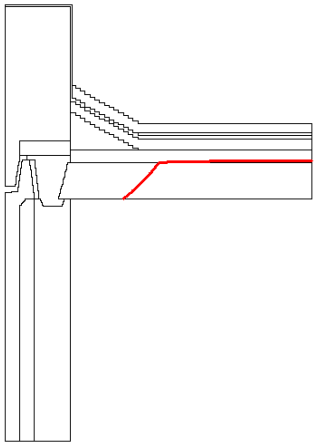
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W R_{se} = 0.08 m^2.K/W

Table 2.38.4 – Thermal-technical evaluation of detail 38

DETAIL 38

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 0.044 W/(m.K) λ = 0.044 W/(m.K) λ = 0.210 W/(m.K) λ = 0.950 W/(m.K) λ = 0.750 W/(m.K) λ = 0.610 W/(m.K) λ = 1.580 W/(m.K) λ = 1.360 W/(m.K) λ = 0.070 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 8.14 °C	f_{Rsi}= 0.661	θ_{si} = 8.14 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
			$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance			ψ = 1.75123 - 0.862 × 1.312 - 0.394 × 1.270 = 0.122 W/(m.K)	

Table 2.39.1 – Marking of the position of detail in the building – detail 39

DETAIL 39
Floor plan

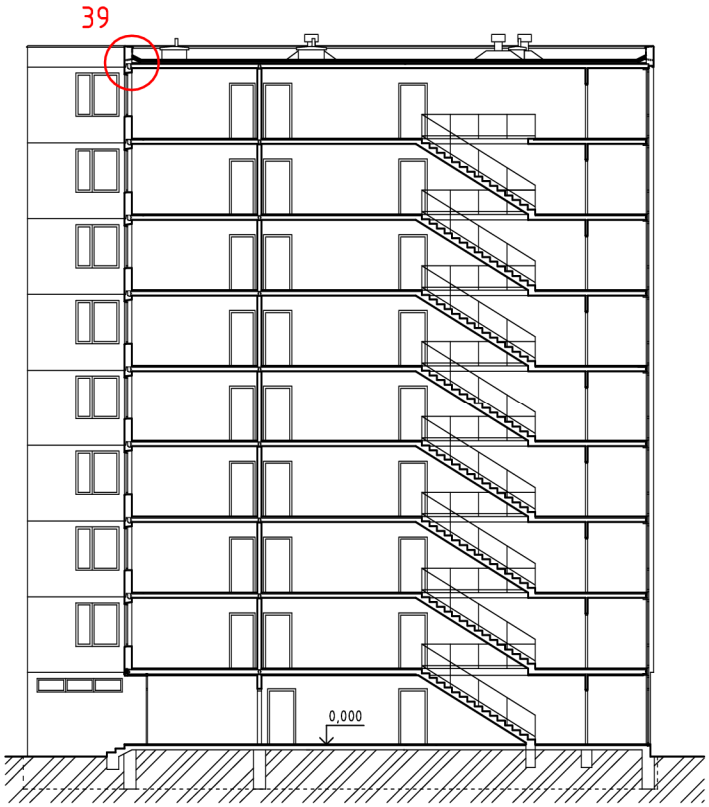
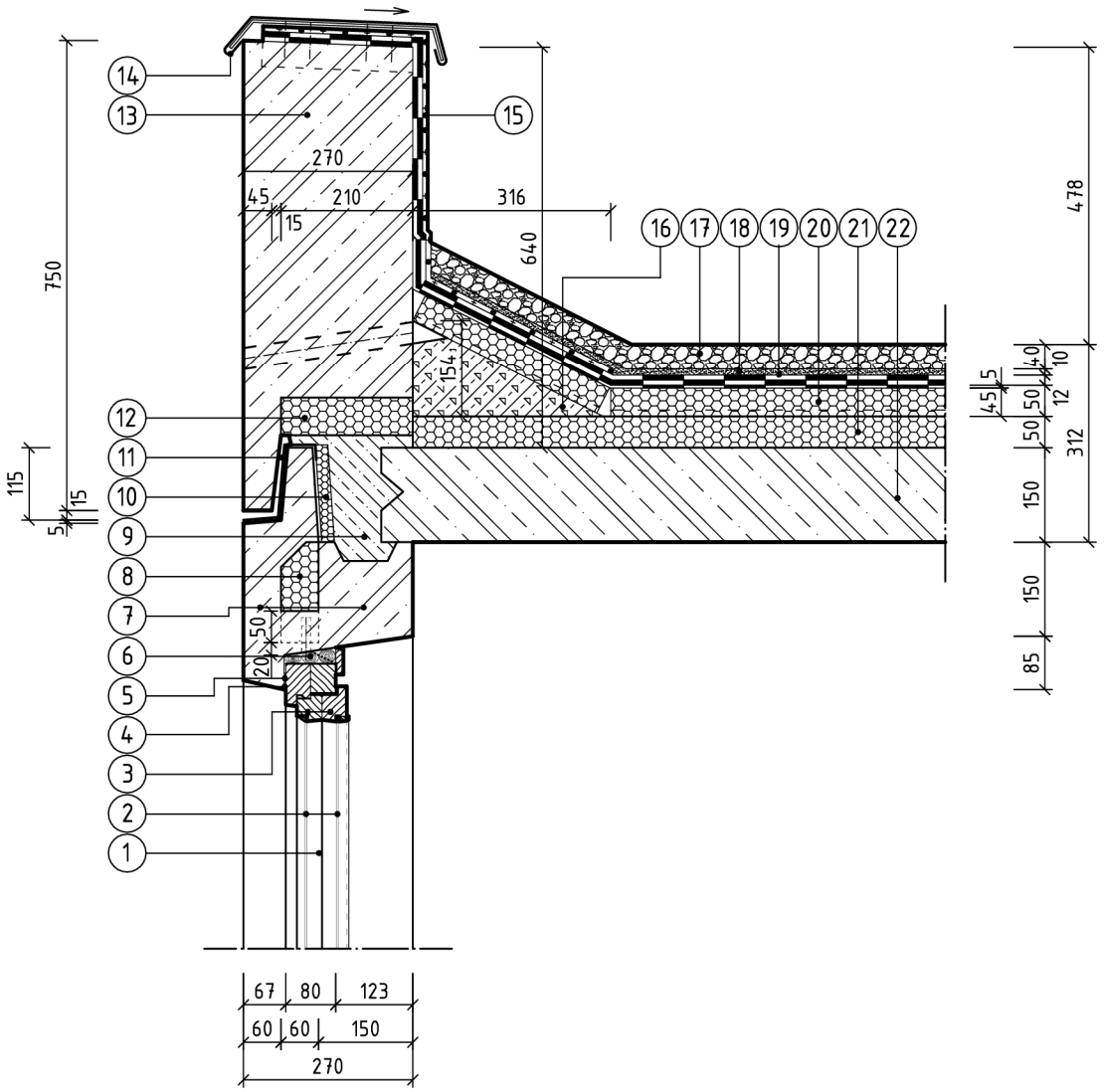
Section A-A


Table 2.39.2 – Structural composition of detail 39

DETAIL 39



Legend:

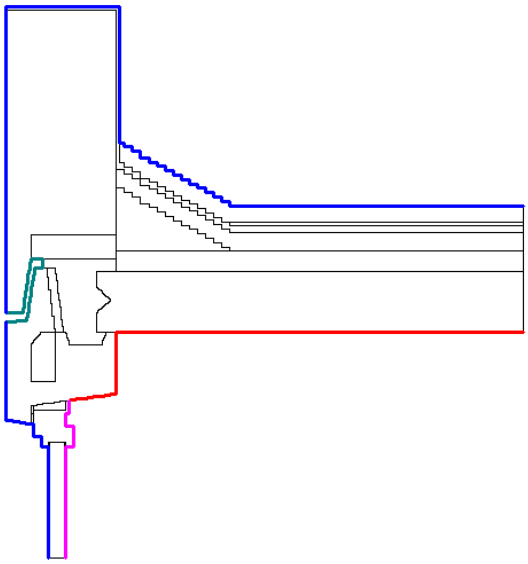
1. Closed air gap 37 mm (λ = 0.204 W/(m.K))
2. Glass 3 mm (λ = 1.00 W/(m.K))
3. Wooden double glazed window (λ = 0.18 W/(m.K))
4. Sealant (λ = 0.22 W/(m.K))
5. Microporous rubber (λ = 0.06 W/(m.K))
6. Seal - glass wool (λ = 0.07 W/(m.K))
7. Reinforced concrete (λ = 1.58 W/(m.K))
8. Polystyrene foam (λ = 0.044 W/(m.K))
9. Concrete grout (λ = 1.36 W/(m.K))
10. Polystyrene foam, thick. 20 mm (λ = 0.044 W/(m.K))
11. Galvanized sheet metal (not considered in model)
12. Polystyrene foam (λ = 0.044 W/(m.K))
13. Reinforced concrete attic panel (λ = 1.58 W/(m.K))
14. Sheet metal covering (not considered in model)
15. Waterproofing rubber foil (not considered in model)
16. Lightweight concrete (λ = 0.61 W/(m.K))
17. Gravel (λ = 0.75 W/(m.K))
18. Sand (λ = 0.95 W/(m.K))
19. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
20. Boards POLSID (λ = 0.044 W/(m.K))
21. Polystyrene foam (λ = 0.044 W/(m.K))
22. Reinforced concrete ceiling panel (λ = 1.58 W/(m.K))

$U_{wall,1}$ = 2.215 W/(m^2.K) **$U_{window,\ wooden}$ = 2.579 W/(m^2.K)** **U_{roof} = 0.985 W/(m^2.K)**

Table 2.39.3 – Boundary conditions for a calculation of detail 39

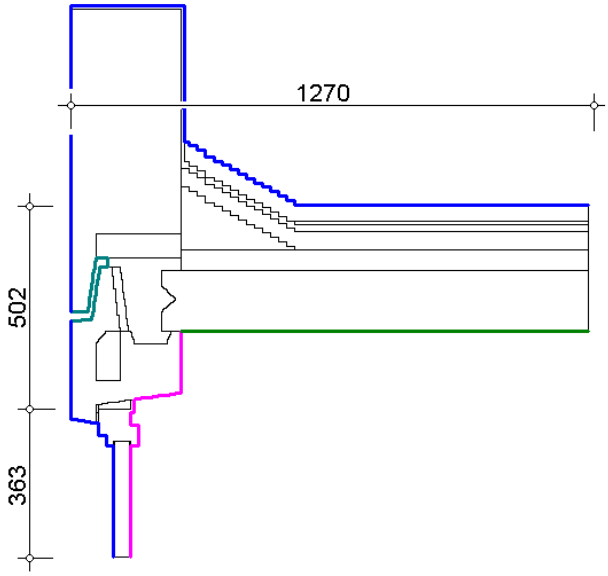
DETAIL 39

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W R_{se} = 0.08 m^2.K/W

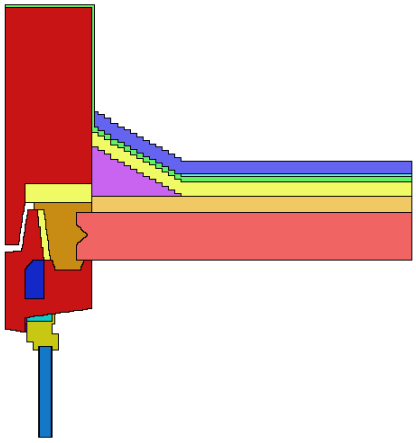
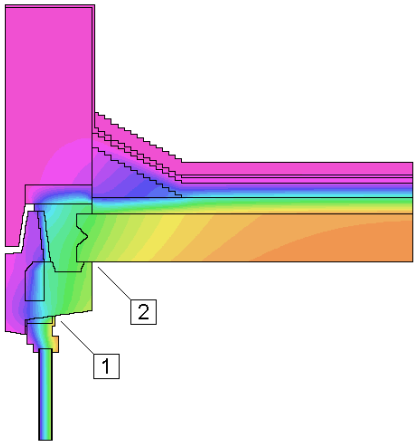
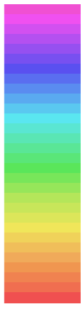
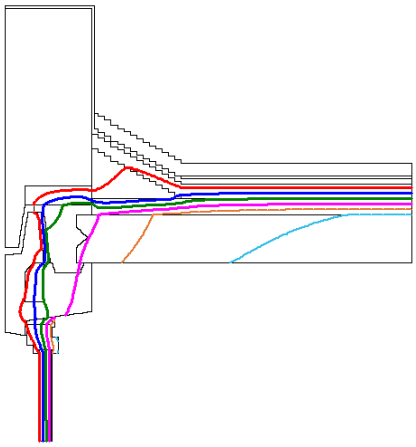
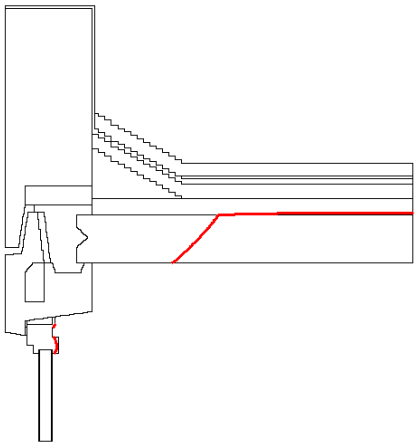
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W R_{se} = 0.08 m^2.K/W

Table 2.39.4 – Thermal-technical evaluation of detail 39

DETAIL 39

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 0.044 W/(m.K) λ = 0.044 W/(m.K) λ = 0.210 W/(m.K) λ = 0.950 W/(m.K) λ = 0.750 W/(m.K) λ = 0.610 W/(m.K) λ = 1.580 W/(m.K) λ = 1.360 W/(m.K) λ = 0.180 W/(m.K) λ = 1.000 W/(m.K) λ = 0.070 W/(m.K) λ = 0.204 W/(m.K) λ = 0.070 W/(m.K) λ = 0.220 W/(m.K) λ = 0.060 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 3.14 °C	f_{Rsi}= 0.518	θ_{si} = 3.14 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 6.62 °C	f_{Rsi}= 0.618	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	

Linear thermal transmittance	ψ = 2.28059 - 2.579 × 0.363 - 0.862 × 0.502 - 0.394 × 1.270 = 0.411 W/(m.K)

Table 2.40.1 – Marking of the position of detail in the building – detail 40

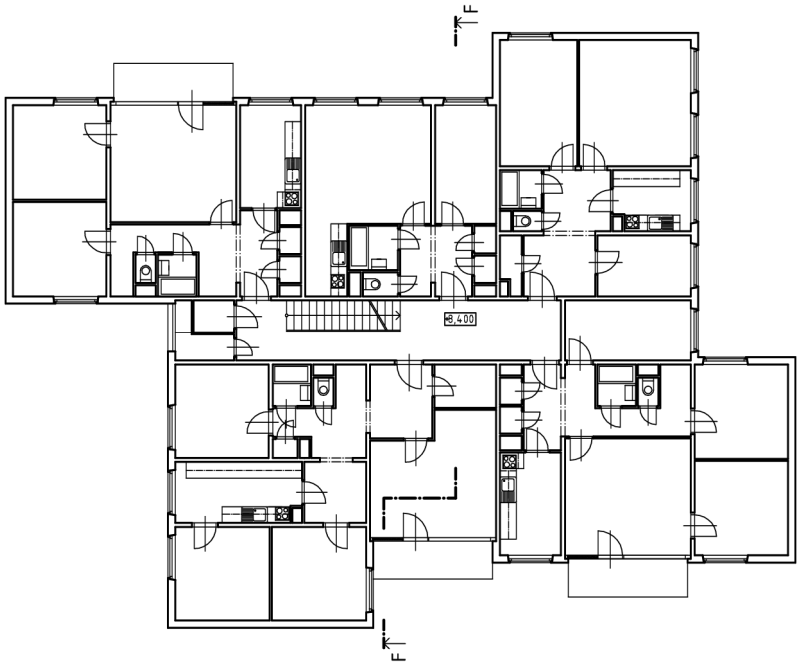
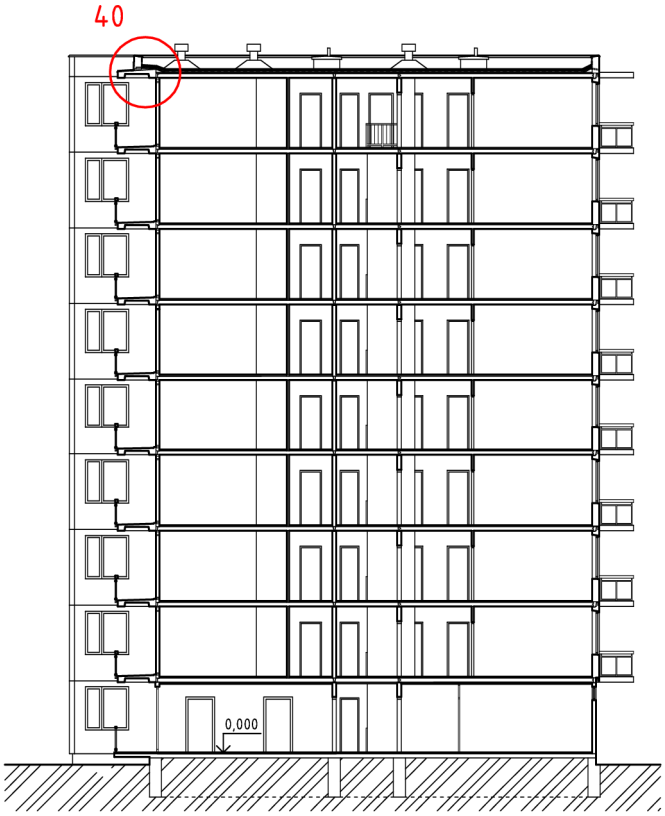
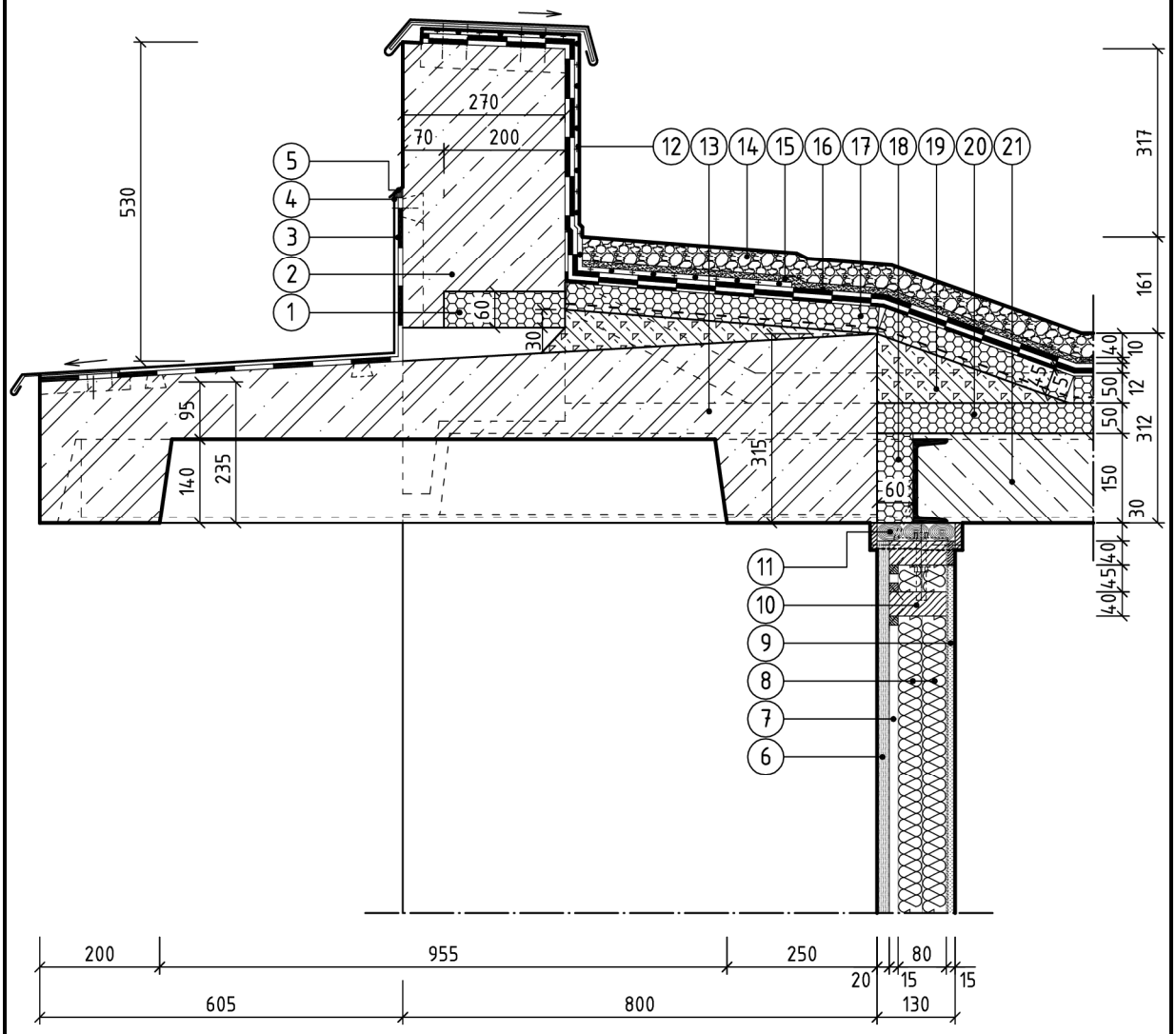
DETAIL 40
Floor plan

Section F-F


Table 2.40.2 – Structural composition of detail 40

DETAIL 40



Legend:

1. Polystyrene foam (λ = 0.044 W/(m.K))
2. Reinforced concrete attic panel (λ = 1.58 W/(m.K))
3. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
4. Galvanized sheet metal (not considered in model)
5. Sealant (λ = 0.22 W/(m.K))
6. Batten siding (λ = 0.18 W/(m.K))
7. Closed air gap (λ = 0.09 W/(m.K))
8. Basalt wool (λ = 0.07 W/(m.K))
9. Particle board (λ = 0.11 W/(m.K))
10. Wooden frame (λ = 0.18 W/(m.K))
11. Seal - glass wool (λ = 0.07 W/(m.K))
12. Waterproofing rubber foil (not considered in model)
13. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))
14. Gravel (λ = 0.75 W/(m.K))
15. Sand (λ = 0.95 W/(m.K))
16. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
17. Boards POLSID (λ = 0.044 W/(m.K))
18. Polystyrene foam (λ = 0.044 W/(m.K))
19. Lightweight concrete (λ = 0.61 W/(m.K))
20. Polystyrene foam (λ = 0.044 W/(m.K))
21. Reinforc. concrete ceiling panel (λ = 1.58 W/(m.K))

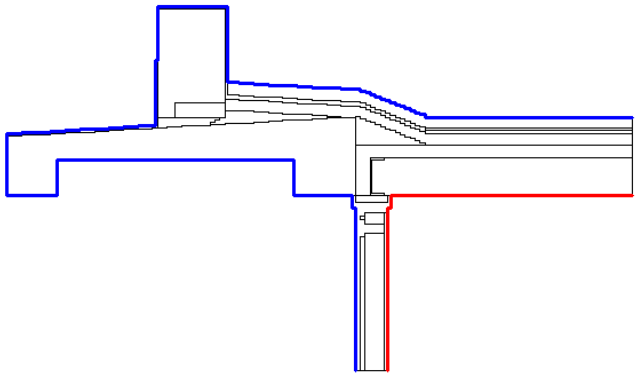
$U_{wall,2}$ = 0.579 W/(m^2.K)

