BUILDING REHABILITATION
3. WATERPROOFINGS, FLAT ROOFS, DOORS AND WINDOWS

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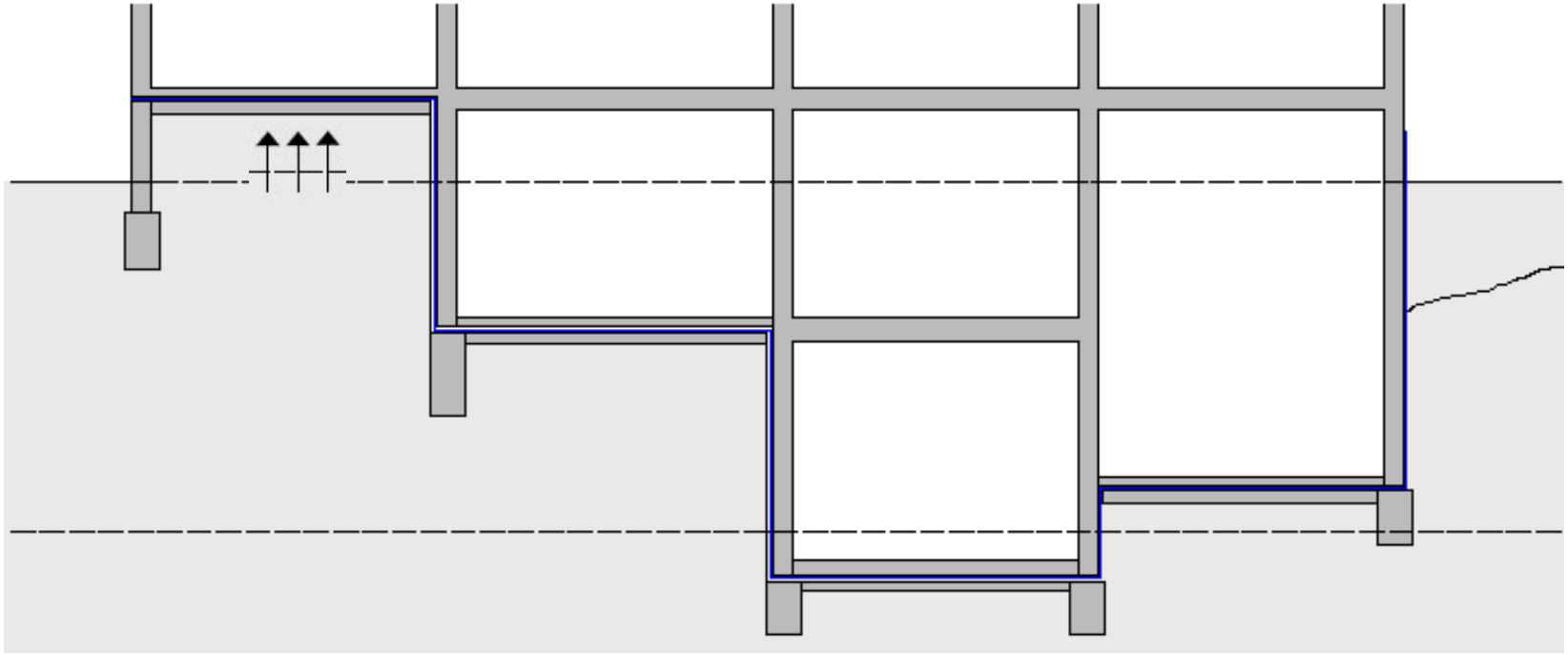
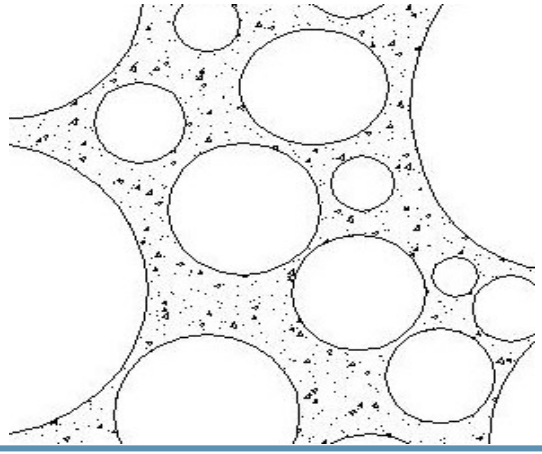
WATERPROOFING FAILURES OF SUBSTRUCTURES