U_{roof} = 0.394 W/(m^2.K)

Table 2.40.3 – Boundary conditions for a calculation of detail 40

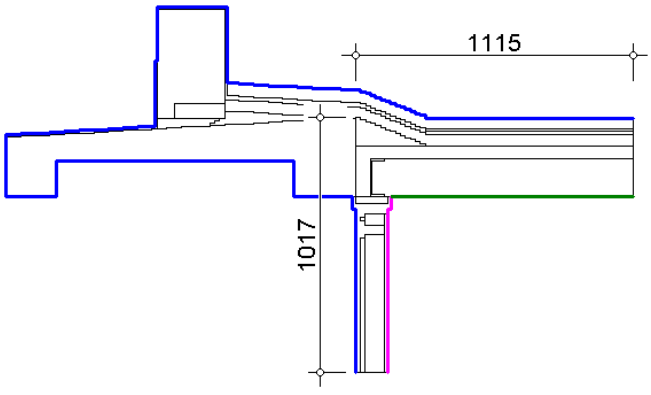
DETAIL 40

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

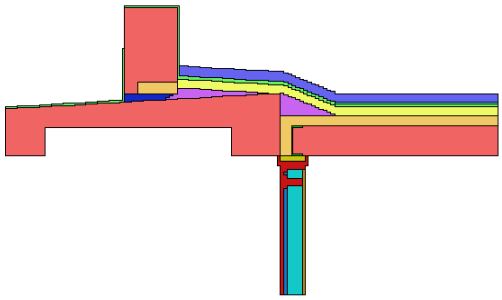
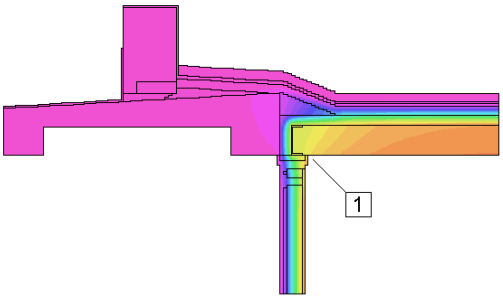
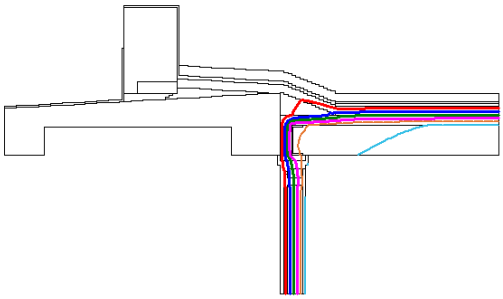
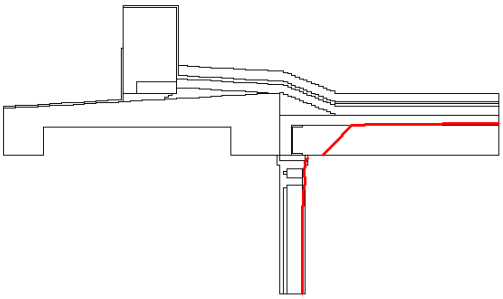
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.40.4 – Thermal-technical evaluation of detail 40

DETAIL 40

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 0.044 W/(m.K) λ = 0.044 W/(m.K) λ = 0.210 W/(m.K) λ = 0.950 W/(m.K) λ = 0.750 W/(m.K) λ = 0.610 W/(m.K) λ = 0.180 W/(m.K) λ = 0.110 W/(m.K) λ = 0.070 W/(m.K) λ = 40.00 W/(m.K) λ = 0.070 W/(m.K) λ = 0.090 W/(m.K) λ = 1.500 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 11.56 °C	f_{Rsi}= 0.759	θ_{si} = 11.56 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
			$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance			ψ = 1.00276 - 0.579 × 1.017 - 0.394 × 1.115 = -0.025 W/(m.K)	

Table 2.41.1 – Marking of the position of detail in the building – detail 41

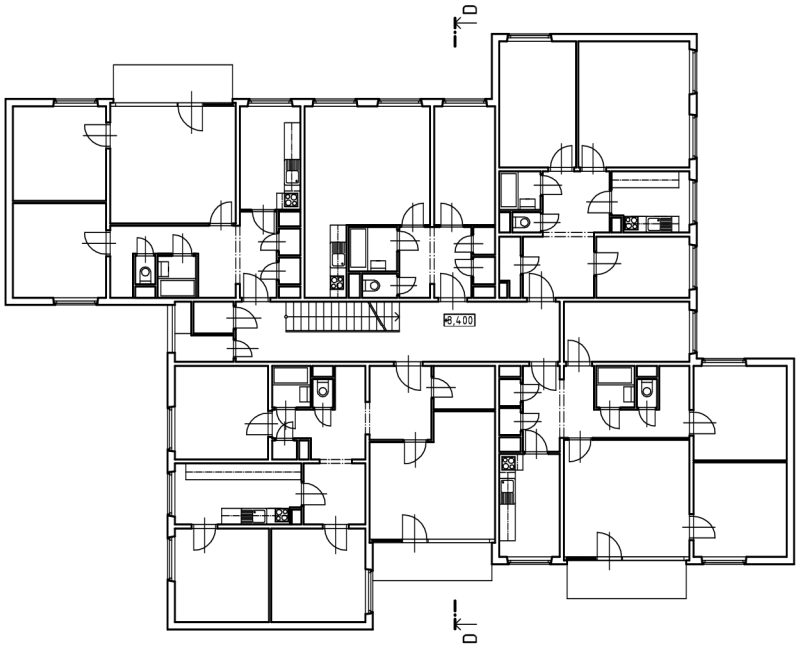
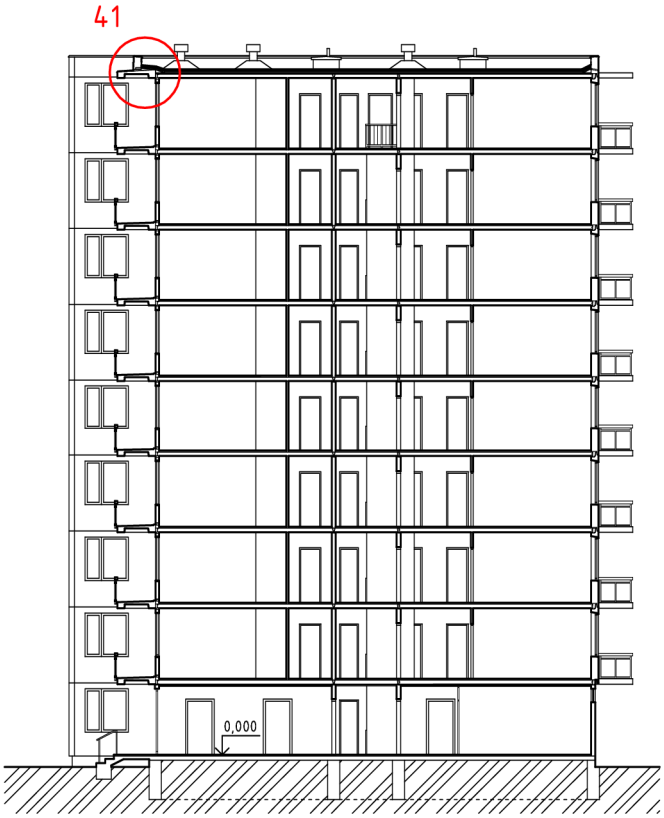
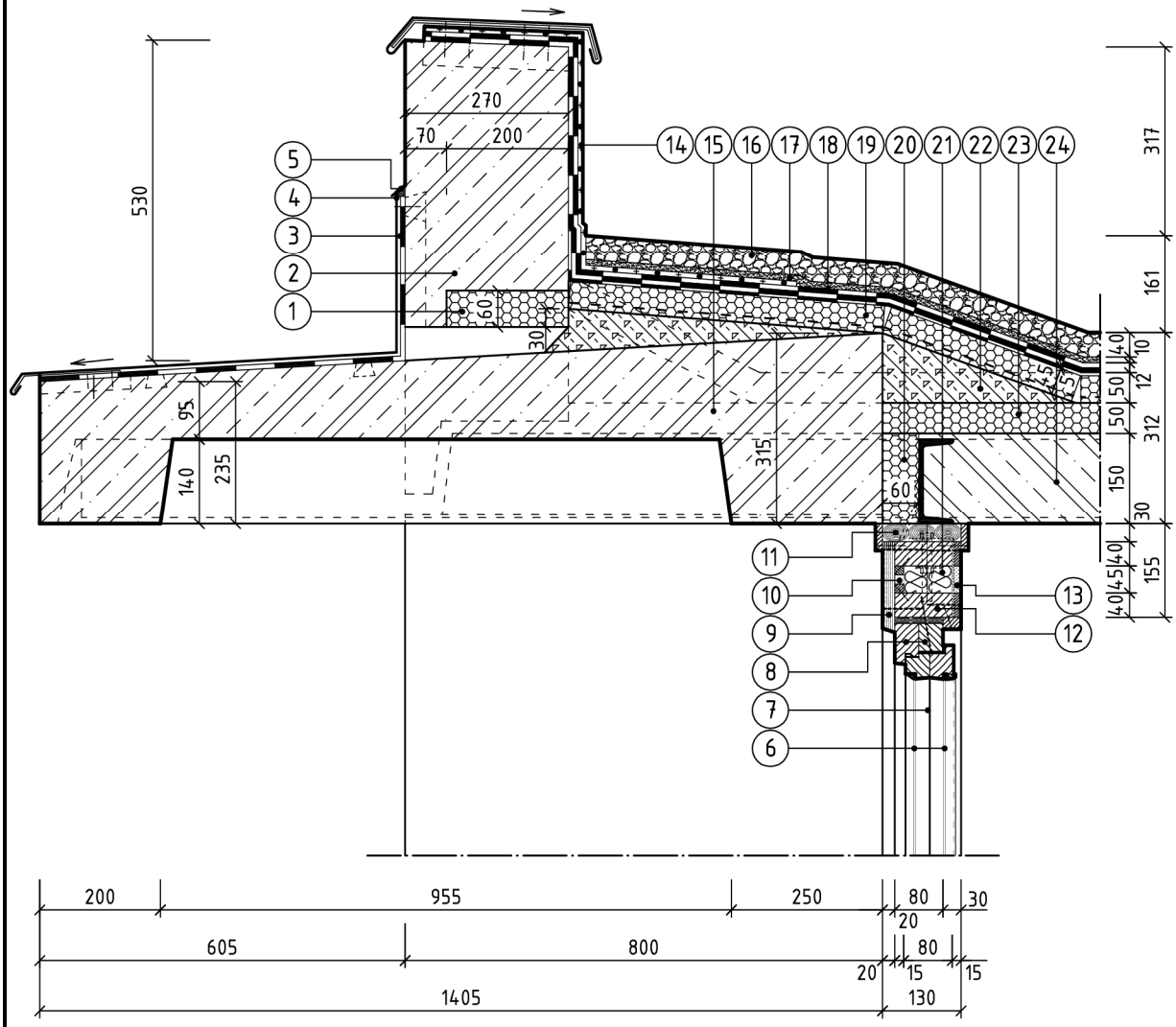
DETAIL 41
Floor plan

Section D-D


Table 2.41.2 – Structural composition of detail 41

DETAIL 41



Legend:

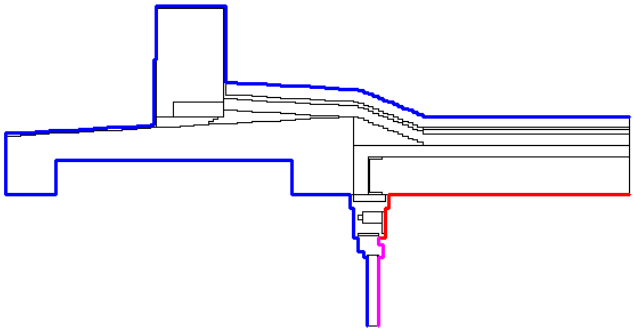
1. Polystyrene foam (λ = 0.044 W/(m.K))
2. Reinforced concrete attic panel (λ = 1.58 W/(m.K))
3. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
4. Galvanized sheet metal (not considered in model)
5. Sealant (λ = 0.22 W/(m.K))
6. Glass 3 mm (λ = 1.00 W/(m.K))
7. Closed air gap 37 mm (λ = 0.204 W/(m.K))
8. Wooden double glazed window (λ = 0.18 W/(m.K))
9. Batten siding (spruce) (λ = 0.18 W/(m.K))
10. Closed air gap (λ = 0.09 W/(m.K))
11. Seal - glass wool (λ = 0.07 W/(m.K))
12. Wooden frame (λ = 0.18 W/(m.K))
13. Particle board (λ = 0.11 W/(m.K))
14. Waterproofing rubber foil (not considered in model)
15. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))
16. Gravel (λ = 0.75 W/(m.K))
17. Sand (λ = 0.95 W/(m.K))
18. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
19. Boards POLSID (λ = 0.044 W/(m.K))
20. Polystyrene foam (λ = 0.044 W/(m.K))
21. Basalt wool (λ = 0.07 W/(m.K))
22. Lightweight concrete (λ = 0.61 W/(m.K))
23. Polystyrene foam (λ = 0.044 W/(m.K))
24. Reinforc. concrete ceiling panel (λ = 1.58 W/(m.K))

$U_{wall,2}$ = 0.579 W/(m^2.K) **$U_{window,\ wooden}$ = 2.579 W/(m^2.K)** **U_{roof} = 0.394 W/(m^2.K)**

Table 2.41.3 – Boundary conditions for a calculation of detail 41

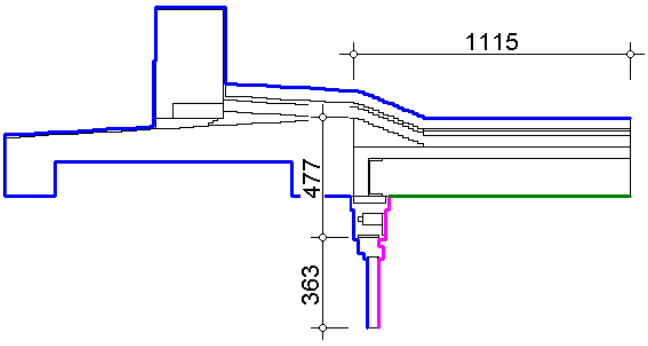
DETAIL 41

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

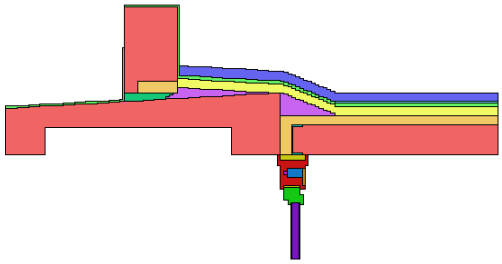
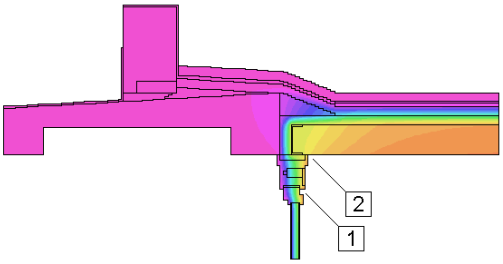
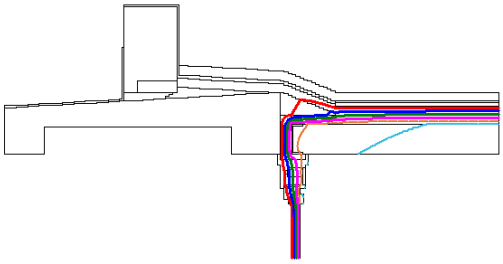
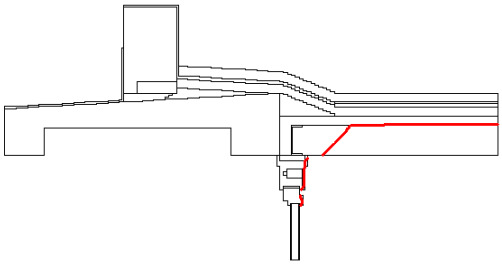
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.41.4 – Thermal-technical evaluation of detail 41

DETAIL 41

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 0.044 W/(m.K) λ = 0.044 W/(m.K) λ = 0.210 W/(m.K) λ = 0.950 W/(m.K) λ = 0.750 W/(m.K) λ = 0.610 W/(m.K) λ = 0.180 W/(m.K) λ = 0.110 W/(m.K) λ = 0.070 W/(m.K) λ = 0.180 W/(m.K) λ = 40.00 W/(m.K) λ = 0.070 W/(m.K) λ = 1.000 W/(m.K) λ = 0.204 W/(m.K) λ = 0.090 W/(m.K) λ = 1.500 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 10.73 °C	f_{Rsi}= 0.735	θ_{si} = 10.73 °C < $\theta_{si,80} + \Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 11.58 °C	f_{Rsi}= 0.759	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance	ψ = 1.63177 - 2.579 × 0.363 - 0.579 × 0.477 - 0.394 × 1.115 = -0.020 W/(m.K)			

Table 2.42.1 – Marking of the position of detail in the building – detail 42

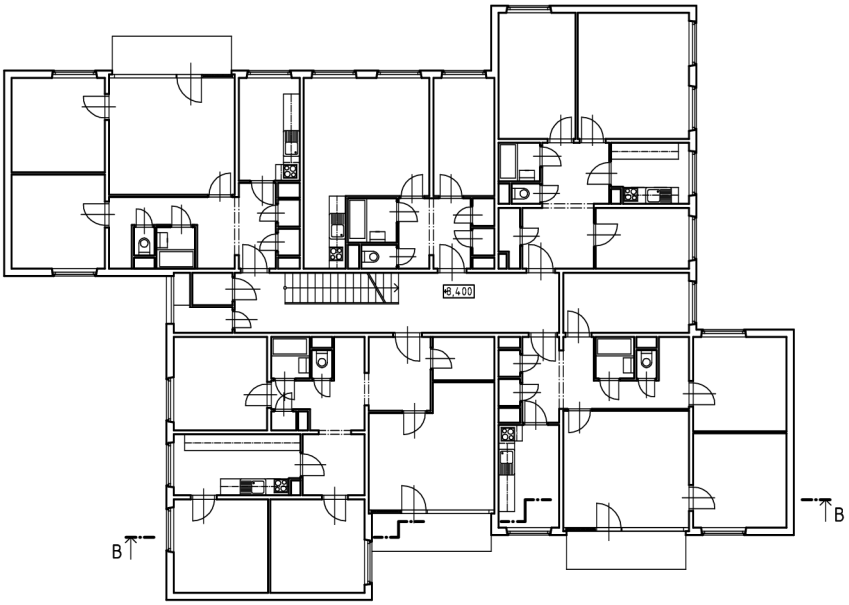
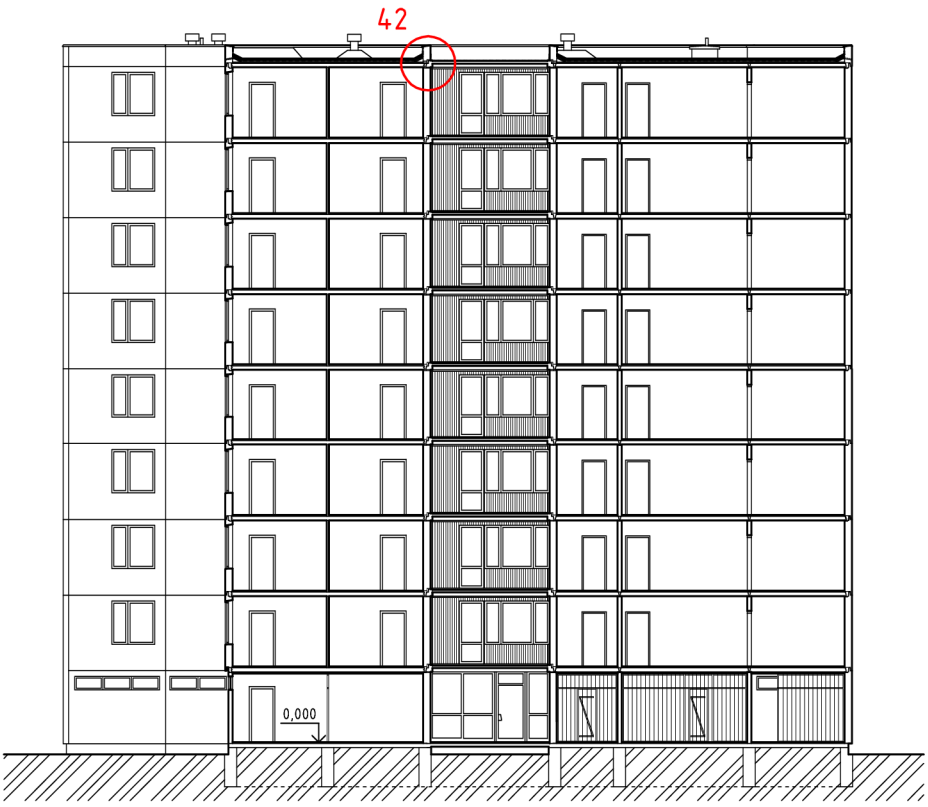
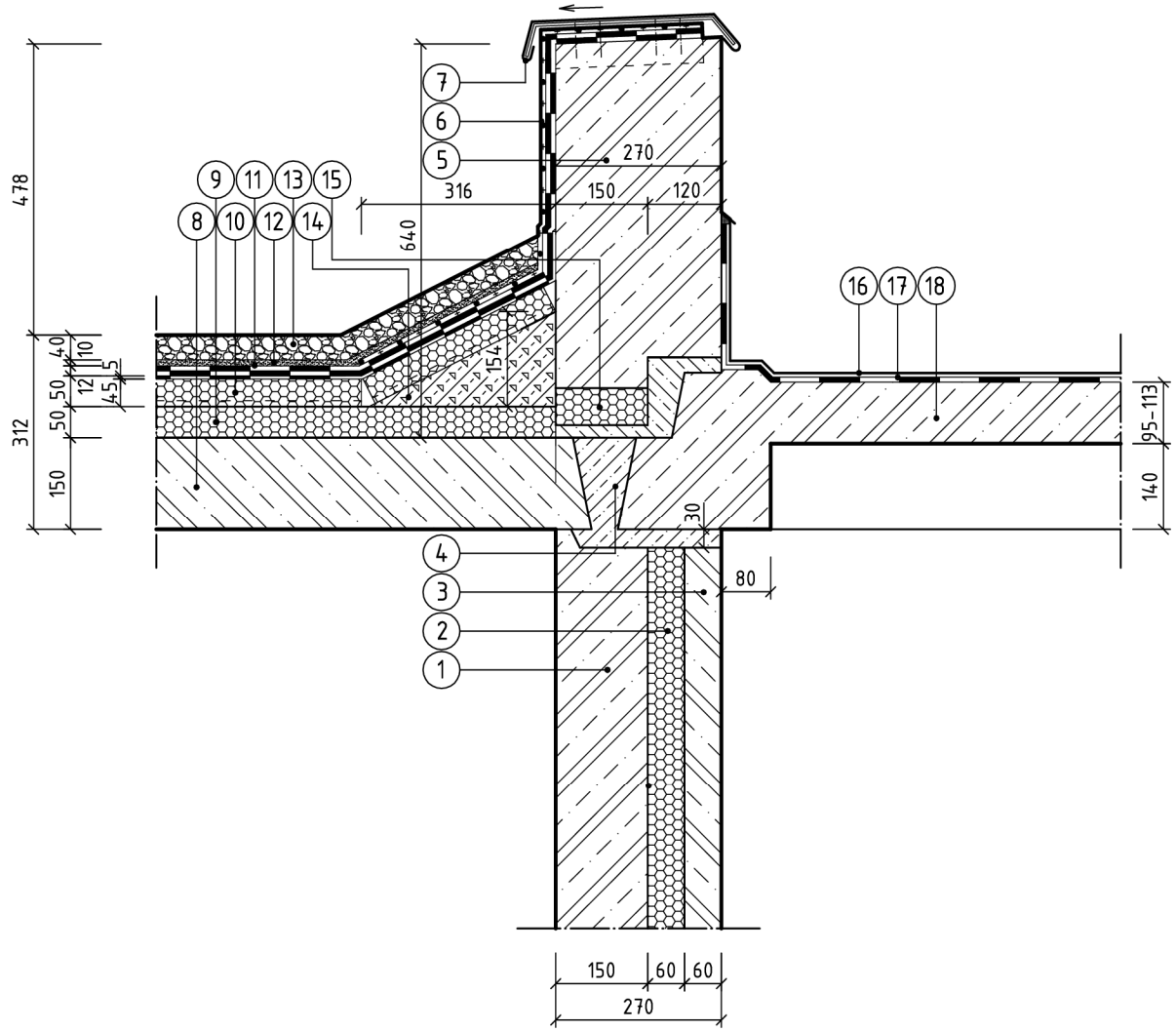
DETAIL 42
Floor plan

Section B-B


Table 2.42.2 – Structural composition of detail 42

DETAIL 42



Legend:

1. Reinforced concrete (λ = 1.58 W/(m.K))
2. Polystyrene foam (λ = 0.07 W/(m.K))
3. Reinforced concrete (λ = 1.58 W/(m.K))
4. Concrete grout (λ = 1.36 W/(m.K))
5. Reinforced concrete attic panel (λ = 1.58 W/(m.K))
6. Waterproofing rubber foil (not considered in model)
7. Sheet metal covering (not considered in model)
8. Reinforced concrete ceiling panel (λ = 1.58 W/(m.K))
9. Polystyrene foam (λ = 0.044 W/(m.K))
10. Boards POLSID (λ = 0.044 W/(m.K))
11. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
12. Sand (λ = 0.95 W/(m.K))
13. Gravel (λ = 0.75 W/(m.K))
14. Lightweight concrete (λ = 0.61 W/(m.K))
15. Polystyrene foam (λ = 0.044 W/(m.K))
16. Galvanized sheet metal (not considered in model)
17. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
18. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))

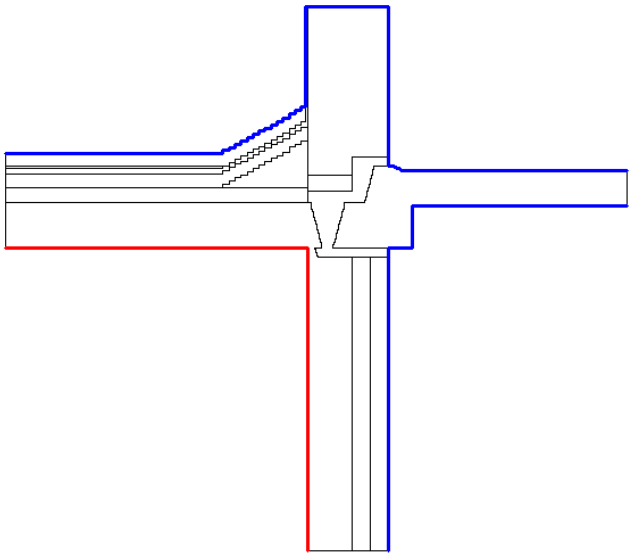
$U_{wall,1}$ = 0.862 W/(m^2.K)

U_{roof} = 0.394 W/(m^2.K)

Table 2.42.3 – Boundary conditions for a calculation of detail 42

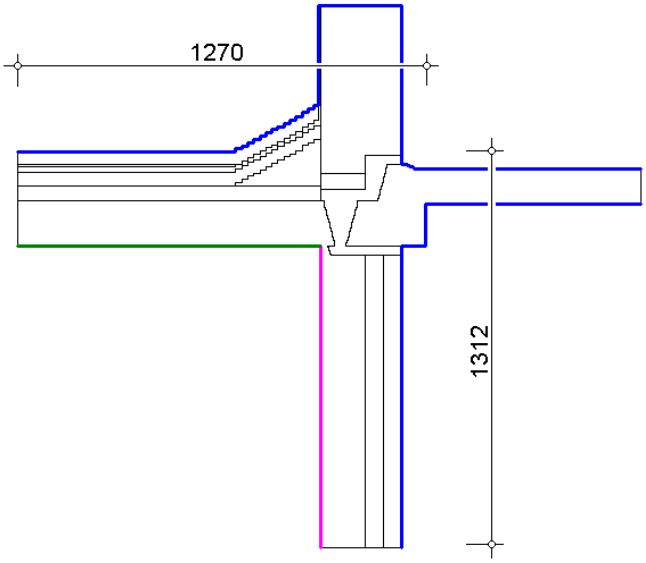
DETAIL 42

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

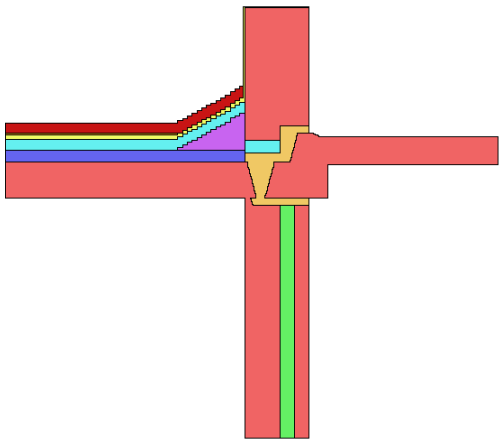
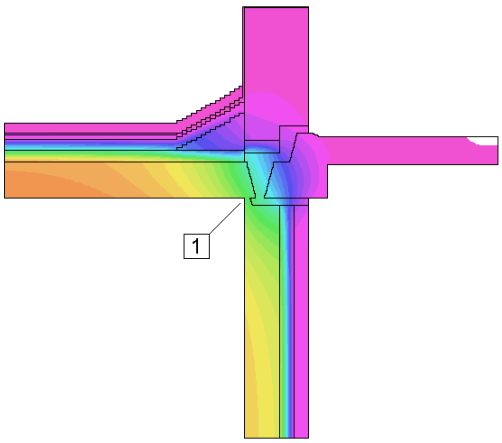
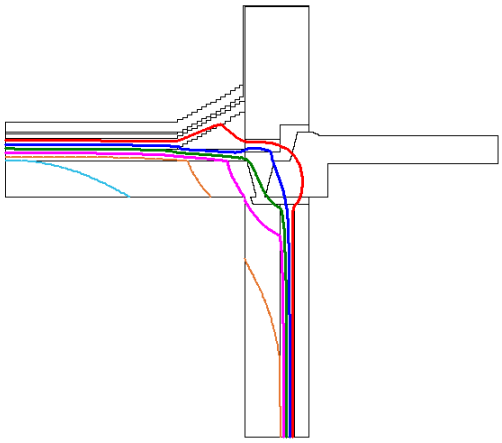
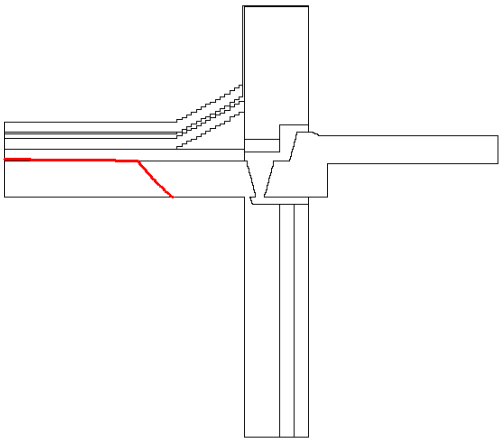
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.42.4 – Thermal-technical evaluation of detail 42

DETAIL 42

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 1.360 W/(m.K) λ = 0.210 W/(m.K) λ = 0.070 W/(m.K) λ = 0.044 W/(m.K) λ = 0.044 W/(m.K) λ = 0.610 W/(m.K) λ = 0.750 W/(m.K) λ = 0.950 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 4.87 °C	f_{Rsi}= 0.568	θ_{si} = 4.87 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
			$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = 2.5 °C)	
Linear thermal transmittance			ψ = 2.01222 - 0.394 × 1.270 - 0.862 × 1.312 = 0.381 W/(m.K)	

Table 2.43.1 – Marking of the position of detail in the building – detail 43

DETAIL 43
Floor plan

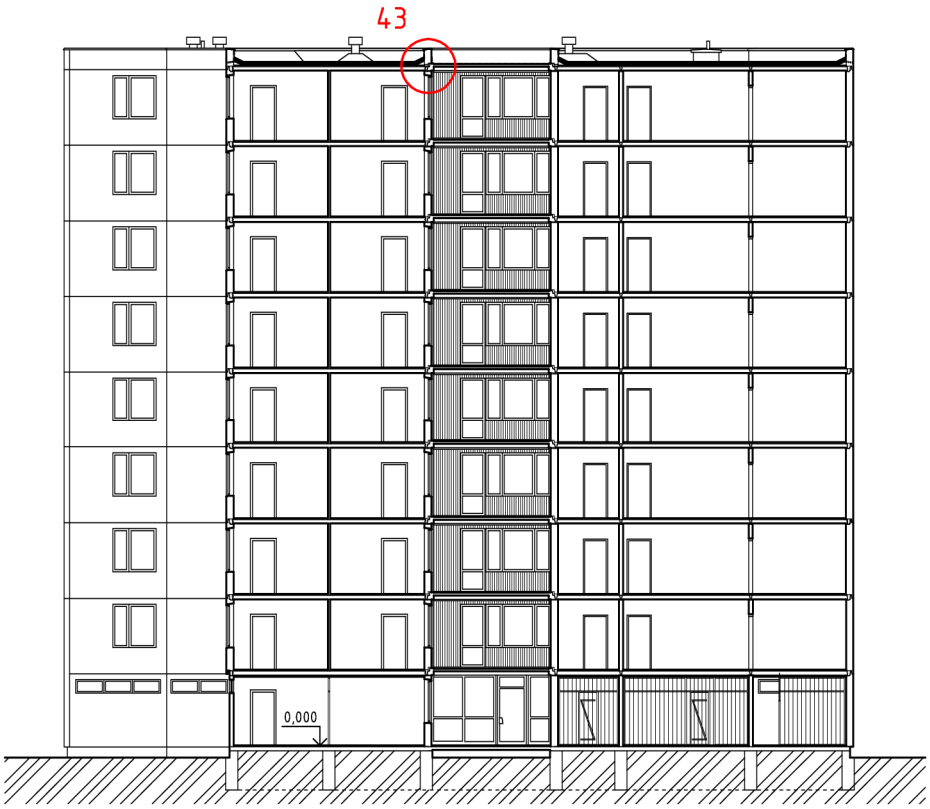
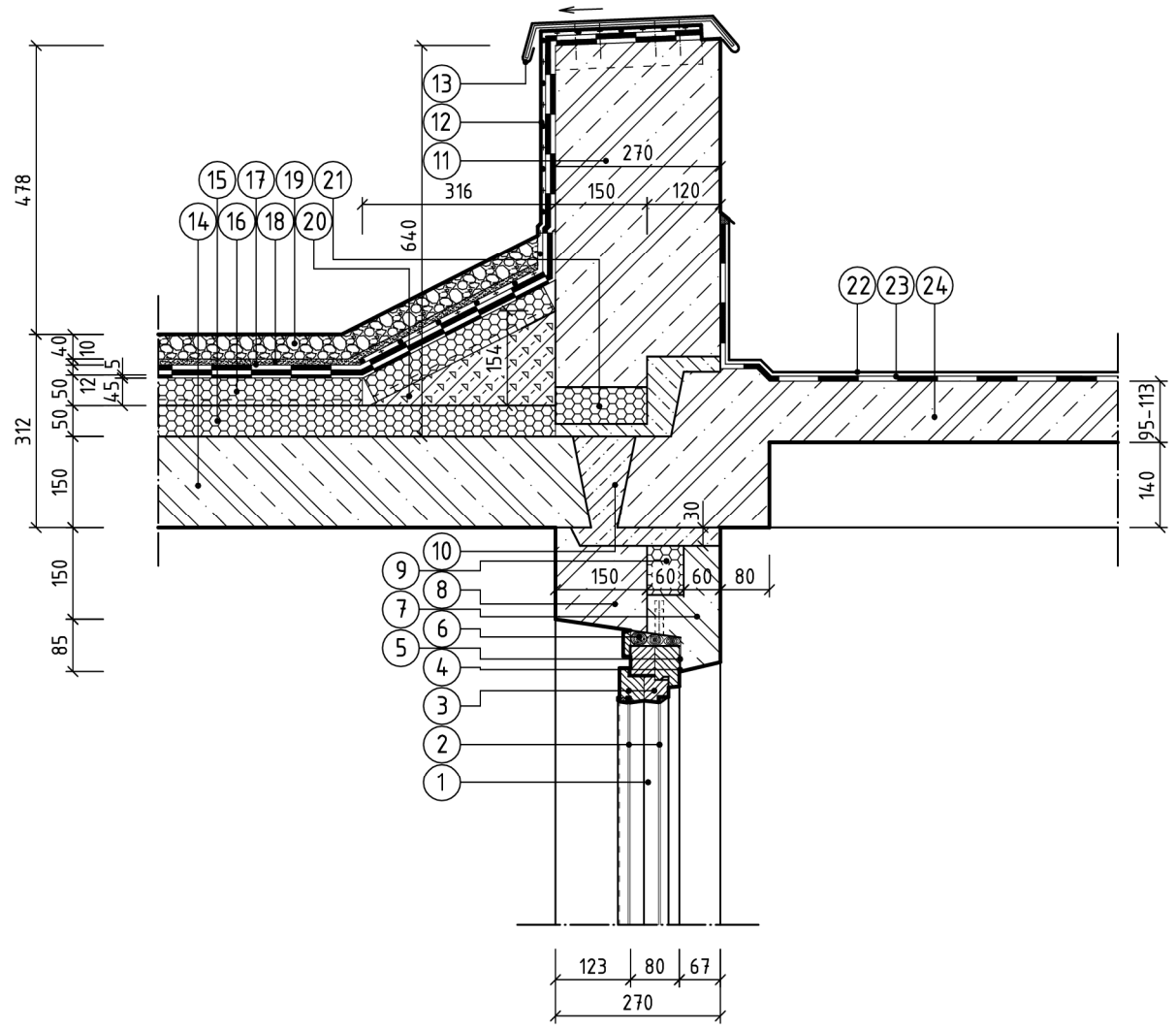
Section J-J


Table 2.43.2 – Structural composition of detail 43

DETAIL 43



Legend:

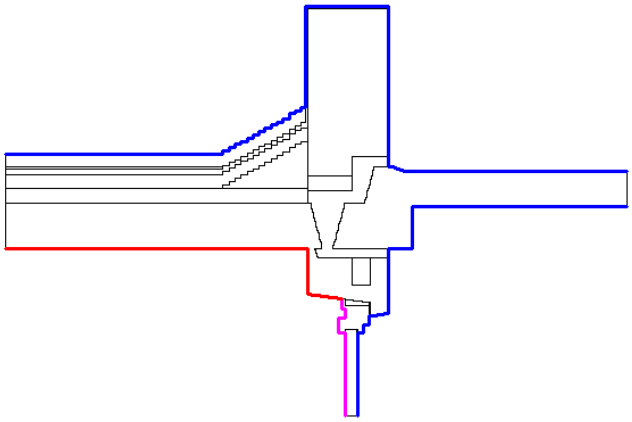
1. Closed air gap 37 mm (λ = 0.204 W/(m.K))
2. Glass 3 mm (λ = 1.00 W/(m.K))
3. Wooden window frame (λ = 0.18 W/(m.K))
4. Sealant (λ = 0.22 W/(m.K))
5. Microporous rubber (λ = 0.06 W/(m.K))
6. Seal - glass wool (λ = 0.07 W/(m.K))
7. Reinforced concrete (λ = 1.58 W/(m.K))
8. Reinforced concrete (λ = 1.58 W/(m.K))
9. Polystyrene foam (λ = 0.07 W/(m.K))
10. Concrete grout (λ = 1.36 W/(m.K))
11. Reinforced concrete attic panel (λ = 1.58 W/(m.K))
12. Waterproofing rubber foil (not consid. in model)
13. Sheet metal covering (not considered in model)
14. Reinforced concrete ceiling panel (λ = 1.58 W/(m.K))
15. Polystyrene foam (λ = 0.044 W/(m.K))
16. Boards POLSID (λ = 0.044 W/(m.K))
17. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
18. Sand (λ = 0.95 W/(m.K))
19. Gravel (λ = 0.75 W/(m.K))
20. Lightweight concrete (λ = 0.61 W/(m.K))
21. Polystyrene foam (λ = 0.044 W/(m.K))
22. Galvanized sheet metal (not considered in model)
23. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
24. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))

$U_{wall,1}$ = 0.862 W/(m^2.K) **$U_{window,\ wooden}$ = 2.579 W/(m^2.K)** **U_{roof} = 0.394 W/(m^2.K)**

Table 2.43.3 – Boundary conditions for a calculation of detail 43

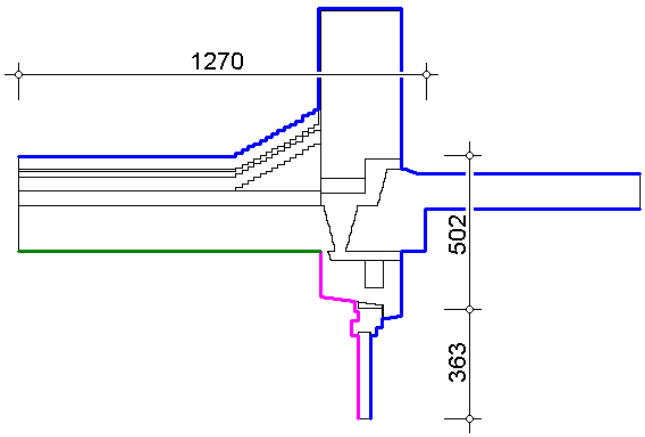
DETAIL 43

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

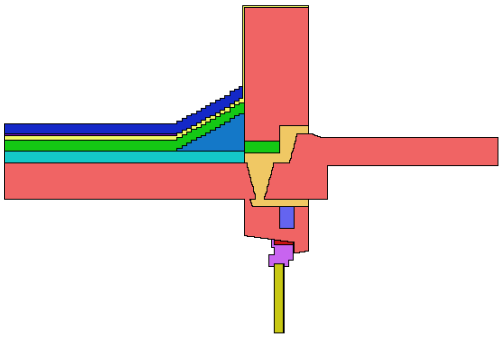
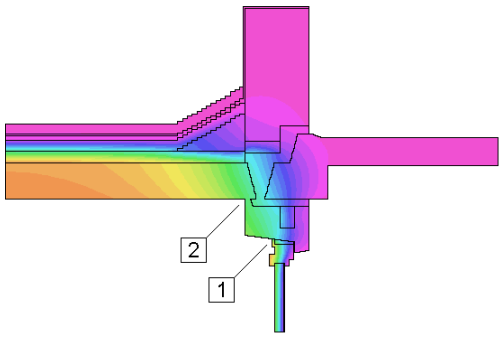
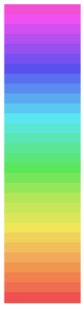
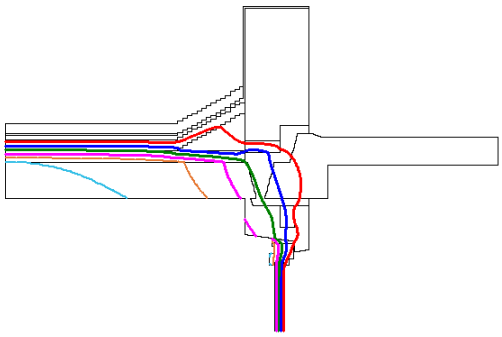
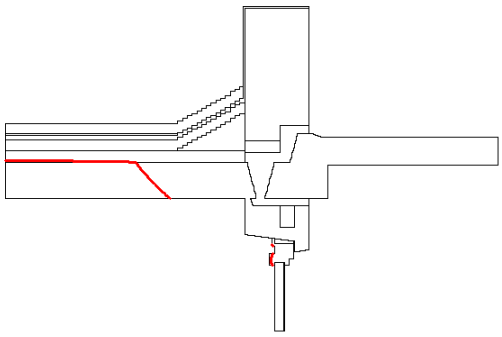
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.43.4 – Thermal-technical evaluation of detail 43

DETAIL 43

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 1.360 W/(m.K) λ = 0.210 W/(m.K) λ = 0.220 W/(m.K) λ = 0.060 W/(m.K) λ = 0.070 W/(m.K) λ = 0.180 W/(m.K) λ = 0.070 W/(m.K) λ = 1.000 W/(m.K) λ = 0.204 W/(m.K) λ = 0.044 W/(m.K) λ = 0.044 W/(m.K) λ = 0.610 W/(m.K) λ = 0.750 W/(m.K) λ = 0.950 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 1.68 °C	f_{Rsi}= 0.477	θ_{si} = 1.68 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 3.81 °C	f_{Rsi}= 0.537	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance	ψ = 2.49612 - 0.394 × 1.270 - 0.862 × 0.502 - 2.579 × 0.363 = 0.627 W/(m.K)			