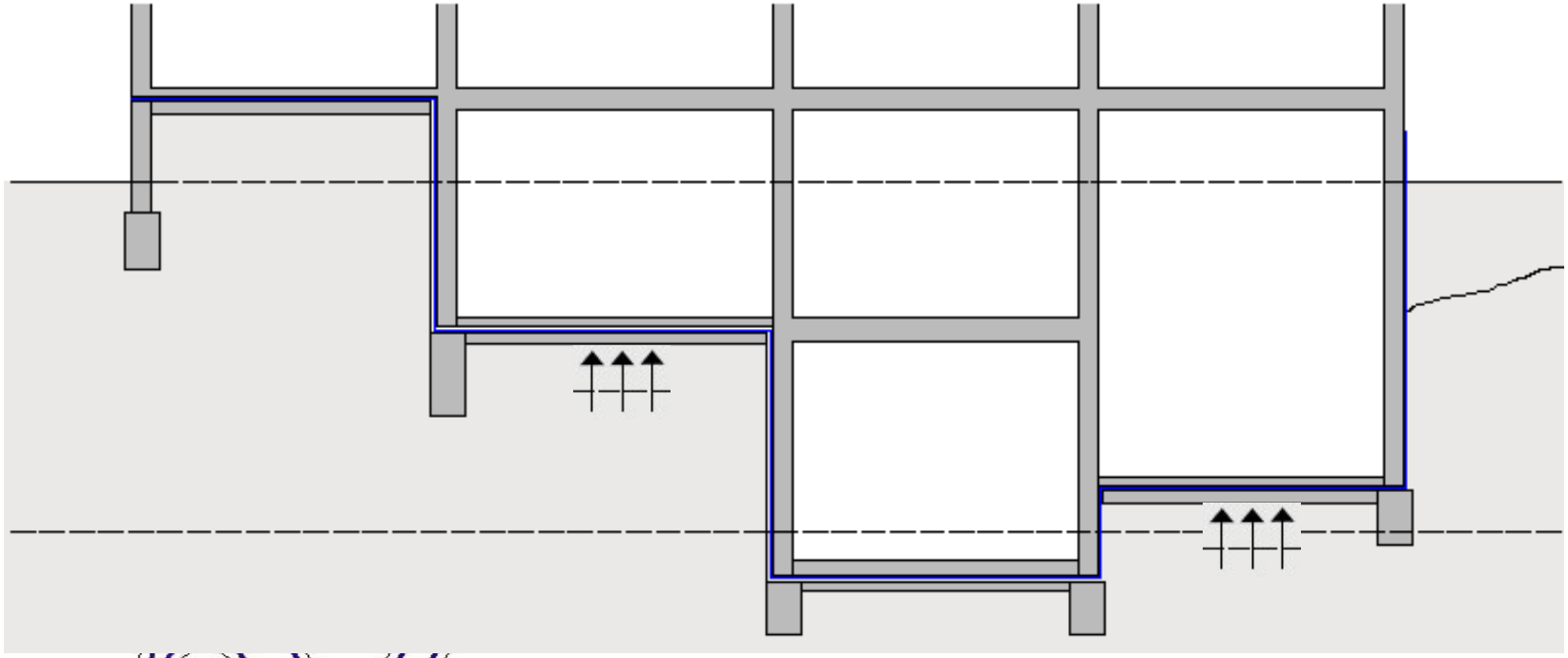
MOISTURE EXPOSURES IN SOIL – SOIL VAPOUR

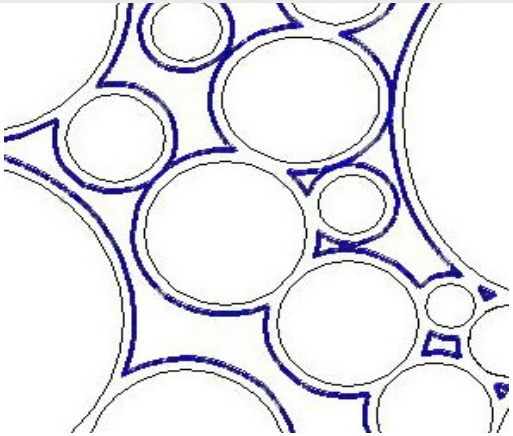




- Vapour between the soil particles
- Comes from the evaporation of the subsoil water
- Condensates of the surface of the subconstructions: **subsoil moisture**