Table 2.44.1 – Marking of the position of detail in the building – detail 44

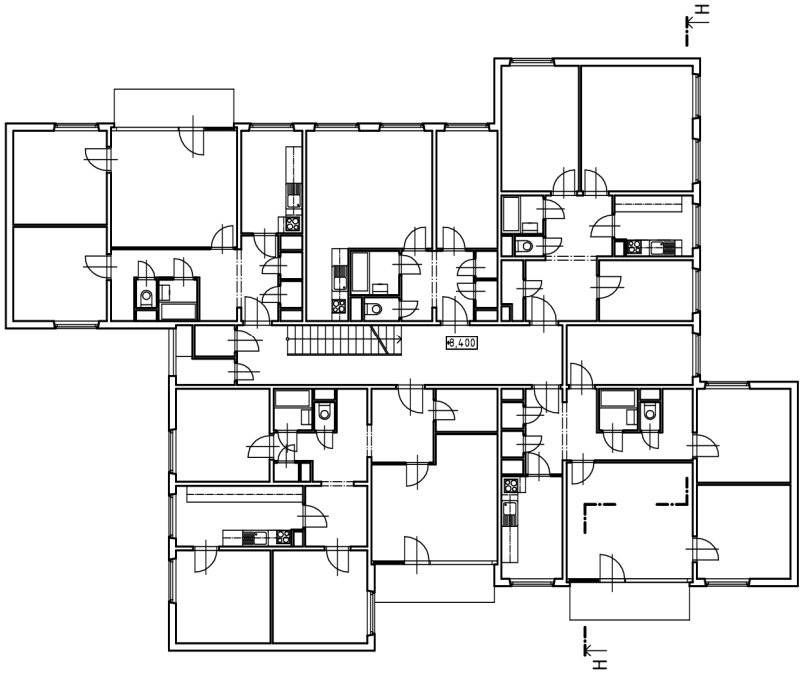
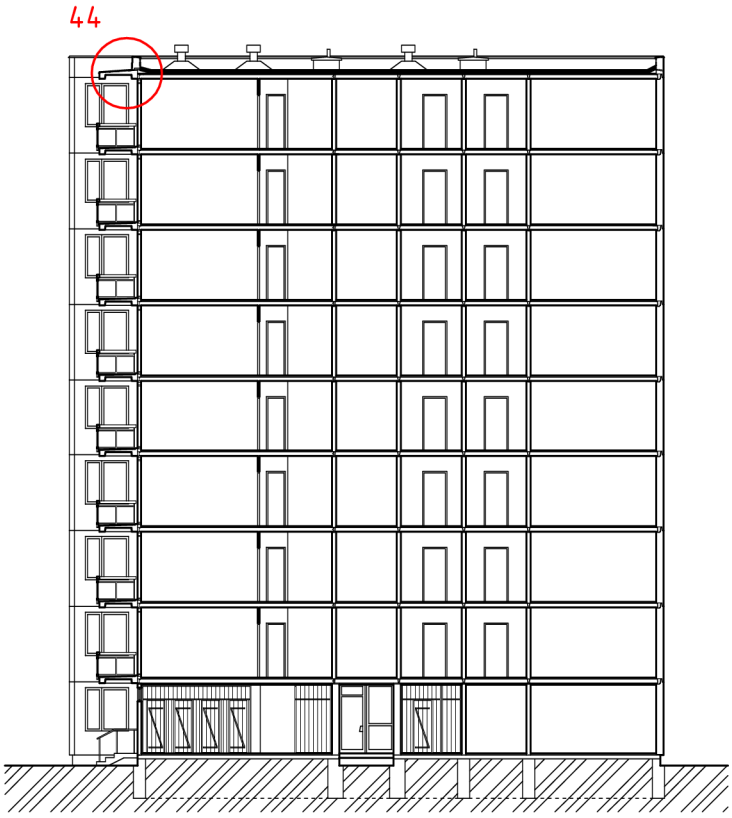
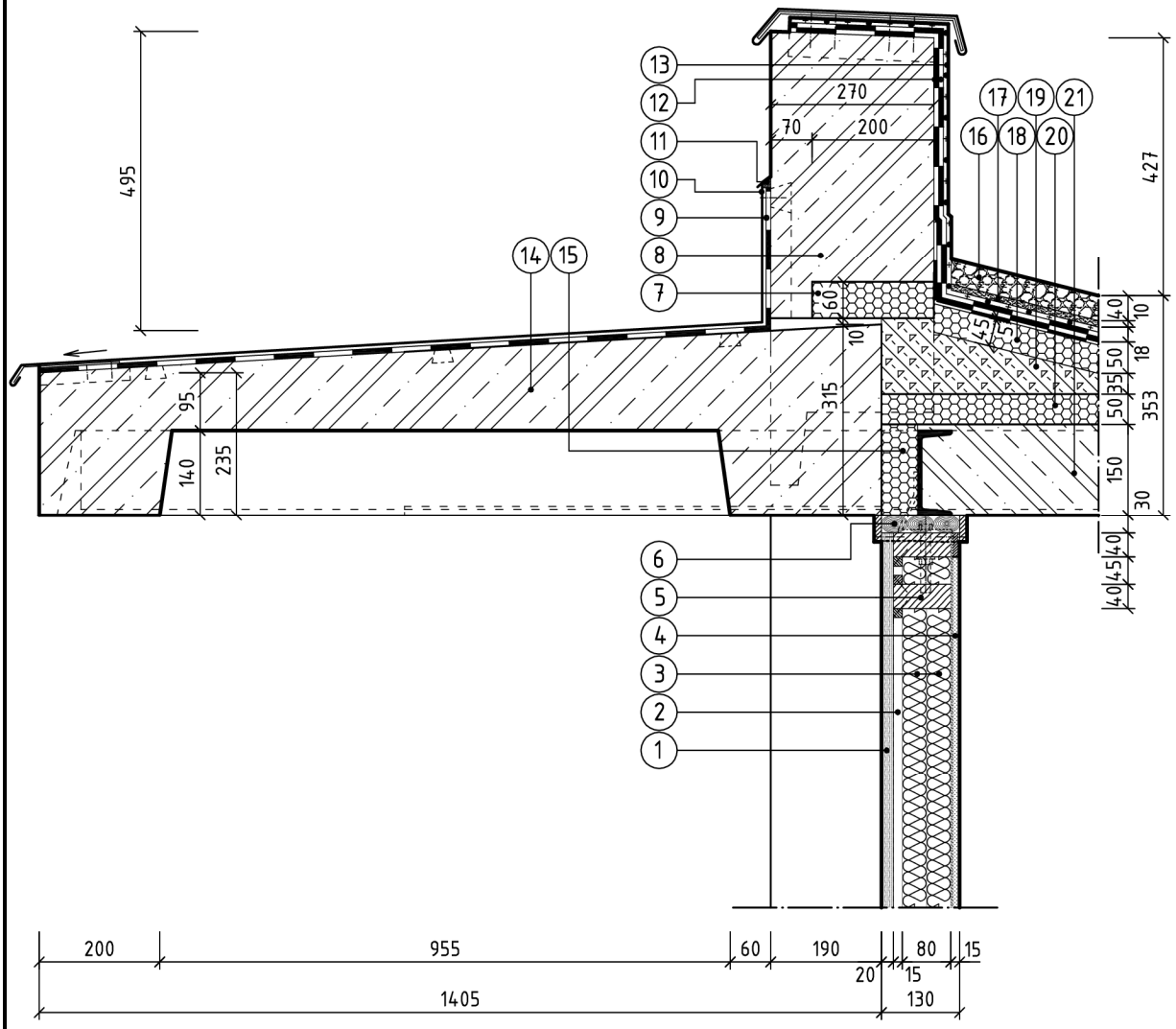
DETAIL 44
Floor plan

Section H-H


Table 2.44.2 – Structural composition of detail 44

DETAIL 44



Legend:

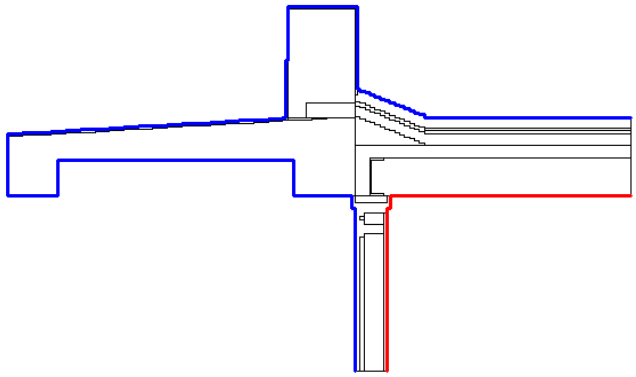
1. Batten siding (λ = 0.18 W/(m.K))
2. Closed air gap (λ = 0.09 W/(m.K))
3. Basalt wool (λ = 0.07 W/(m.K))
4. Particle board (λ = 0.11 W/(m.K))
5. Wooden frame (λ = 0.18 W/(m.K))
6. Seal - glass wool (λ = 0.07 W/(m.K))
7. Polystyrene foam (λ = 0.044 W/(m.K))
8. Reinforced concrete attic panel (λ = 1.58 W/(m.K))
9. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
10. Galvanized sheet metal (not considered in model)
11. Sealant (λ = 0.22 W/(m.K))
12. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
13. Waterproofing rubber foil (not consid. in model)
14. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))
15. Polystyrene foam (λ = 0.044 W/(m.K))
16. Gravel (λ = 0.75 W/(m.K))
17. Sand (λ = 0.95 W/(m.K))
18. Boards POLSID (λ = 0.044 W/(m.K))
19. Lightweight concrete (λ = 0.61 W/(m.K))
20. Polystyrene foam (λ = 0.044 W/(m.K))
21. Reinforc. concrete ceiling panel (λ = 1.58 W/(m.K))

$U_{wall,2}$ = 0.579 W/(m^2.K) **U_{roof} = 0.394 W/(m^2.K)**

Table 2.44.3 – Boundary conditions for a calculation of detail 44

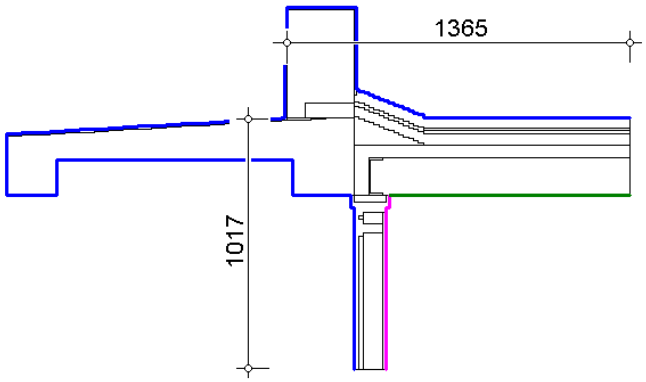
DETAIL 44

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

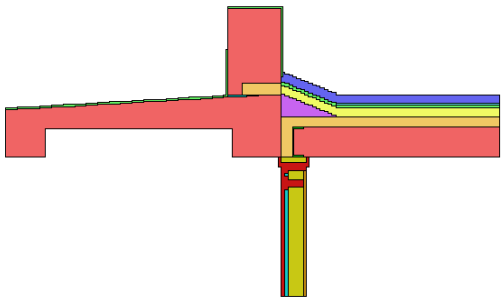
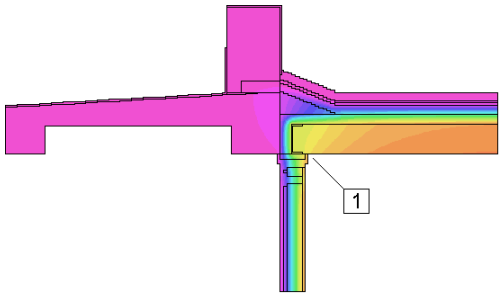
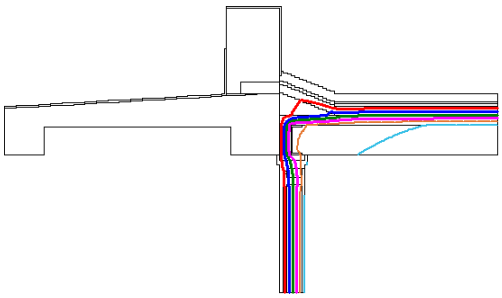
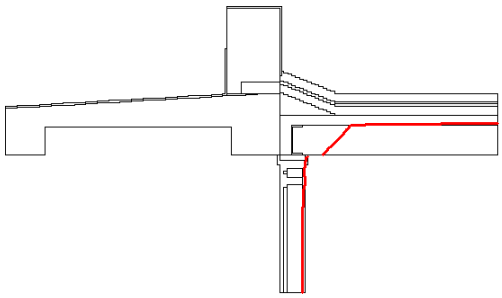
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.44.4 – Thermal-technical evaluation of detail 44

DETAIL 44

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 0.044 W/(m.K) λ = 0.044 W/(m.K) λ = 0.210 W/(m.K) λ = 0.950 W/(m.K) λ = 0.750 W/(m.K) λ = 0.610 W/(m.K) λ = 0.180 W/(m.K) λ = 0.110 W/(m.K) λ = 0.070 W/(m.K) λ = 40.00 W/(m.K) λ = 0.090 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 11.54 °C	f_{Rsi}= 0.758	θ_{si} = 11.54 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
			$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance			ψ = 1.00054 - 0.579 × 1.017 - 0.394 × 1.365 = -0.126 W/(m.K)	

Table 2.45.1 – Marking of the position of detail in the building – detail 45

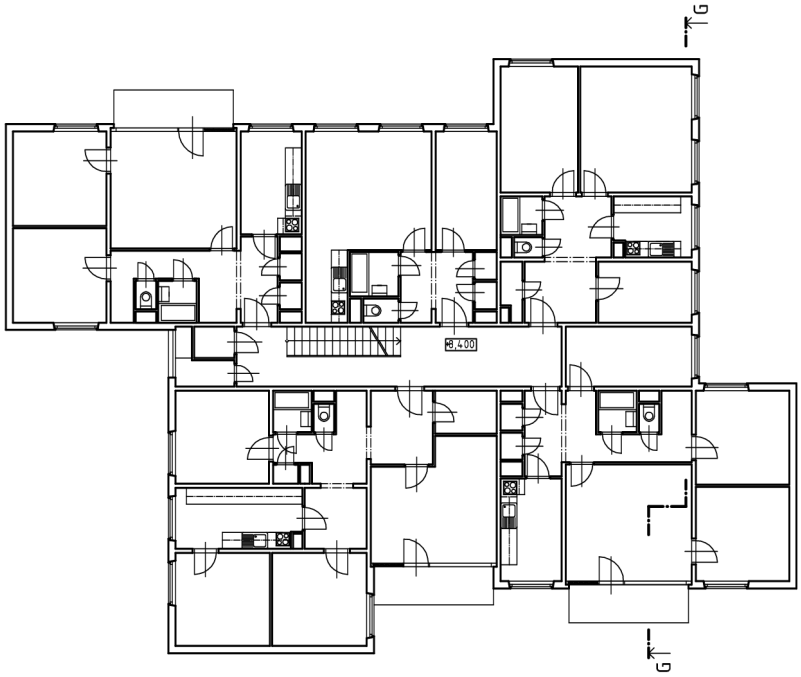
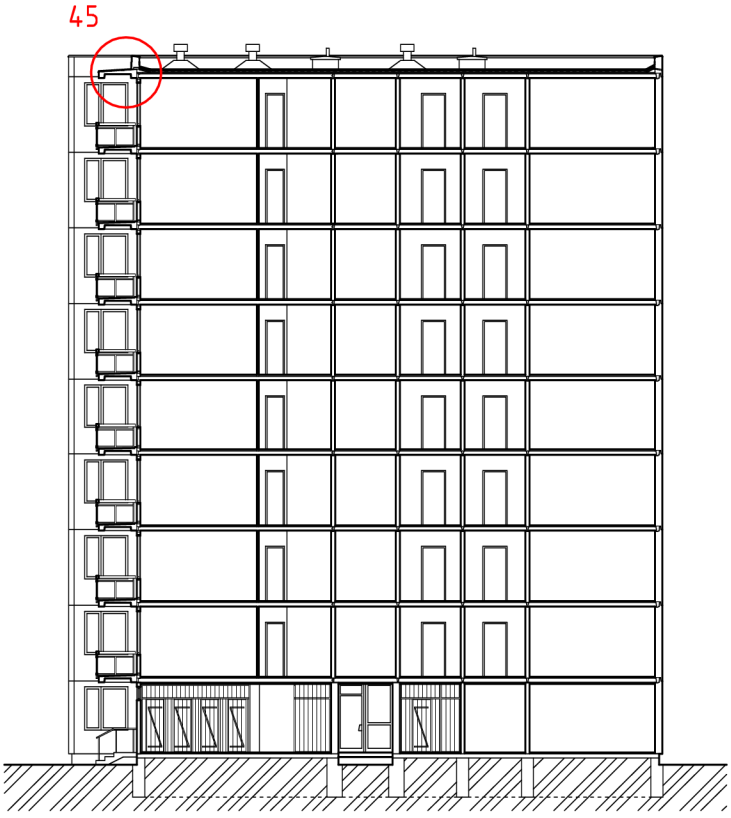
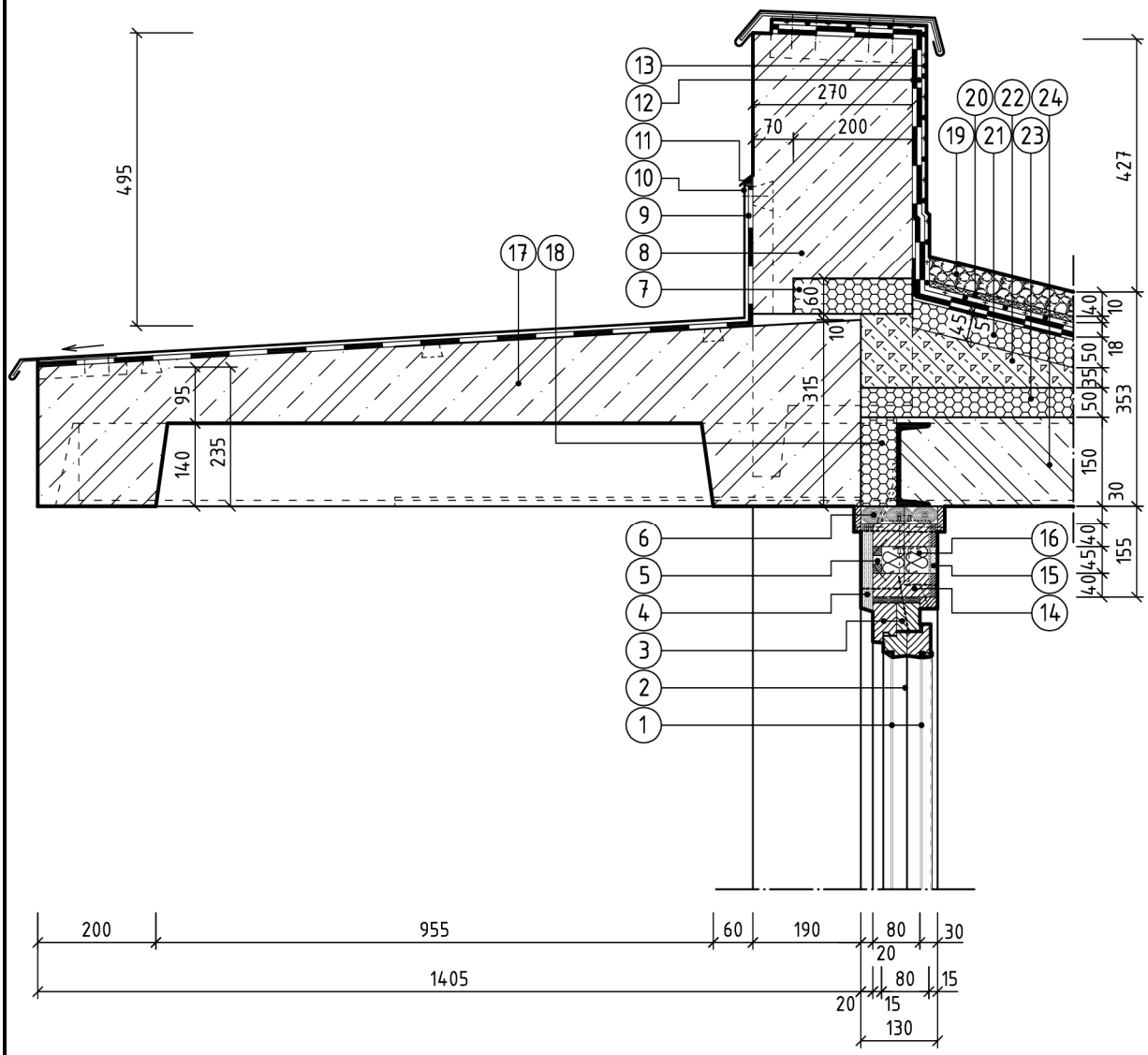
DETAIL 45
Floor plan

Section G-G


Table 2.45.2 – Structural composition of detail 45

DETAIL 45



Legend:

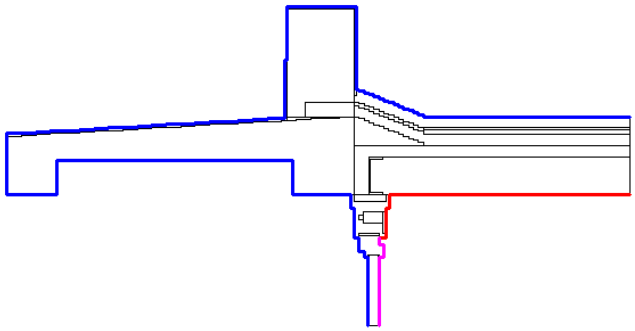
1. Glass 3 mm (λ = 1.00 W/(m.K))
2. Closed air gap 37 mm (λ = 0.204 W/(m.K))
3. Wooden window frame (λ = 0.18 W/(m.K))
4. Batten siding (spruce) (λ = 0.18 W/(m.K))
5. Closed air gap (λ = 0.09 W/(m.K))
6. Seal - glass wool (λ = 0.07 W/(m.K))
7. Polystyrene foam (λ = 0.044 W/(m.K))
8. Reinforced concrete attic panel (λ = 1.58 W/(m.K))
9. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
10. Galvanized sheet metal (not considered in model)
11. Sealant (λ = 0.22 W/(m.K))
12. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
13. Waterproofing rubber foil (not consid. in model)
14. Wooden frame (λ = 0.18 W/(m.K))
15. Particle board (λ = 0.11 W/(m.K))
16. Basalt wool (λ = 0.07 W/(m.K))
17. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))
18. Polystyrene foam (λ = 0.044 W/(m.K))
19. Gravel (λ = 0.75 W/(m.K))
20. Sand (λ = 0.95 W/(m.K))
21. Boards POLSID (λ = 0.044 W/(m.K))
22. Lightweight concrete (λ = 0.61 W/(m.K))
23. Polystyrene foam (λ = 0.044 W/(m.K))
24. Reinforc. concrete ceiling panel (λ = 1.58 W/(m.K))

$U_{wall,2}$ = 0.579 W/(m^2.K) **$U_{window,\ wooden}$ = 2.579 W/(m^2.K)** **U_{roof} = 0.394 W/(m^2.K)**

Table 2.45.3 – Boundary conditions for a calculation of detail 45

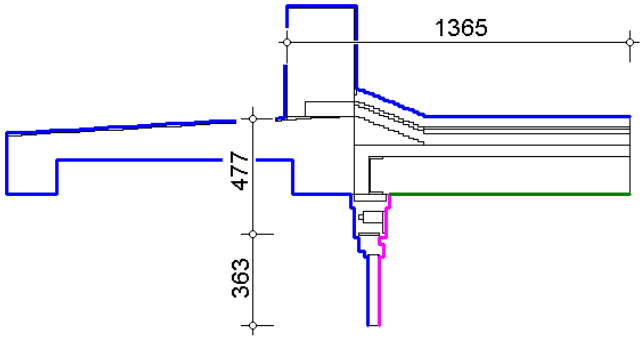
DETAIL 45

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

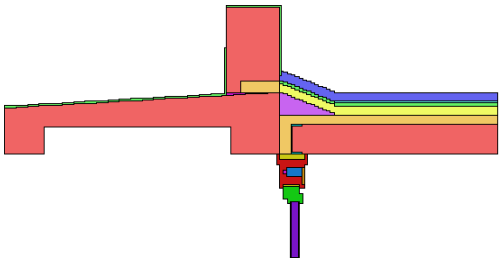
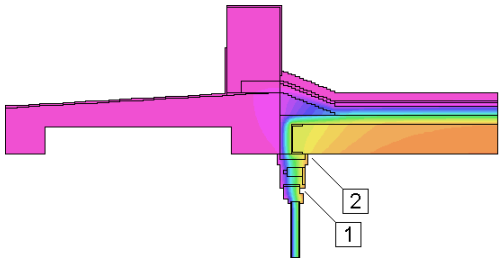
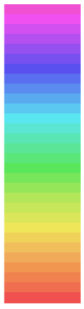
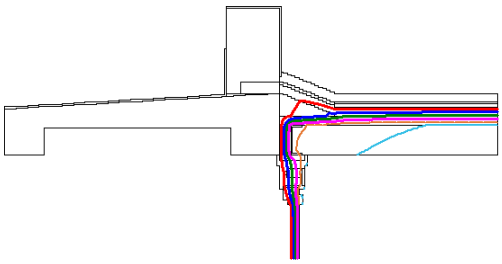
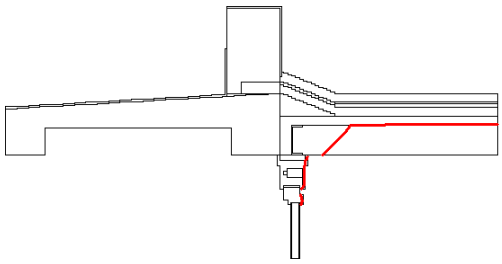
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.45.4 – Thermal-technical evaluation of detail 45