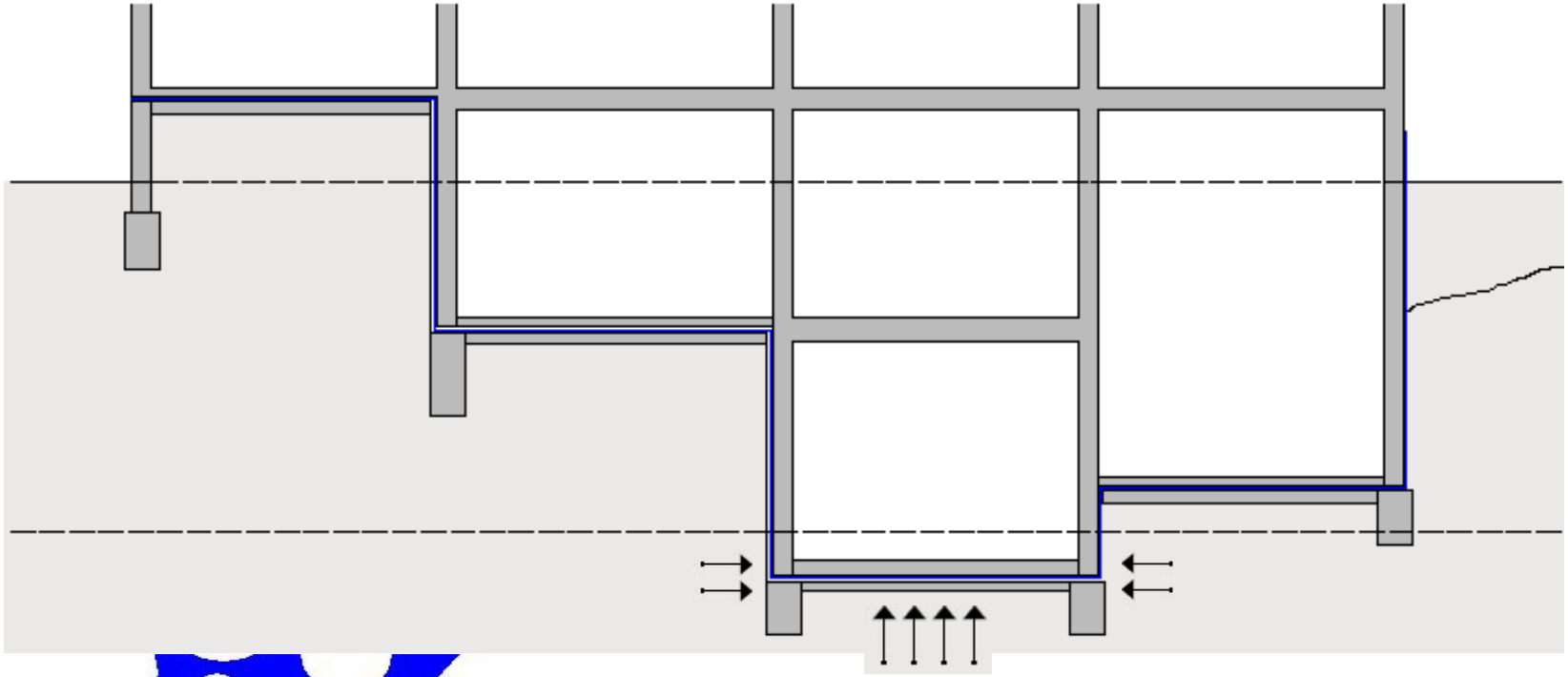
MOISTURE EXPOSURES IN SOIL – SOIL VAPOUR

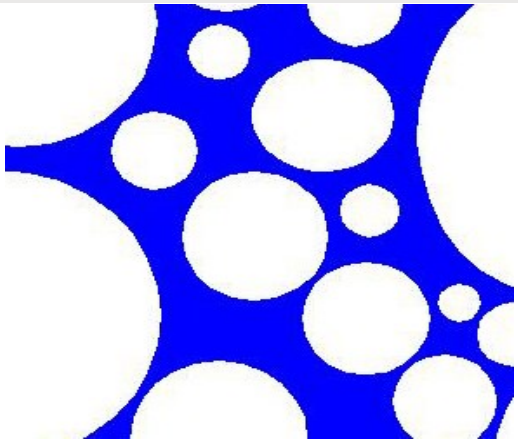




- Water on the surface of the particles
- No hydrostatic pressure
- Capillarity
  - Abrasive particle subsoil – 2-3 cm
  - in adherent subsoil – clay – even 300 m!