DETAIL 45

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 0.044 W/(m.K) λ = 0.044 W/(m.K) λ = 0.210 W/(m.K) λ = 0.950 W/(m.K) λ = 0.750 W/(m.K) λ = 0.610 W/(m.K) λ = 0.180 W/(m.K) λ = 0.110 W/(m.K) λ = 0.070 W/(m.K) λ = 0.180 W/(m.K) λ = 40.00 W/(m.K) λ = 0.070 W/(m.K) λ = 1.000 W/(m.K) λ = 0.204 W/(m.K) λ = 0.090 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 10.75 °C	f_{Rsi}= 0.736	θ_{si} = 10.75 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
2	θ_{si} = 11.57 °C	f_{Rsi}= 0.759	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance	ψ = 1.62862 - 2.579 × 0.363 - 0.579 × 0.477 - 0.394 × 1.365 = -0.122 W/(m.K)			

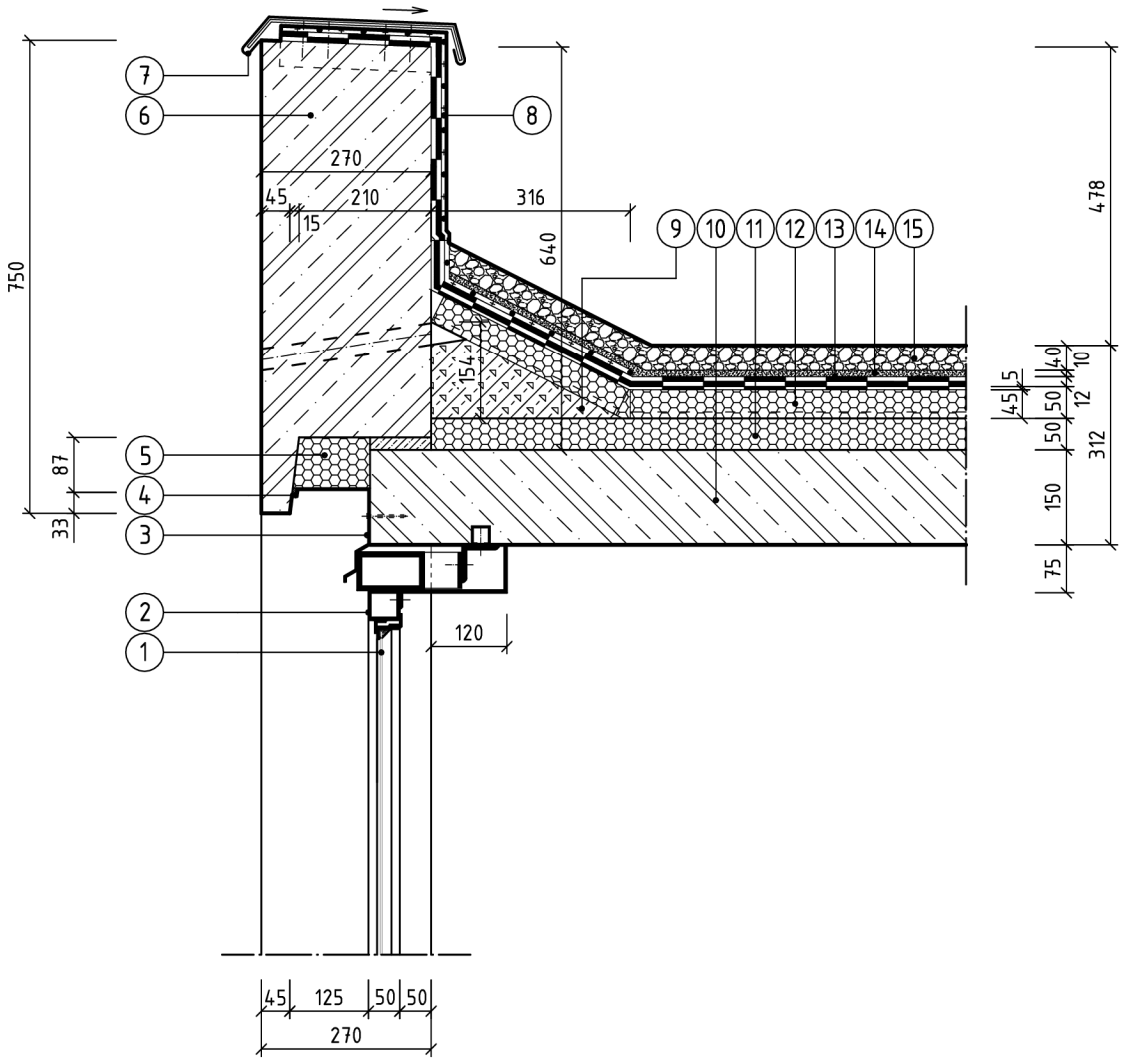
Table 2.46.1 – Marking of the position of detail in the building – detail 46

DETAIL 46
Floor plan

Section I-I


Table 2.46.2 – Structural composition of detail 46

DETAIL 46



Legend:

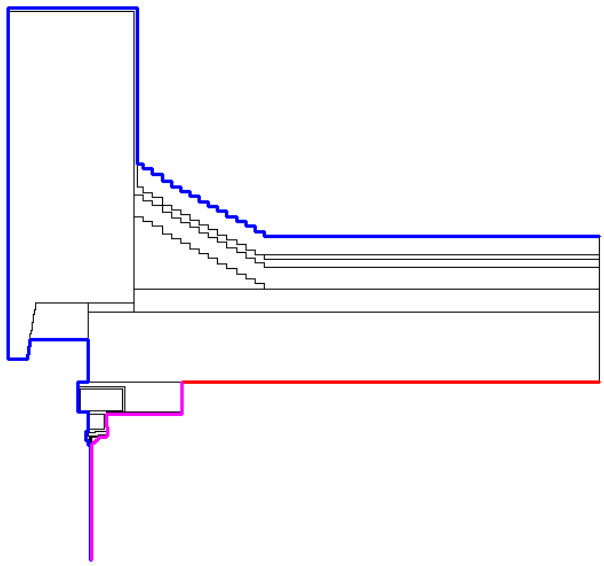
1. Glass 4 mm (λ = 1.00 W/(m.K))
2. Steel window (λ = 50 W/(m.K), λ = 0.5 W/(m.K))
3. Sheet metal covering (not considered in model)
4. Sealant (λ = 0.22 W/(m.K))
5. Polystyrene foam (λ = 0.044 W/(m.K))
6. Attic panel – reinforced concrete (λ = 1.58 W/(m.K))
7. Sheet metal covering (not considered in model)
8. Waterproofing rubber foil (not considered in model)
9. Lightweight concrete (λ = 0.61 W/(m.K))
10. Reinforc. concrete ceiling panel (λ = 1.58 W/(m.K))
11. Polystyrene foam (λ = 0.044 W/(m.K))
12. Boards POLSID (λ = 0.044 W/(m.K))
13. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
14. Sand (λ = 0.95 W/(m.K))
15. Gravel (λ = 0.75 W/(m.K))

$U_{wall,1}$ = 0.862 W/(m^2.K) **$U_{window,\ steel}$ = 6.238 W/(m^2.K)** **U_{roof} = 0.394 W/(m^2.K)**

Table 2.46.3 – Boundary conditions for a calculation of detail 46

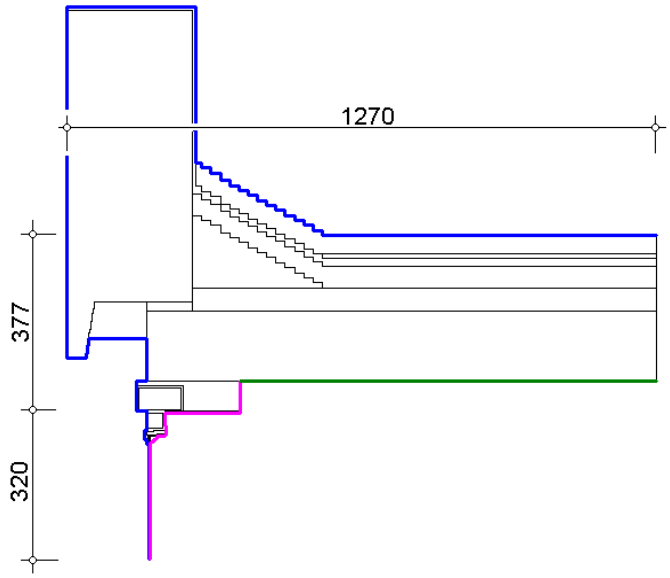
DETAIL 46

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W R_{si} = 0.13 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

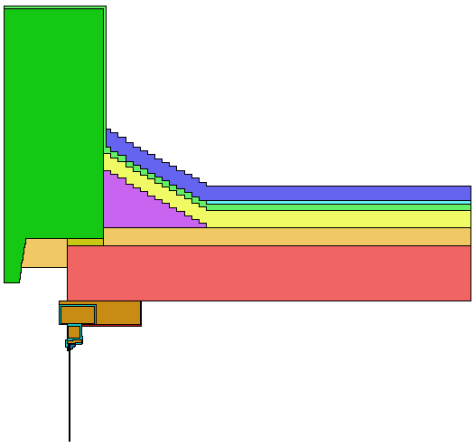
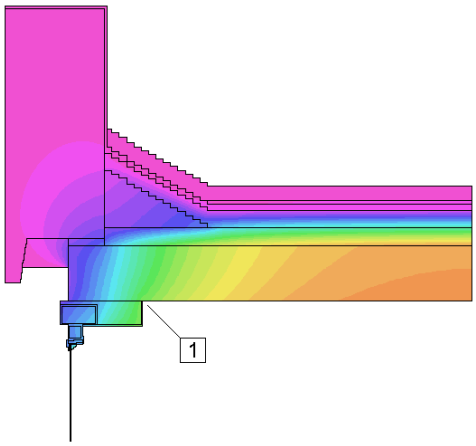
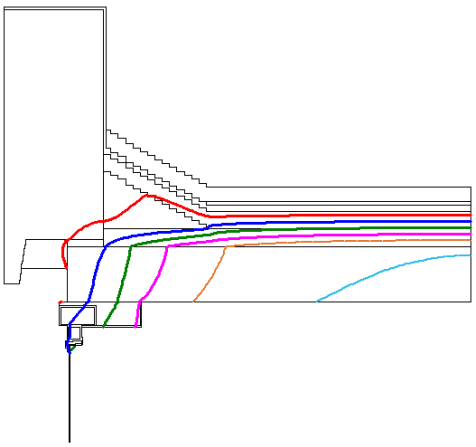
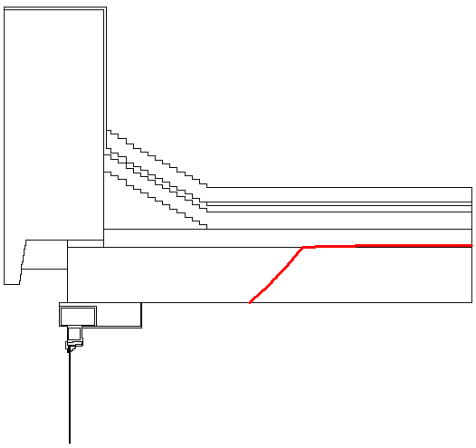
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.46.4 – Thermal-technical evaluation of detail 46

DETAIL 46

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 0.044 W/(m.K) λ = 0.044 W/(m.K) λ = 0.210 W/(m.K) λ = 0.950 W/(m.K) λ = 0.750 W/(m.K) λ = 0.610 W/(m.K) λ = 40.00 W/(m.K) λ = 0.500 W/(m.K) λ = 1.160 W/(m.K) λ = 1.580 W/(m.K) λ = 50.00 W/(m.K) λ = 0.220 W/(m.K) λ = 1.000 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 5.28 °C	f_{Rsi}= 0.580	θ_{si} = 5.28 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
			$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	

Linear thermal transmittance	ψ = 3.63647 - 6.238 × 0.320 - 0.862 × 0.377 - 0.394 × 1.270 = 0.815 W/(m.K)

Table 2.47.1 – Marking of the position of detail in the building – detail 47

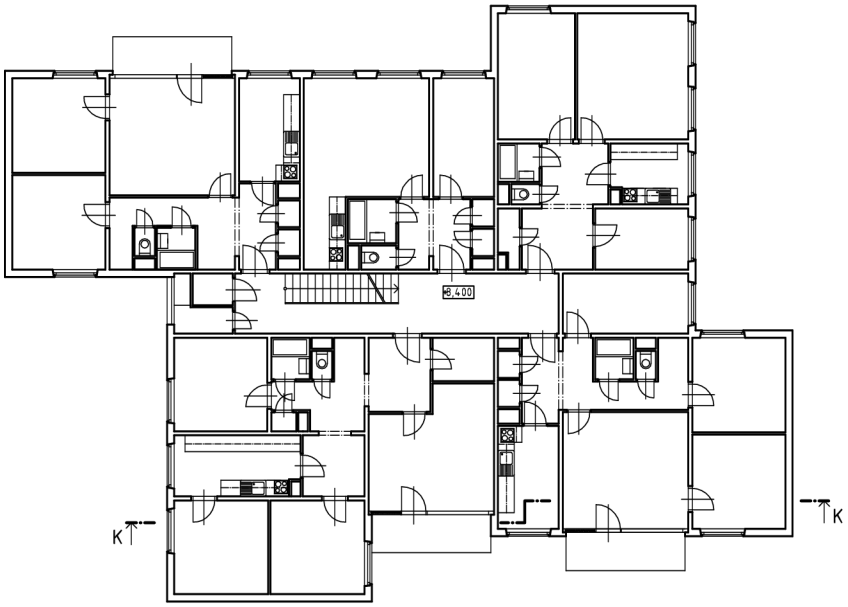
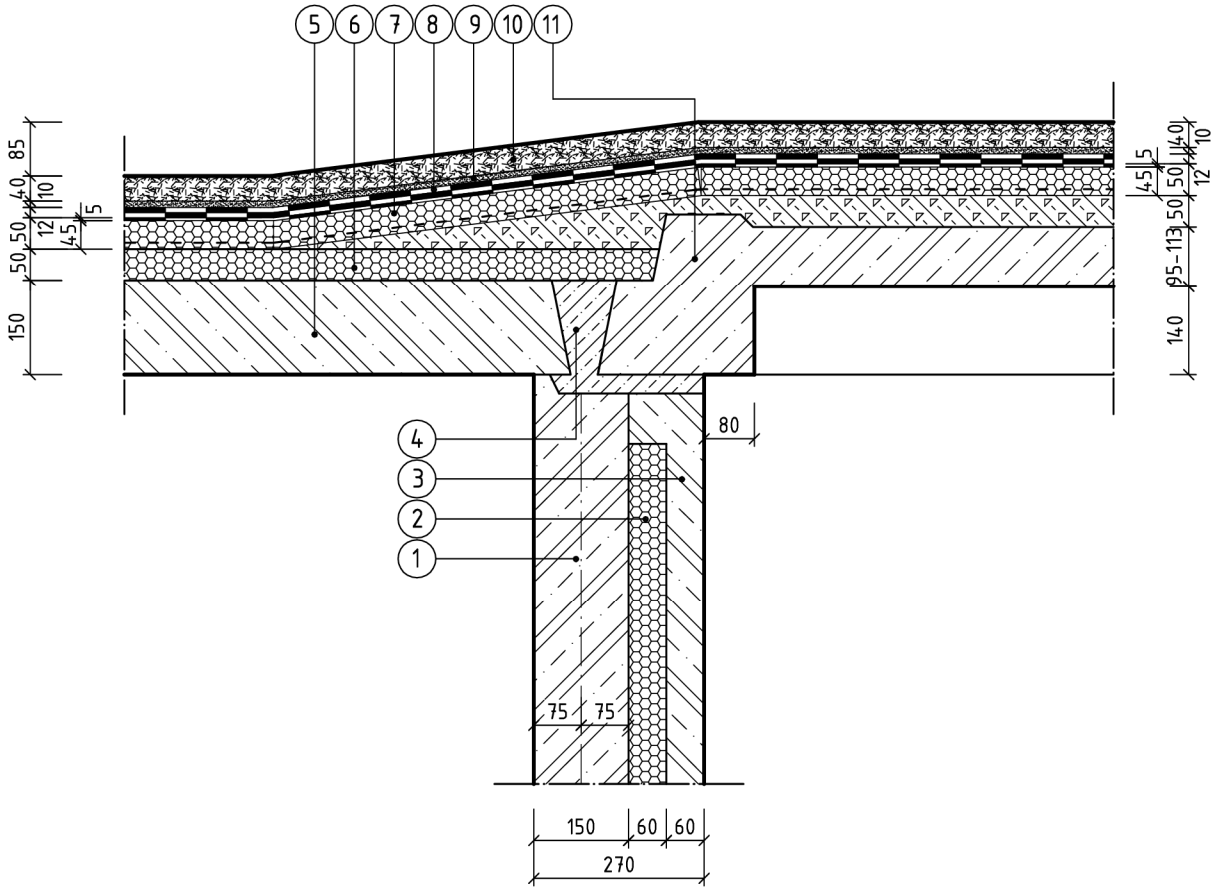
DETAIL 47
Floor plan

Section K-K


Table 2.47.2 – Structural composition of detail 47

DETAIL 47



Legend:

1. Reinforced concrete (λ = 1.58 W/(m.K))
2. Polystyrene foam (λ = 0.07 W/(m.K))
3. Reinforced concrete (λ = 1.58 W/(m.K))
4. Concrete grout (λ = 1.36 W/(m.K))
5. Reinforc. concr. ceiling panel (λ = 1.58 W/(m.K))
6. Polystyrene foam (λ = 0.044 W/(m.K))
7. Boards POLSID (λ = 0.044 W/(m.K))
8. Bituminous waterproof. membrane (λ = 0.21 W/(m.K))
9. Sand (λ = 0.95 W/(m.K))
10. Gravel (λ = 0.75 W/(m.K))
11. Loggia reinforced concrete panel (λ = 1.58 W/(m.K))

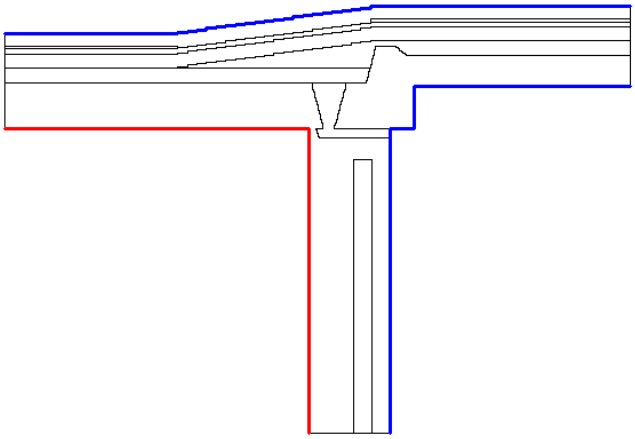
$U_{wall,1}$ = 0.862 W/(m^2.K)

U_{roof} = 0.394 W/(m^2.K)

Table 2.47.3 – Boundary conditions for a calculation of detail 47

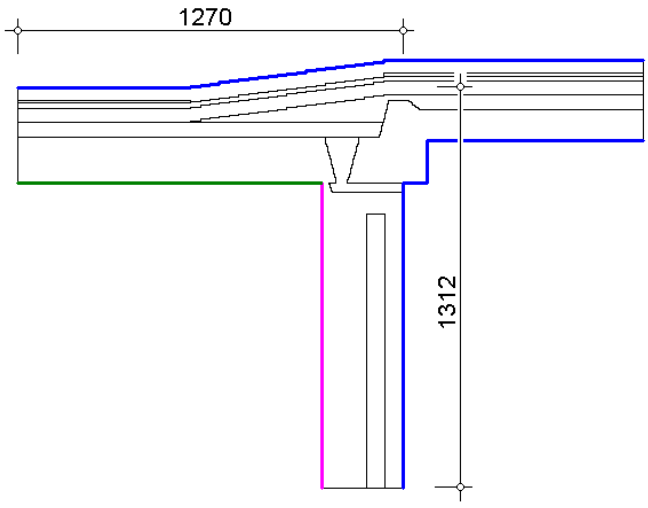
DETAIL 47

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

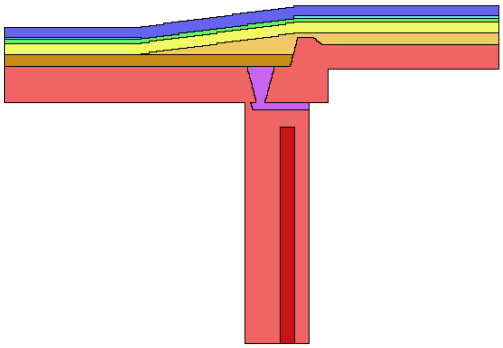
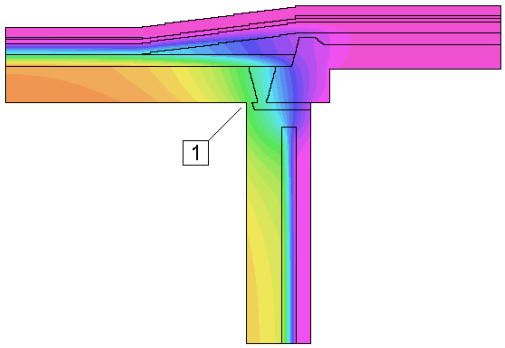
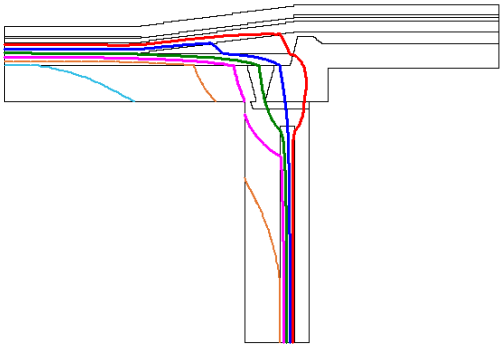
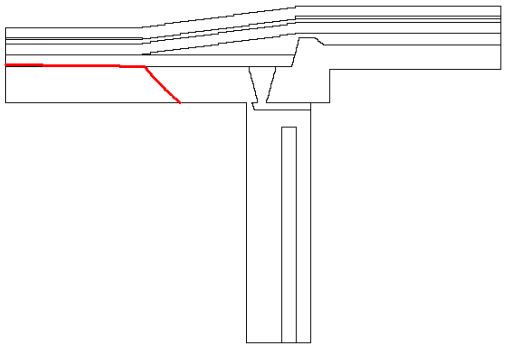
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.47.4 – Thermal-technical evaluation of detail 47

DETAIL 47

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 0.610 W/(m.K) λ = 0.044 W/(m.K) λ = 0.210 W/(m.K) λ = 0.950 W/(m.K) λ = 0.750 W/(m.K) λ = 1.360 W/(m.K) λ = 0.070 W/(m.K) λ = 0.044 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 4.69 °C	f_{Rsi}= 0.563	θ_{si} = 4.69 °C < $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	not meet
			$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = 2.5 °C)	
Linear thermal transmittance			ψ = 2.05647 - 0.862 × 1.312 - 0.394 × 1.270 = 0.425 W/(m.K)	