MOISTURE EXPOSURES IN SOIL – SOIL VAPOUR



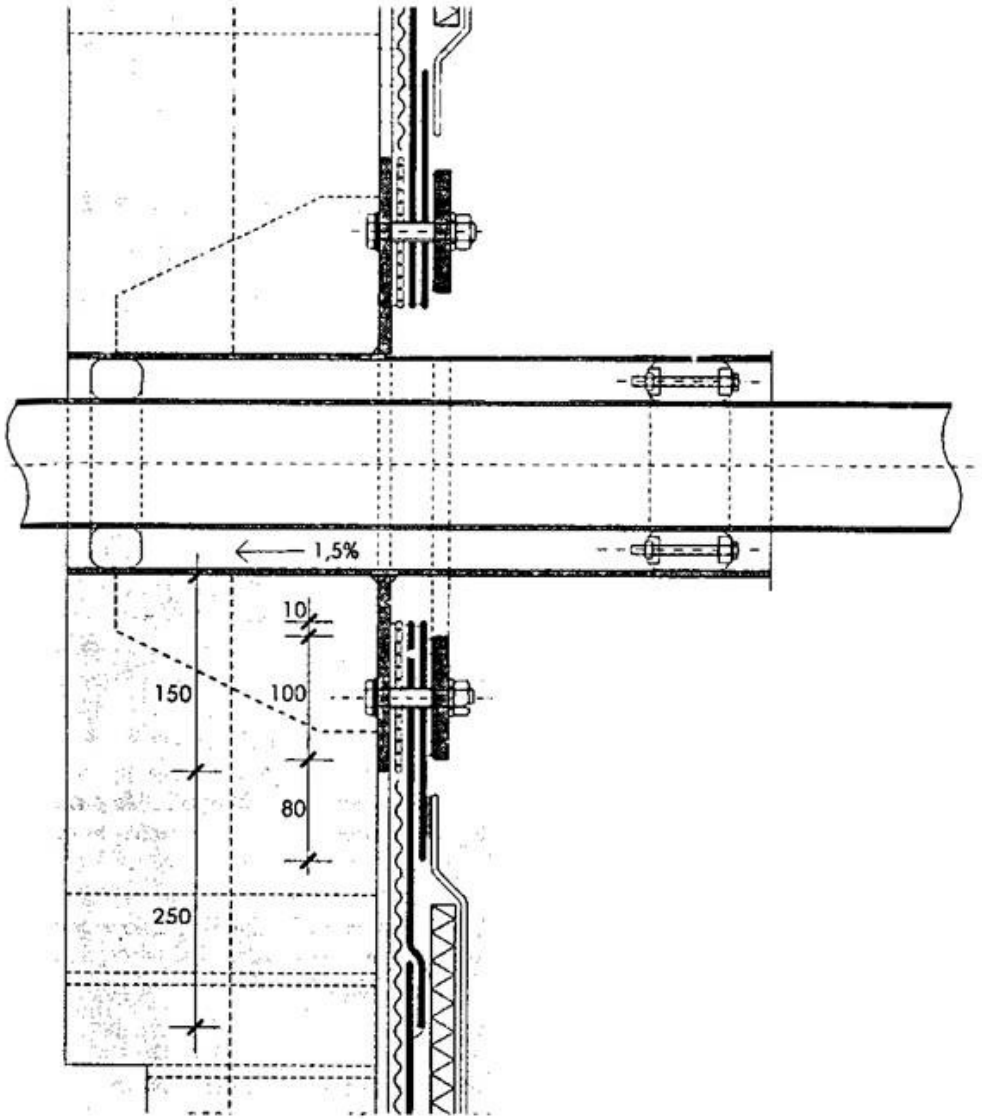


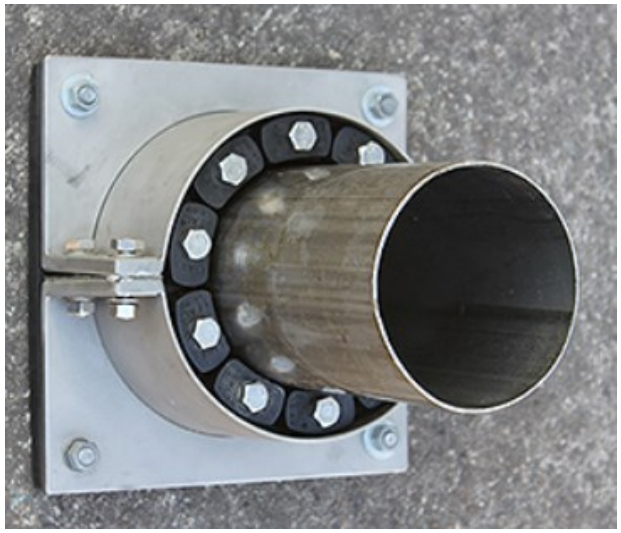
- Gaps between the soil particles filled completely with subsoil water
- Hydraulic pressure (depends on the level difference between the floor and the water table)
- Uplift hazard

WATERPROOFINGS – TYPICAL MISTAKES

- Design and construction failures
- Mechanical damage
- Lack of performance based design – inadequate waterproofing for the given exposure (f.i. 1 layer of bituminous sheet against subsoil water)
- Discontinous waterproofing – missing parts or inadequate joints

PIPE PENETRATIONS OF WATERPROOFINGS – SLEEVE + LINK-SEAL





PIPE PENETRATIONS OF WATERPROOFINGS – SLEEVE + LINK-SEAL

FAILURE: MISSING SLEEVE + LINK-SEAL

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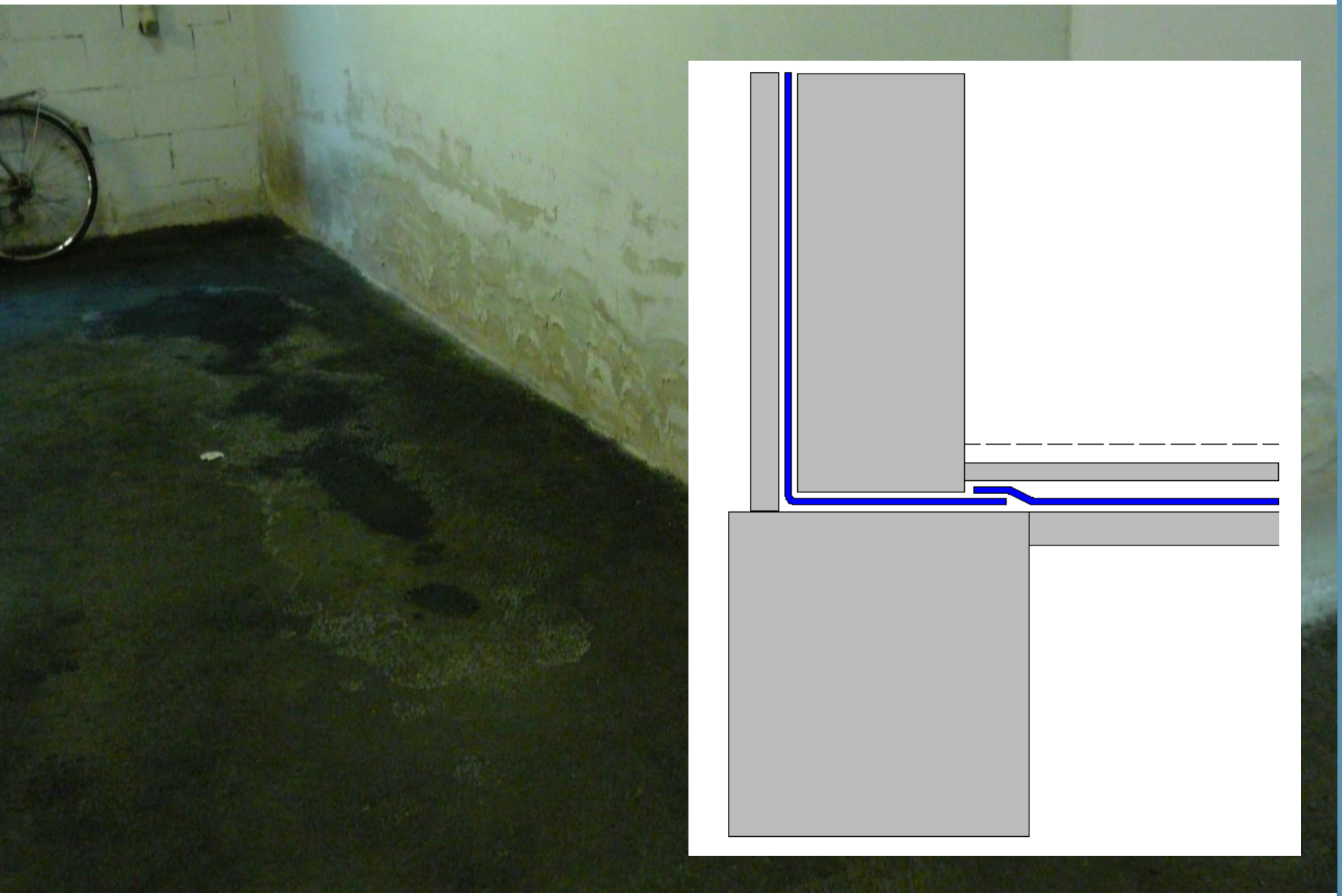
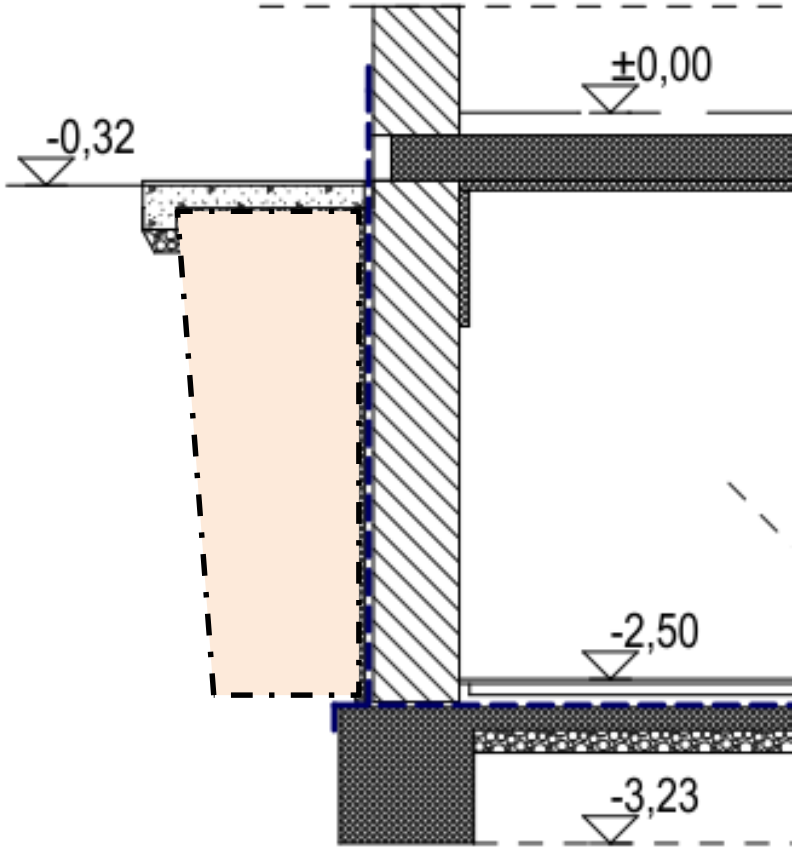


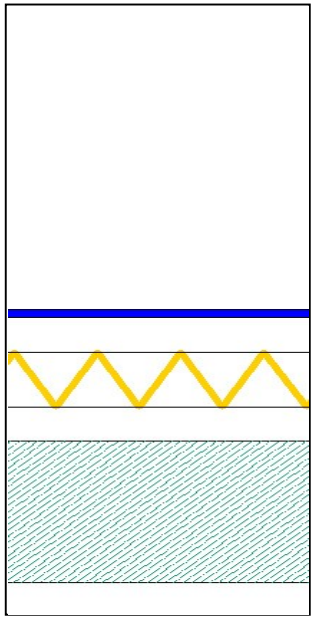
INADEQUATE SOIL BACKFILL
POOR COMPRESSING