Table 2.48.1 – Marking of the position of detail in the building – detail 48

DETAIL 48
Floor plan

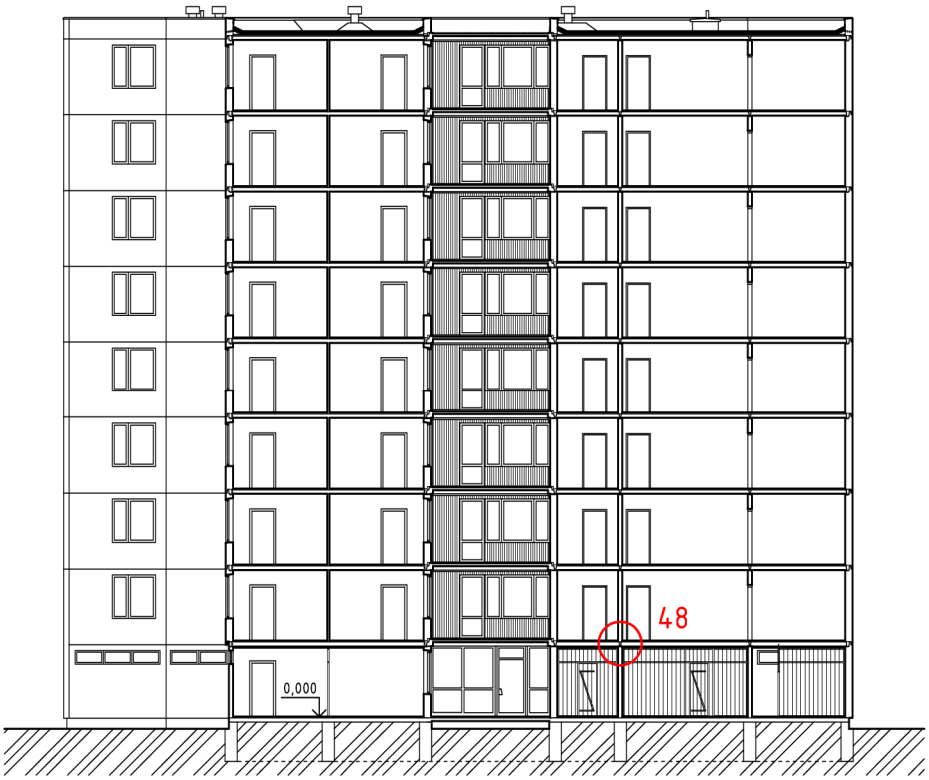
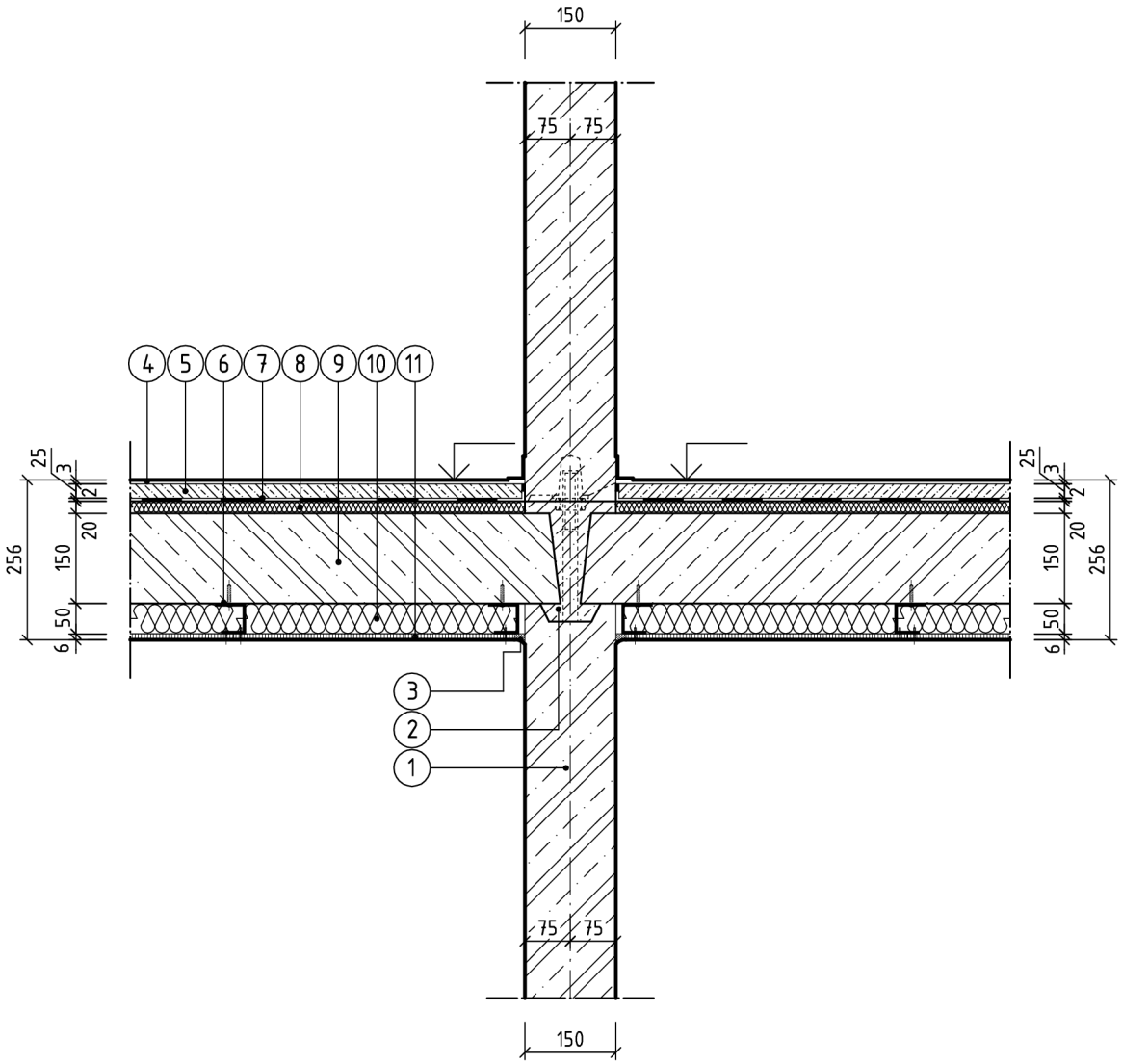
Section J-J


Table 2.48.2 – Structural composition of detail 48

DETAIL 48



Legend:

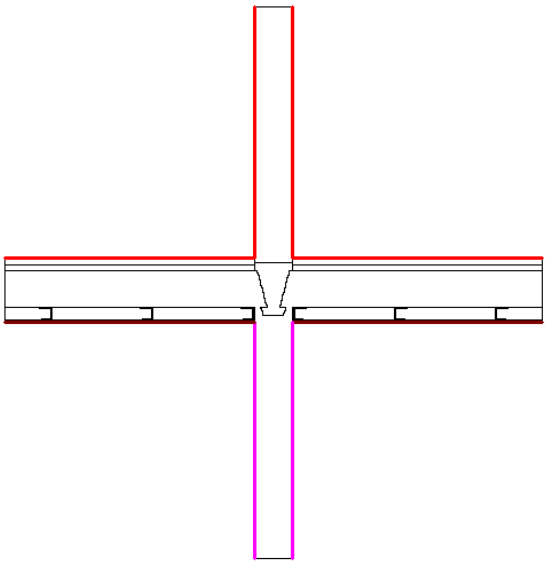
1. Reinforced concrete (λ = 1.34 W/(m.K))
2. Concrete grout (λ = 1.16 W/(m.K))
3. Sealant (λ = 0.22 W/(m.K))
4. PVC + adhesive (λ = 0.16 W/(m.K))
5. Cement coating (λ = 1.02 W/(m.K))
6. Steel profile (λ = 40.0 W/(m.K))
7. Tar paper (λ = 0.21 W/(m.K))
8. Boards FIBREX (λ = 0.05 W/(m.K))
9. Reinforc. concrete ceiling panel (λ = 1.34 W/(m.K))
10. Basalt felt (λ = 0.06 W/(m.K))
11. Particle boards (λ = 0.22 W/(m.K))

U_{floor} = 0.566 W/(m^2.K)

Table 2.48.3 – Boundary conditions for a calculation of detail 48

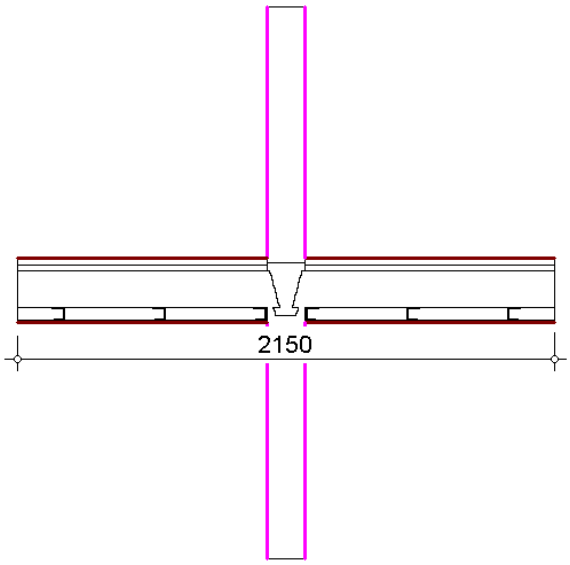
DETAIL 48

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior (unheated space)
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = 2.5 °C φ_e = 60 % R_{se} = 0.17 m^2.K/W R_{se} = 0.13 m^2.K/W

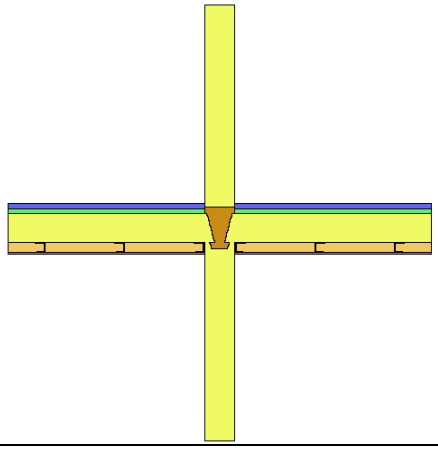
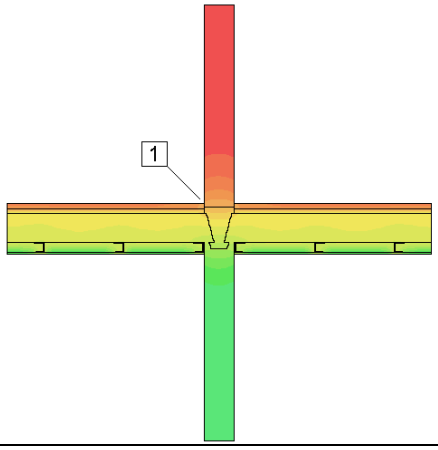
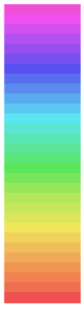
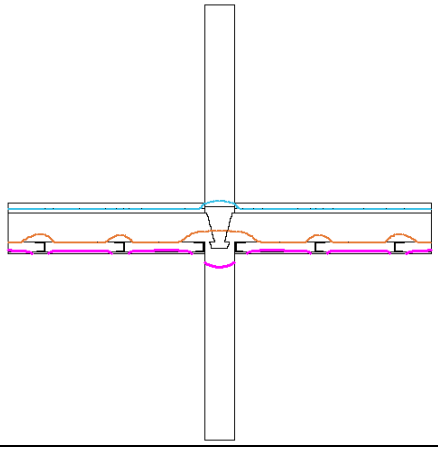
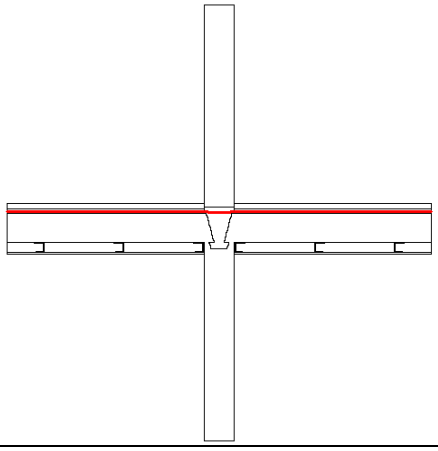
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior (unheated space)
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.17 m^2.K/W	θ_e = 2.5 °C φ_e = 60 % R_{se} = 0.17 m^2.K/W R_{se} = 0.13 m^2.K/W

Table 2.48.4 – Thermal-technical evaluation of detail 48

DETAIL 48

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 0.220 W/(m.K) λ = 0.060 W/(m.K) λ = 1.340 W/(m.K) λ = 0.050 W/(m.K) λ = 0.210 W/(m.K) λ = 1.020 W/(m.K) λ = 0.160 W/(m.K) λ = 40.00 W/(m.K) λ = 1.160 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 15.18 °C	f_{Rsi}= 0.725	θ_{si} = 15.18 °C > $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	meet
			$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = 2.5 °C)	
Linear thermal transmittance			ψ = 1.93526 - 0.566 × 2.150 = 0.718 W/(m.K)	

Table 2.49.1 – Marking of the position of detail in the building – detail 49

DETAIL 49
Floor plan

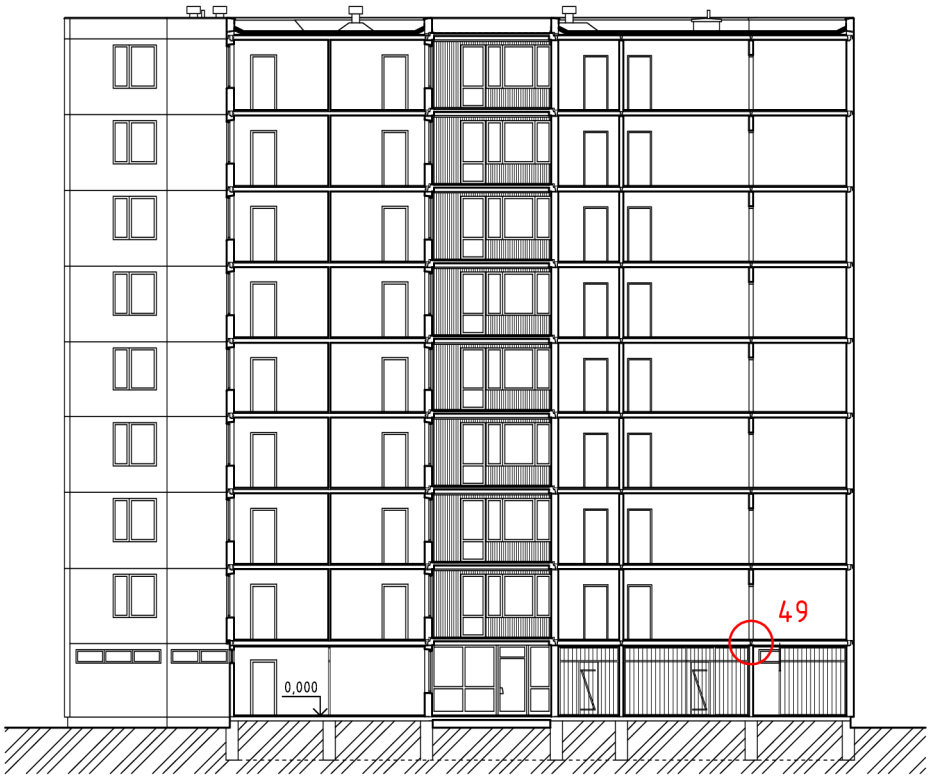
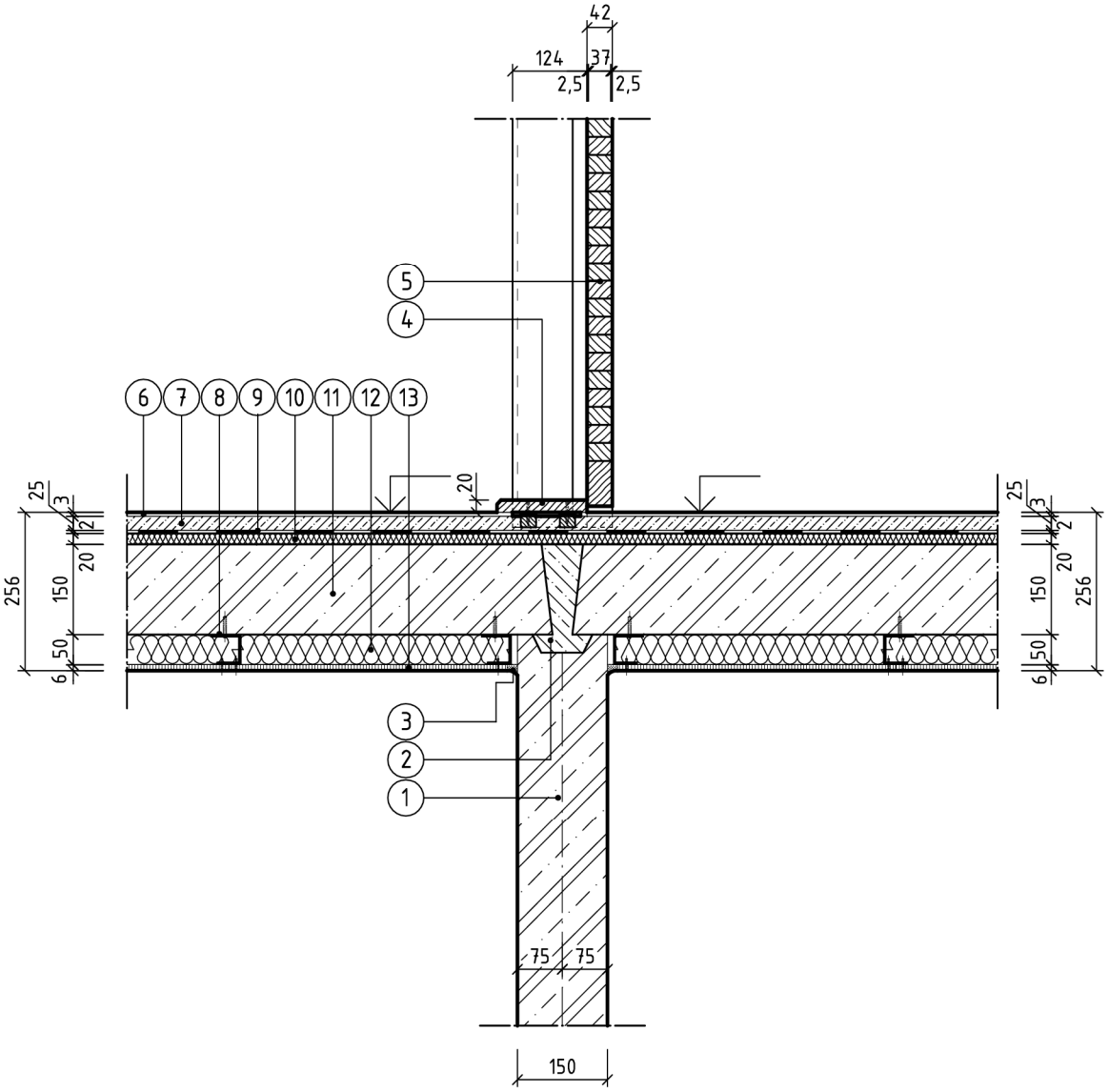
Section J-J


Table 2.49.2 – Structural composition of detail 49

DETAIL 49



Legend:

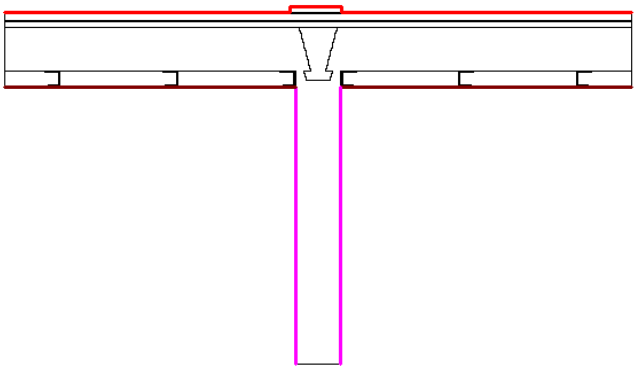
1. Reinforced concrete (λ = 1.34 W/(m.K))
2. Concrete grout (λ = 1.16 W/(m.K))
3. Sealant (λ = 0.22 W/(m.K))
4. Door sill (λ = 0.18 W/(m.K))
5. Door leaf (not considered in model)
6. PVC + adhesive (λ = 0.16 W/(m.K))
7. Cement coating (λ = 1.02 W/(m.K))
8. Steel profile (λ = 40.0 W/(m.K))
9. Tar paper (λ = 0.21 W/(m.K))
10. Boards FIBREX (λ = 0.05 W/(m.K))
11. Reinforced concrete ceiling panel (λ = 1.34 W/(m.K))
12. Basalt felt (λ = 0.06 W/(m.K))
13. Particle boards (λ = 0.22 W/(m.K))

U_{floor} = 0.566 W/(m^2.K)

Table 2.49.3 – Boundary conditions for a calculation of detail 49

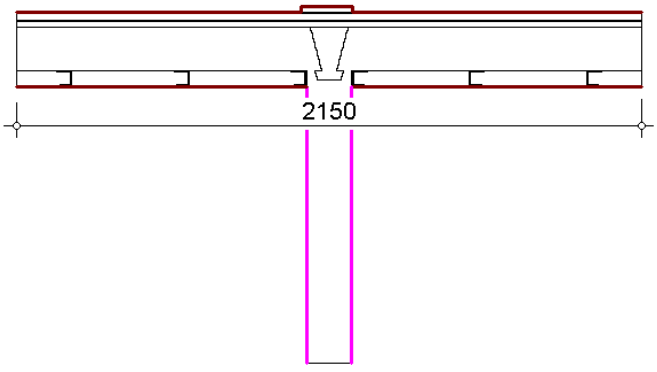
DETAIL 49

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior (unheated space)
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = 2.5 °C φ_e = 60 % R_{se} = 0.17 m^2.K/W R_{se} = 0.13 m^2.K/W

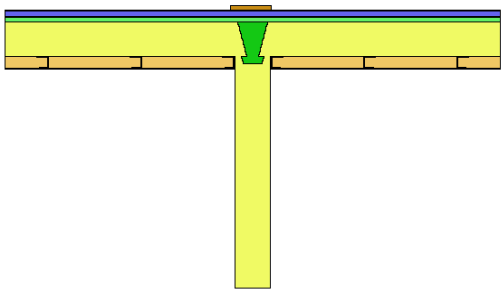
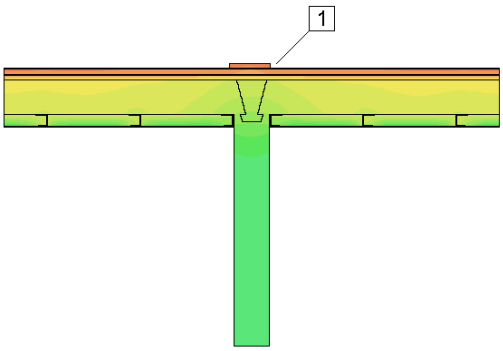
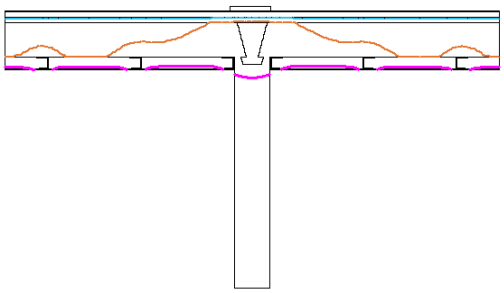
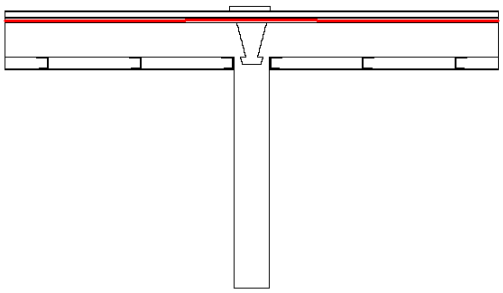
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior (unheated space)
θ_i = 20 °C φ_i = 50 % R_{si} = 0.17 m^2.K/W	θ_e = 2.5 °C φ_e = 60 % R_{se} = 0.17 m^2.K/W R_{se} = 0.13 m^2.K/W

Table 2.49.4 – Thermal-technical evaluation of detail 49

DETAIL 49

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legenda: λ = 0.220 W/(m.K) λ = 0.060 W/(m.K) λ = 1.340 W/(m.K) λ = 0.050 W/(m.K) λ = 0.210 W/(m.K) λ = 1.020 W/(m.K) λ = 0.160 W/(m.K) λ = 40.00 W/(m.K) λ = 0.180 W/(m.K) λ = 0.050 W/(m.K) λ = 1.160 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 16.13 °C	f_{Rsi}= 0.779	θ_{si} = 16.13 °C > $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	meet
			$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = 2.5 °C)	
Linear thermal transmittance			ψ = 1.71072 - 0.566 × 2.150 = 0.494 W/(m.K)	

Table 2.50.1 – Marking of the position of detail in the building – detail 50

DETAIL 50
Floor plan

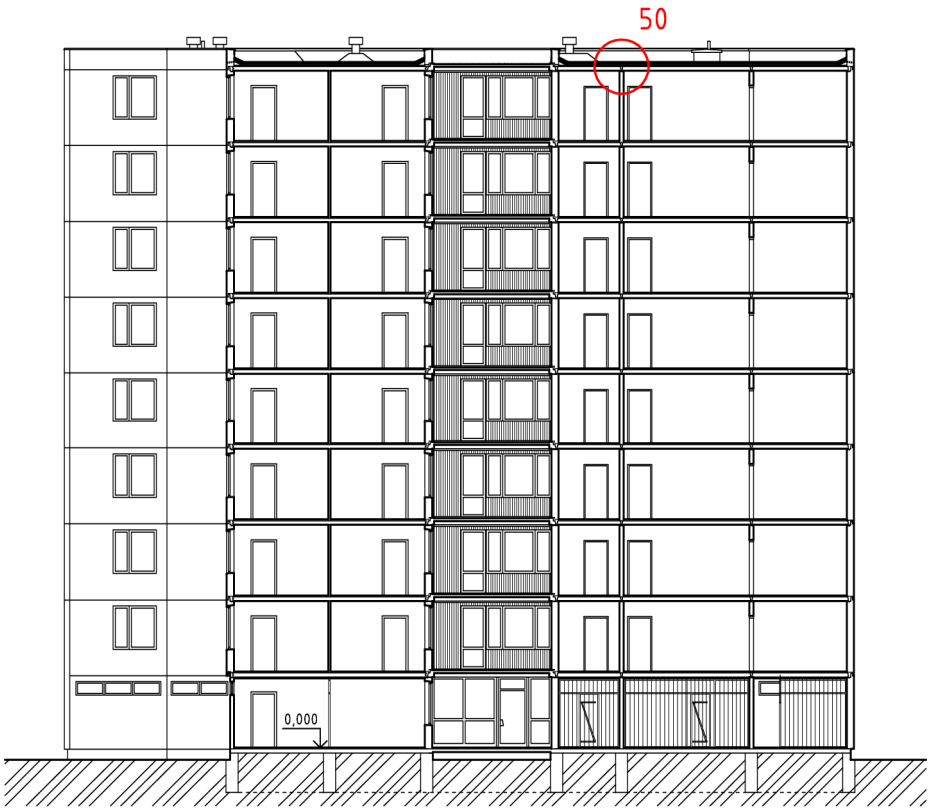
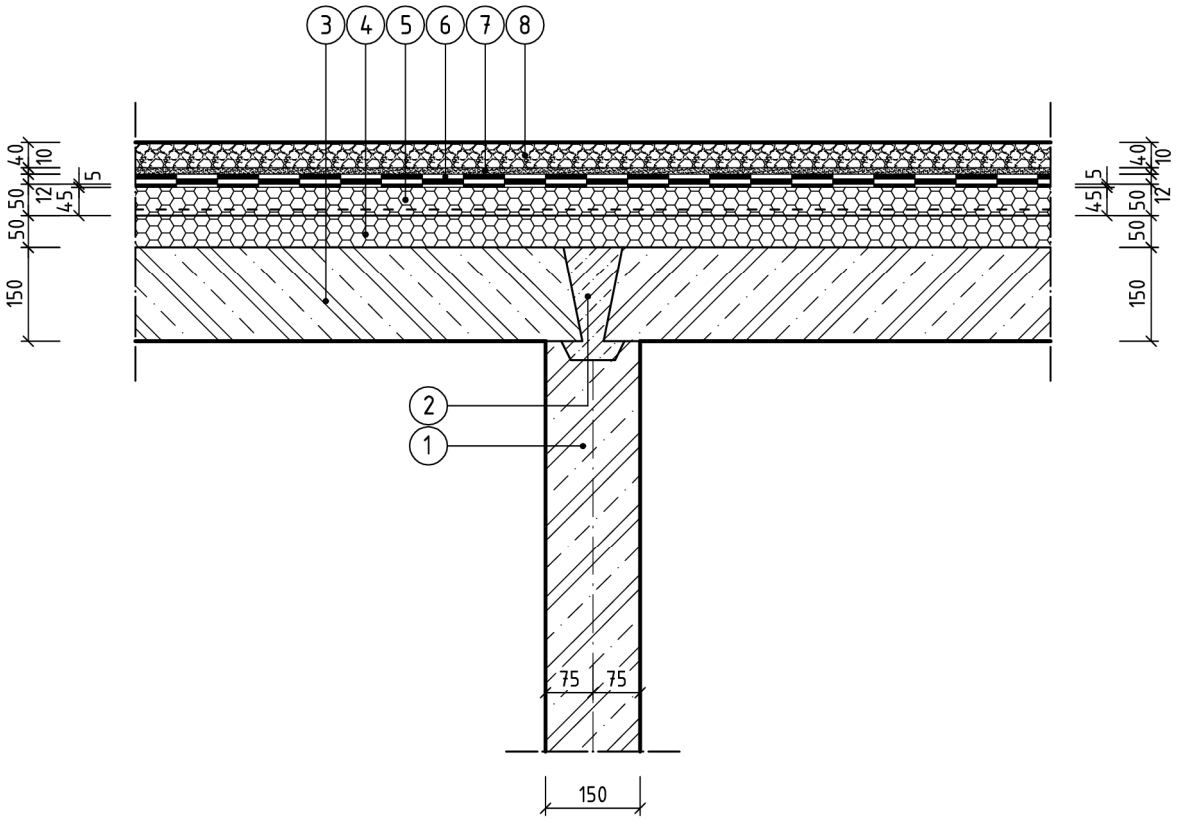
Section J-J


Table 2.50.2 – Structural composition of detail 50

DETAIL 50



Legend:

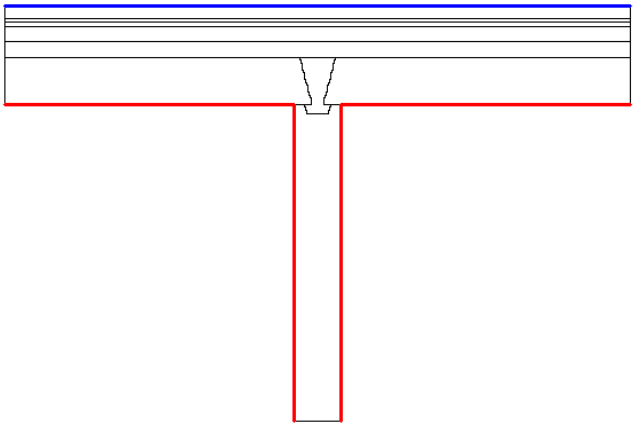
1. Reinforced concrete (λ = 1.34 W/(m.K))
2. Concrete grout (λ = 1.36 W/(m.K))
3. Reinforc. concrete ceiling panel (λ = 1.58 W/(m.K))
4. Polystyrene foam (λ = 0.044 W/(m.K))
5. Boards POLSID (λ = 0.044 W/(m.K))
6. Bituminous waterproof. membr. (λ = 0.21 W/(m.K))
7. Sand (λ = 0.95 W/(m.K))
8. Gravel (λ = 0.75 W/(m.K))

U_{roof} = 0.985 W/(m^2.K)

Table 2.50.3 – Boundary conditions for a calculation of detail 50

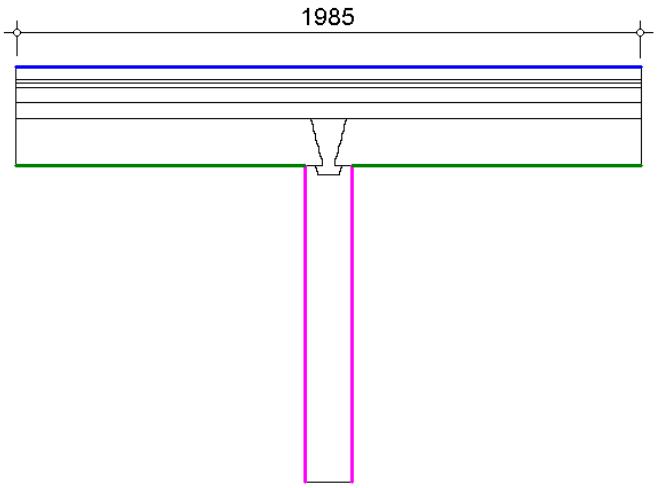
DETAIL 50

Boundary conditions for calculation of surface temperatures



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.25 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

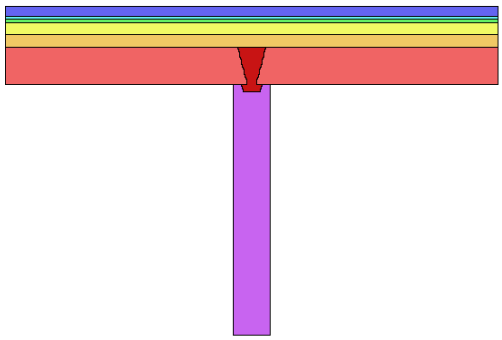
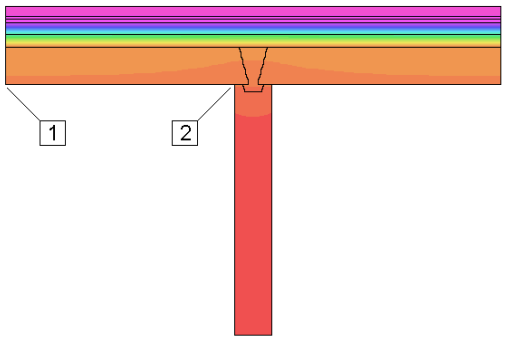
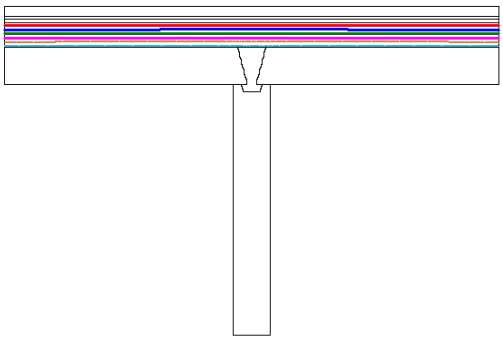
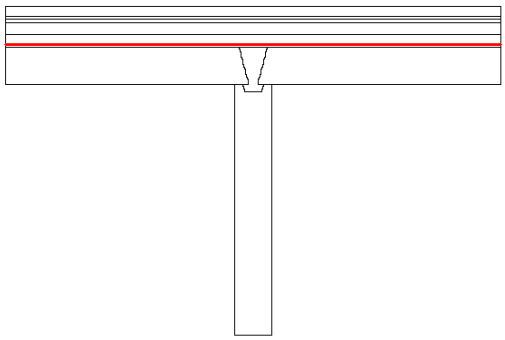
Boundary conditions and corresponding lengths for a calculation of the linear thermal transmittance



Boundary conditions for interior	Boundary conditions for exterior
θ_i = 20 °C φ_i = 50 % R_{si} = 0.13 m^2.K/W R_{si} = 0.10 m^2.K/W	θ_e = -15 °C φ_e = 84 % R_{se} = 0.04 m^2.K/W

Table 2.50.4 – Thermal-technical evaluation of detail 50

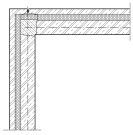
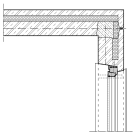
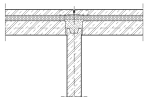
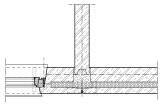
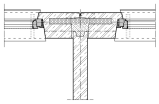
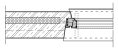
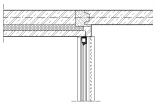
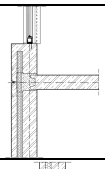
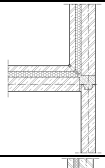
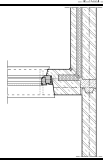
DETAIL 50

Modeled detail with marking the materials	Temperature field with marked critical temperatures
	
Legend: λ = 1.580 W/(m.K) λ = 0.044 W/(m.K) λ = 0.044 W/(m.K) λ = 0.210 W/(m.K) λ = 0.950 W/(m.K) λ = 0.750 W/(m.K) λ = 1.340 W/(m.K) λ = 1.360 W/(m.K)	 -15.0 °C ... -11.5 °C -11.5 °C ... -8.0 °C -8.0 °C ... -4.5 °C -4.5 °C ... -1.0 °C -1.0 °C ... 2.5 °C 2.5 °C ... 6.0 °C 6.0 °C ... 9.5 °C 9.5 °C ... 13.0 °C 13.0 °C ... 16.5 °C 16.5 °C ... 20.0 °C
Representation of characteristic isotherms	Representation of the critical isotherm
	
-10 °C -5 °C 0 °C 5 °C 10 °C 15 °C	13.12 °C

Point	Temperature	Temperat. factor	Evaluation of hygienic criterion	Rating
1	θ_{si} = 16.77 °C	f_{Rsi}= 0.908	θ_{si} = 16.77 °C > $\theta_{si,80}$ + $\Delta\theta_{si}$ = 13.12 °C	meet
2	θ_{si} = 17.44 °C	f_{Rsi}= 0.927	$\theta_{si} = f_{Rsi}.(\theta_i - \theta_e) + \theta_e$ (Considered θ_i = 20 °C; θ_e = -15 °C)	
Linear thermal transmittance			ψ = 0.78190 - 0.394 × 1.985 = -0.000 W/(m.K)	

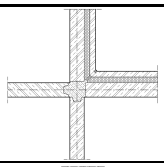
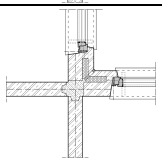
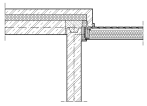
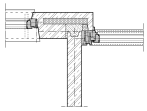
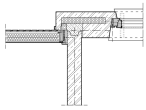
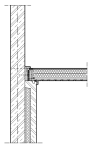
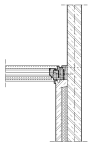
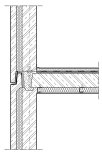
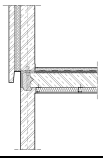
3 Calculation of Increase of Thermal Transmittance Due to Thermal Bridges

Table 3.1.1 Calculation of ΔU - value

	Detail	Scheme	Length *l* (m)	ψ (W/(m.K))	$l.\psi$ (W/K)
Details solved in the previous publication (Part 1), Chapter 4	01		143.744	-0.192	-27.599
	02		51.200	0.122	6.246
	03		79.744	0.020	1.595
	04		22.768	0.359	8.174
	05		89.600	0.741	66.394
	06		153.600	0.336	51.610
	07		22.768	0.695	15.824
	08		22.768	0.804	18.305
	09		9.968	0.129	1.286
	10		12.800	0.480	6.144

The table continues on the next page

Table 3.1.2 Calculation of ΔU - value

	Detail	Scheme	Length *l* (m)	ψ (W/(m.K))	$l.\psi$ (W/K)
Details solved in the previous publication (Part 1), Chapter 4	11		22.768	0.134	3.051
	12		12.800	0.843	10.790
	13		39.872	0.092	3.668
	14		25.600	0.427	10.931
	15		25.600	0.429	10.982
	16		32.736	0.436	14.273
	17		12.800	0.420	5.376
	18		76.800	0.032	2.458
	19		33.355	0.134	4.470
	20		9.680	0.302	2.923

The table continues on the next page

Table 3.1.3 Calculation of ΔU - value

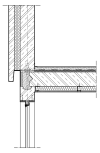
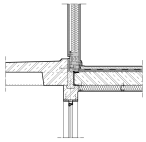
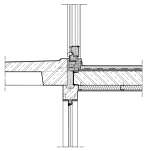
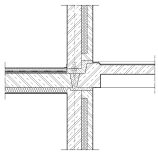
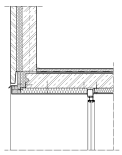
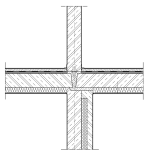
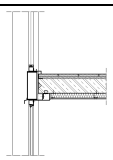
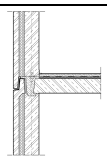
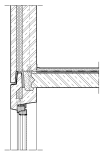
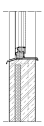
	Detail	Scheme	Length *l* (m)	ψ (W/(m.K))	$l.\psi$ (W/K)
Details solved in the previous publication (Part 1), Chapter 4	21		42.150	0.303	12.771
	22		10.530	0.150	1.580
	23		2.700	0.121	0.327
	24		2.205	0.516	1.138
Details solved in this publication, Chapter 2	25		2.010	0.918	1.845
	26		1.600	0.471	0.754
	27		1.800	1.008	1.814
	28		401.31	0.314	126.011
	29		210.000	0.621	130.410
	30		233.600	0.364	85.030

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Table 3.1.4 Calculation of ΔU - value

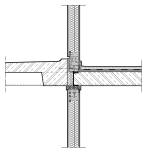
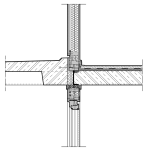
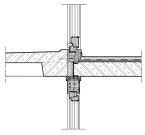
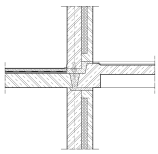
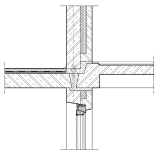
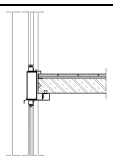
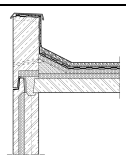
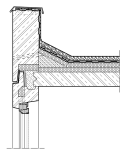
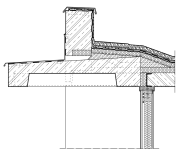
Details solved in this publication, Chapter 2	Detail	Scheme	Length *l* (m)	ψ (W/(m.K))	$l.\psi$ (W/K)
	31		23.310	0.633	14.755
	32		50.400	0.636	32.054
	33		18.900	0.602	11.378
	34		57.600	0.047	2.707
	35		11.200	1.191	13.339
	36		2.800	1.283	3.592
	37		12.600	1.648	20.765
	38		57.330	0.122	6.994
	39		30.000	0.411	12.330
	40		1.110	-0.025	-0.028

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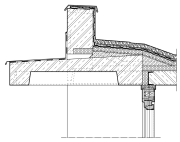
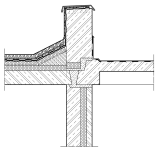
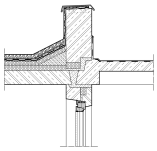
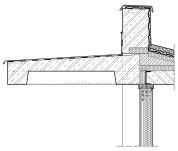
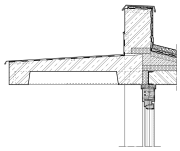
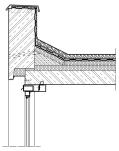
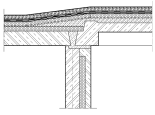
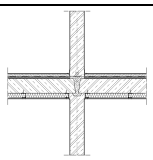
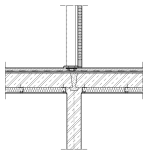
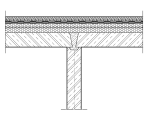
Table 3.1.5 Calculation of ΔU - value

Details solved in this publication, Chapter 2	Detail	Scheme	Length l (m)	ψ (W/(m.K))	$l.\psi$ (W/K)
	41		3.300	-0.020	-0.066
	42		0.475	0.381	0.181
	43		0.400	0.627	0.251
	44		2.220	-0.126	-0.280
	45		6.600	-0.122	-0.805
	46		1.800	0.815	1.467
	47		1.060	0.425	0.451
	48		113.635	0.718	81.590
	49		15.300	0.494	7.558
	50		128.935	-0.000	0.000
Calculation of ΔU-value: $\Delta U = \Sigma(l.\psi) / A_e$ = 638.695 / 3252.002 = 0.196 W/(m^2.K)					**Σ = 638.837**

4 Calculation and Evaluation of Energy Need for Heating of the Building

Table 4.1.1 Marking of the heat-exchanging envelope of building

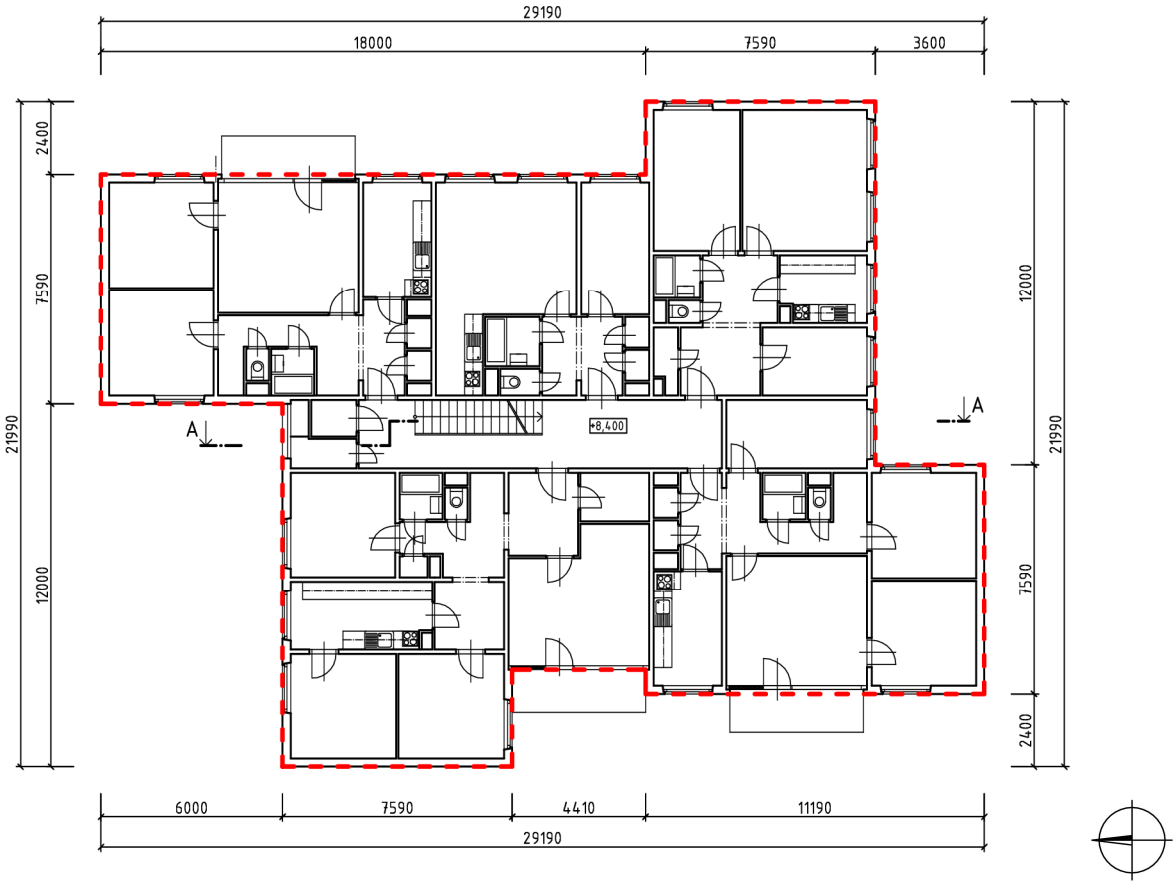
Structural system B 70 - detached house
Floor plan


Table 4.1.2 Marking of the heat-exchanging envelope of building

Structural system B 70 - detached house
Cross-section A-A


Table 4.1.3 Marking of the heat-exchanging envelope of building

Structural system B 70 - detached house
Western view


Table 4.1.4 Marking of the heat-exchanging envelope of building

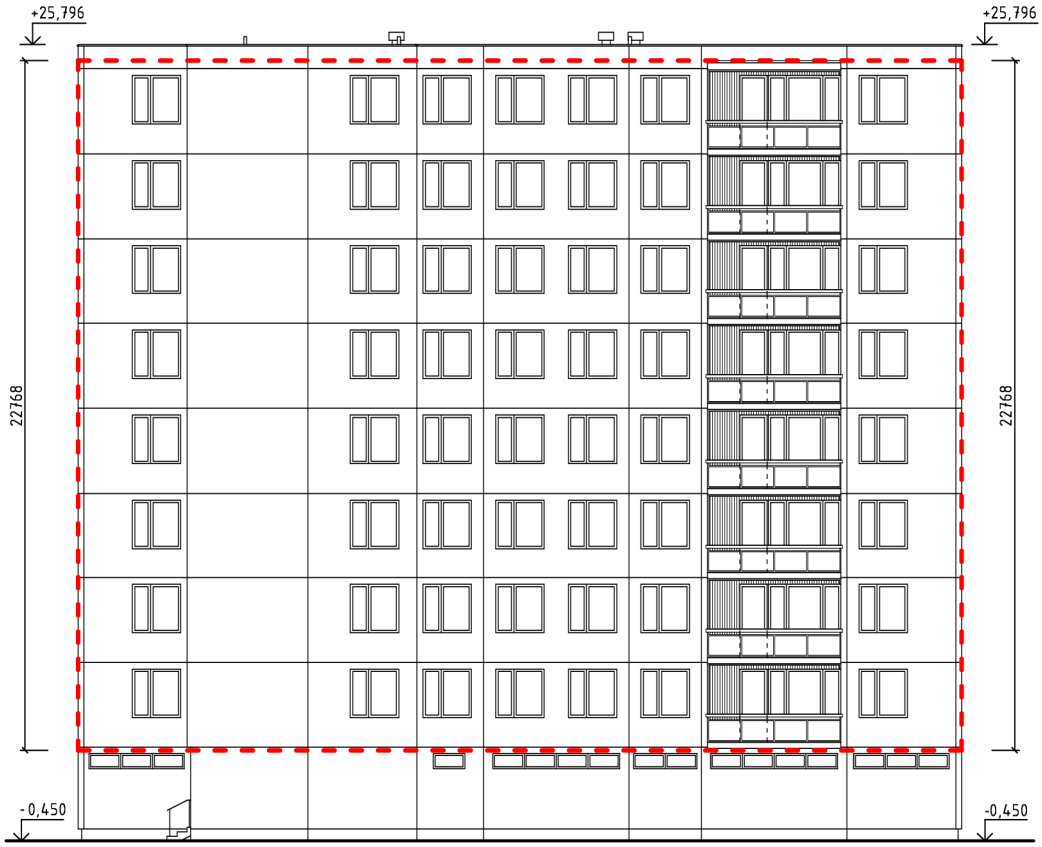
Structural system B 70 - detached house
Eastern view


Table 4.1.5 Marking of the heat-exchanging envelope of building

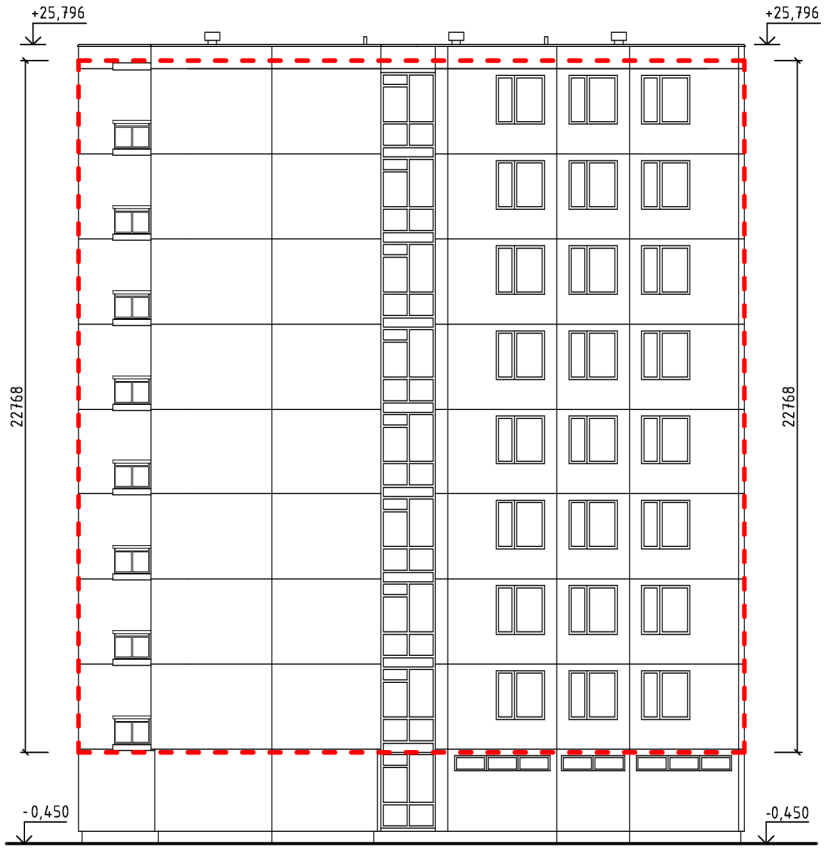
Structural system B 70 - detached house
Northern view


Table 4.1.6 Marking of the heat-exchanging envelope of building

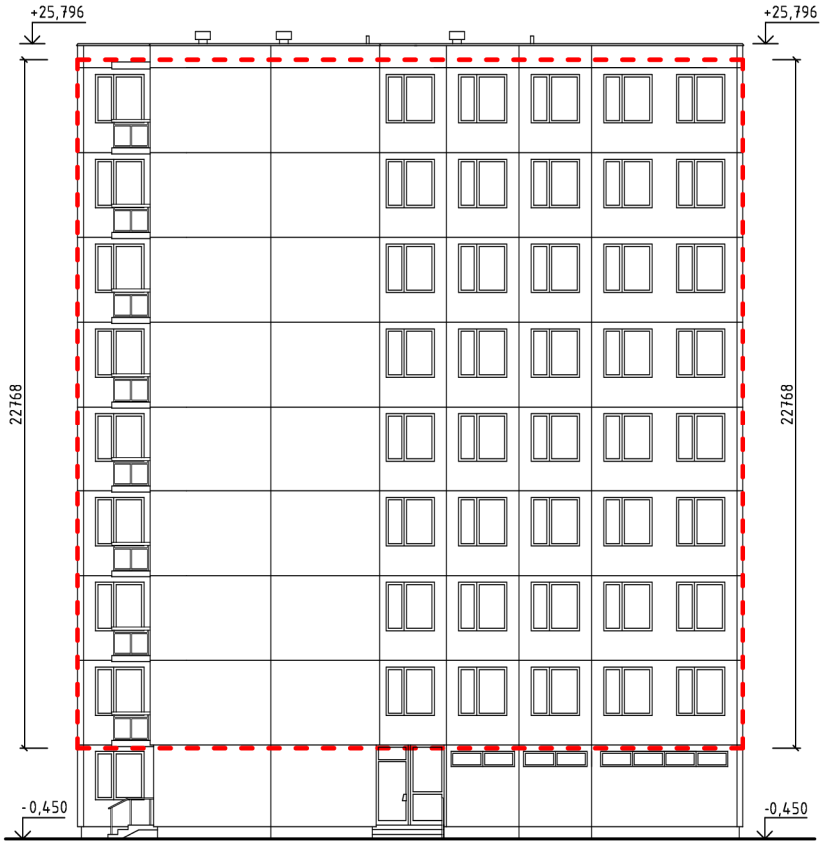
Structural system B 70 - detached house
Southern view


Table 4.1.7 Calculation of parameters of the heat-exchanging envelope of building

Structural system B 70 - detached house
Calculation of important parameters of heat-exchanging envelope of building

Volume of the heated space of building:

V_b = [(29.190 × 21.990) - (6.000 × 12.000) - (2.400 × 18.000) - (3.600 × 12.000) - (2.400 × 15.600) - - (0.800 × 4.410)] × 22.768 = 10075.298 m^3

Total floor area of building:

A_b = [(29.190 × 21.990) - (6.000 × 12.000) - (2.400 × 18.000) - (3.600 × 12.000) - (2.400 × 15.600) - - (0.800 × 4.410)] × 8 = 3540.161 m^2

Windows (wooden) to the west:

A = (1.600 × 1.600) × 24 = 61.440 m^2

Windows (wooden) to the west (shaded):

A = [(2.400 × 1.600) × 8 + (0.900 × 2.400) × 8] × 2 = 96.000 m^2

Windows (wooden) to the east:

A = (1.600 × 1.600) × 56 = 143.360 m^2

Windows (wooden) to the east (shaded):

A = (2.400 × 1.600) × 8 + (0.900 × 2.400) × 8 = 48.000 m^2

Windows (wooden) to the north:

A = (1.600 × 1.600) × 24 = 61.440 m^2

Windows (wooden) to the south:

A = (1.600 × 1.600) × 48 = 122.880 m^2

Windows (wooden) – total area:

A = 61.440 + 96.000 + 143.360 + 48.000 + 61.440 + 122.880 = 533.120 m^2

Windows (steel) to the north:

A = (1.800 × 2.500) × 8 = 36.000 m^2

External wall 01:

A = {[(29.190 - 4.410 - 4.410) + 21.990 + (29.190 - 4.410) + 21.990 + 0.800 + 0.800] × 22.768} - - (1.600 × 1.600) × 152 - (1.800 × 2.500) ×8 = 1640.621 m^2

External wall 02:

A = [(4.410 × 3) × 22.768] - (48.000 × 3) = 157.221 m^2

Flat roof:

A = (29.190 × 21.990) - (6.000 × 12.000) - (2.400 × 18.000) - (3.600 × 12.000) - (2.400 × 15.600) - - (0.800 × 4.410) = 442.520 m^2

Ceiling above the exterior:

A = 2.010 × 0.800 = 1.608 m^2

Floor on the ceiling:

A = (29.190 × 21.990) - (6.000 × 12.000) - (2.400 × 18.000) - (3.600 × 12.000) - (2.400 × 15.600) - - (0.800 × 4.410) - (0.800 × 2.010) = 440.912 m^2

Total area of heat-exchanging envelope of building:

A_e = 3252.002 m^2

Tab. 4.2.1 Calculation of energy need for heating of building using the calculated ΔU – value

Structural system B 70 - detached house

Calculation of energy need for heating of building using the calculated ΔU – value

ASSIGNED BOUNDARY CONDITIONS:

```
Volume of the heated space of building ..... Vb:   10075.3 m3
Total floor area of building ............... Ab:    3540.2 m2
Average construction height of storeys ... hk:     2.846 m
Included influence of thermal bridges  DeltaU:     0.196 W/m2K

Adapted internal temperature ......... ThetaI:     20.00°C
Average external temperature ......... ThetaE:      3.79°C
Length of duration of calculation period .. t:       212 days
Number of climatic day degrees ............ D:      3437 Kday

Average air change rate ................... n:      0.50 1/h
Characteristic number of building ......... B:      8.00 Pa0.67
Ratio of internal and external volume ..... k:      0.80 Vb
Heat power of internal heat sources ...... qi:      5.00 W/m2
Category of building .......................:      apartment house
```

THERMAL-TECHNICAL PROPERTIES OF CONSTRUCTIONS AND REDUCTION FACTORS:

CONSTRUCTION	Ai [m2]	Ui [W/m2K]	bxi [-]	Ai.Ui.bxi [W/K]	Percent. [%]
1 External wall 1	1640.62	0.862	1.00	1414.21	41.54
2 External wall 2	157.22	0.579	1.00	91.03	2.67
3 Windows steel	36.00	6.238	1.00	224.57	6.60
4 Windows wooden	533.12	2.579	1.00	1374.92	40.38
5 Flat roof	442.52	0.394	1.00	174.35	5.12
6 Ceiling above the ext	1.61	0.522	1.00	0.84	0.02
7 Floor on the ceiling	440.91	0.566	0.50	124.78	3.66
Ae = SUM(Ai) = 3252.00		SUM(Ai.Ui.bxi) = 3404.70			100.00

CALCULATION RESULTS:

```
Included influence of therm. bridges DeltaHtm:   637.39 W/K
Transmission heat loss coefficient ...... Htr:  4042.09 W/K
Average thermal transmittance ........... Uem:     1.24 W/m2K

Calculated air change rate ................ n:     0.64 1/h
Considered air change rate ................ n:     0.64 1/h
Ventilation heat loss coefficient ....... Hve:  1703.12 W/K
Heat transfer coeff. of building .. H=Htr+Hve:  5745.21 W/K
```

ENERGY NEED AND SPECIFIC ENERGY NEED FOR HEATING:

```
Energy need for heating ....................... Qhnd:    353967 kWh/a
Specific energy need for heating .............. Qhnd1:     35.13 kWh/m3a
Specific energy need for heating .............. Qhnd2:     99.98 kWh/m2a
Standard specific energy need ................ QhndN1:     9.22 kWh/m3a
Standard specific energy need ................ QhndN2:    25.82 kWh/m2a
Shape factor of building ..................... Ae/Vb:     0.323 1/m
```

Tab. 4.2.2 Calculation of energy need for heating of building using the standard ΔU – value

Structural system B 70 - detached house

Calculation of energy need for heating of building using the standard ΔU – value

ASSIGNED BOUNDARY CONDITIONS:

Volume of the heated space of building	Vb:	10075.3 m3
Total floor area of building	Ab:	3540.2 m2
Average construction height of storeys ...	hk:	2.846 m
Included influence of thermal bridges	DeltaU:	0.100 W/m2K
Adapted internal temperature	ThetaI:	20.00°C
Average external temperature	ThetaE:	3.79°C
Length of duration of calculation period ..	t:	212 days
Number of climatic day degrees	D:	3437 Kday
Average air change rate	n:	0.50 1/h
Characteristic number of building	B:	8.00 Pa0.67
Ratio of internal and external volume	k:	0.80 Vb
Heat power of internal heat sources	qi:	5.00 W/m2
Category of building	:	apartment house

THERMAL-TECHNICAL PROPERTIES OF CONSTRUCTIONS AND REDUCTION FACTORS:

CONSTRUCTION	Ai [m2]	Ui [W/m2K]	bxi [-]	Ai.Ui.bxi [W/K]	Percent. [%]
1 External wall 1	1640.62	0.862	1.00	1414.21	41.54
2 External wall 2	157.22	0.579	1.00	91.03	2.67
3 Windows steel	36.00	6.238	1.00	224.57	6.60
4 Windows wooden	533.12	2.579	1.00	1374.92	40.38
5 Flat roof	442.52	0.394	1.00	174.35	5.12
6 Ceiling above the ext	1.61	0.522	1.00	0.84	0.02
7 Floor on the ceiling	440.91	0.566	0.50	124.78	3.66
Ae = SUM(Ai) = 3252.00		SUM(Ai.Ui.bxi) = 3404.70			100.00

CALCULATION RESULTS:

Included influence of therm. bridges	DeltaHtm:	325.20 W/K
Transmission heat loss coefficient	Htr:	3729.90 W/K
Average thermal transmittance	Uem:	1.15 W/m2K
Calculated air change rate	n:	0.64 1/h
Considered air change rate	n:	0.64 1/h
Ventilation heat loss coefficient	Hve:	1703.12 W/K
Heat transfer coeff. of building .. H=Htr+Hve:		5433.02 W/K

ENERGY NEED AND SPECIFIC ENERGY NEED FOR HEATING:

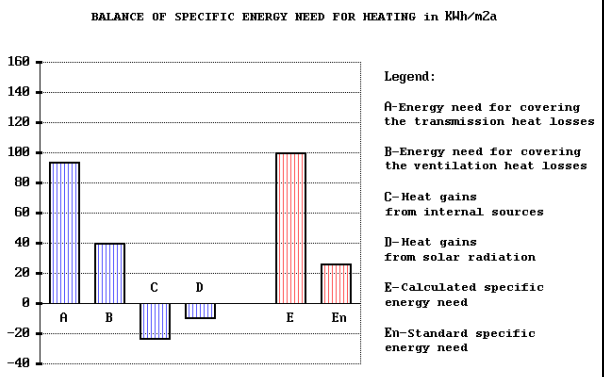
Energy need for heating	Qhnd:	328336 kWh/a
Specific energy need for heating	Qhnd1:	32.59 kWh/m3a
Specific energy need for heating	Qhnd2:	92.74 kWh/m2a
Standard specific energy need	QhndN1:	9.22 kWh/m3a
Standard specific energy need	QhndN2:	25.82 kWh/m2a
Shape factor of building	Ae/Vb:	0.323 1/m

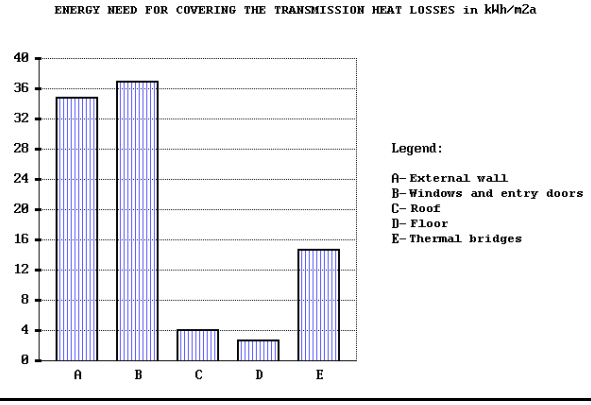
Table 4.3. Comparison of energy need for heating using calculated and standard ΔU – value

Energy evaluation of building using a calculated ΔU – value (ΔU = 0.196 W/(m^2.K))

```
ENERGY NEED AND SPECIFIC ENERGY NEED FOR HEATING:
================================================
Specific energy need for heating ..... Qhnd2:     99.98 kWh/m2a
Standard specific energy need ..... QhndN2:     25.82 kWh/m2a

COMPLEX EVALUATION OF BUILDING ON STANDARD VALUES:
================================================
+---------------+-----------------------------------------------+------------+
¦ Uem – value   ¦ Uem = 1.24 W/m2K   >   UemN = 0.37 W/m2K     ¦  not meet  ¦
+---------------+-----------------------------------------------+------------+
¦ Economy       ¦ Qep = 96.9 kWh/m2a >  QepN = 25.0 kWh/m2a    ¦  not meet  ¦
+---------------+-----------------------------------------------+------------+
¦ Energy need   ¦ Qhnd2 = 100.0 kWh/m2a > QhndN2 = 25.8 kWh/m2a¦  not meet  ¦
+---------------+-----------------------------------------------+------------+
```

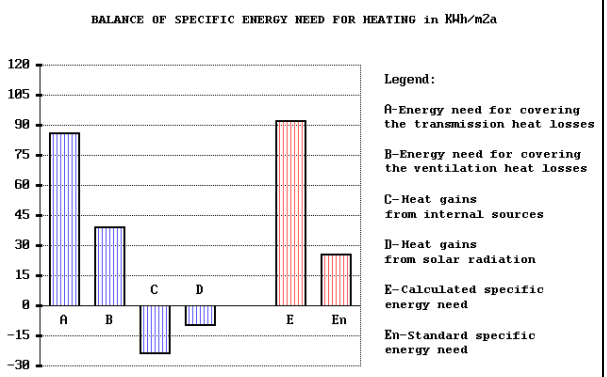


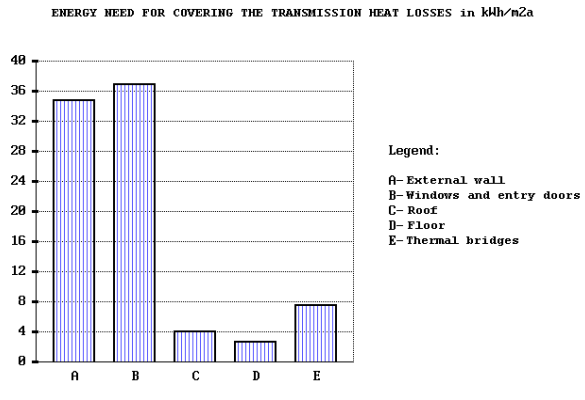


Energy evaluation of building using a standard ΔU – value (ΔU = 0.100 W/(m^2.K))

```
ENERGY NEED AND SPECIFIC ENERGY NEED FOR HEATING:
================================================
Specific energy need for heating ..... Qhnd2:     92.74 kWh/m2a
Standard specific energy need ..... QhndN2:     25.82 kWh/m2a

COMPLEX EVALUATION OF BUILDING ON STANDARD VALUES:
================================================
+---------------+-----------------------------------------------+------------+
¦ Uem – value   ¦ Uem = 1.15 W/m2K   >   UemN = 0.37 W/m2K     ¦  not meet  ¦
+---------------+-----------------------------------------------+------------+
¦ Economy       ¦ Qep = 89.7 kWh/m2a  >  QepN = 25.0 kWh/m2a    ¦  not meet  ¦
+---------------+-----------------------------------------------+------------+
¦ Energy need   ¦ Qhnd2 = 92.7 kWh/m2a > QhndN2 = 25.8 kWh/m2a¦  not meet  ¦
+---------------+-----------------------------------------------+------------+
```





Conclusion

In this publication an evaluation of another 26 details from the viewpoint of hygienic criterion, calculation of linear themal transmittance, thermal transmittance due to thermal bridges ΔU and calculation and comparison of energy need for heating was carried out.

The evaluation of hygienic criterion and calculation of the linear thermal transmittance of details realized in chapter 2 showed that all details (except 3 details) do not meet the requirement on hygienic criterion according to the standard [15]. The analysis and comparison of the calculated ΔU-value and standard ΔU-value [15] in chapter 3 shows, that the calculated ΔU-value (ΔU = 0.196 W/(m^{2}K) is much higher than the ΔU-value given in the standard (ΔU = 0.100 W/(m^{2}K)). The value of energy need for heating (chapter 4) determined using the calculated ΔU-value is higher than the energy need for heating calculated using the standard ΔU-value and both values do not meet the requirement of the standard [15]. It means, that an additional thermal insulation of envelope constructions must be realized at the building and the windows must be replaced by new ones to meet the current standard requirements.

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