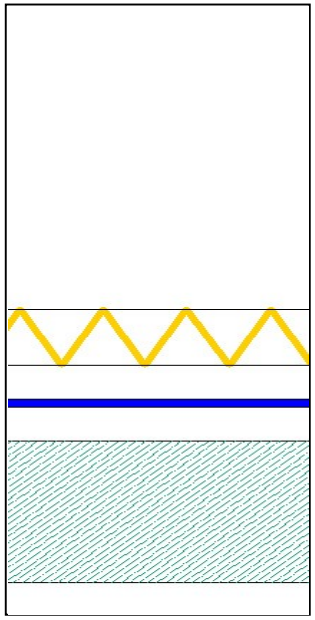
FLAT ROOF FAILURES

FLAT ROOF ALTERNATIVES

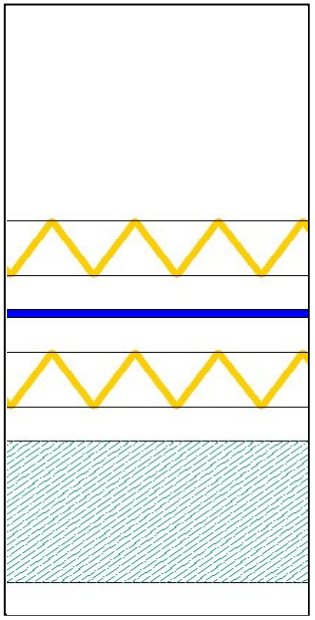
normal



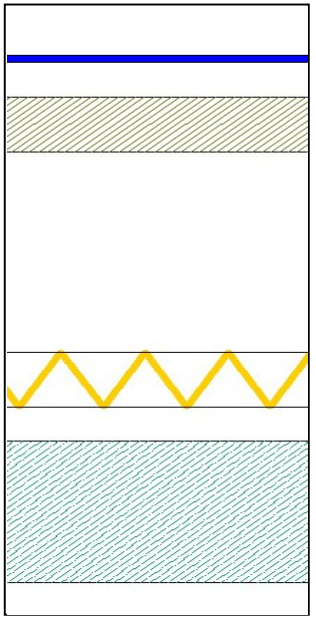
inverted



DUO



Double shell



$t_i \geq 24°C$

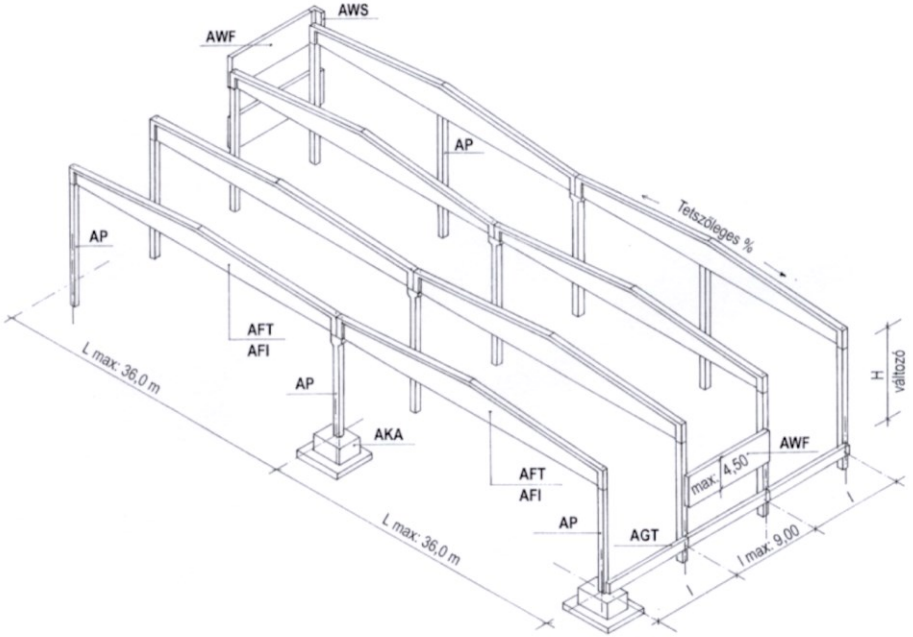
$j_i \geq 75\%$

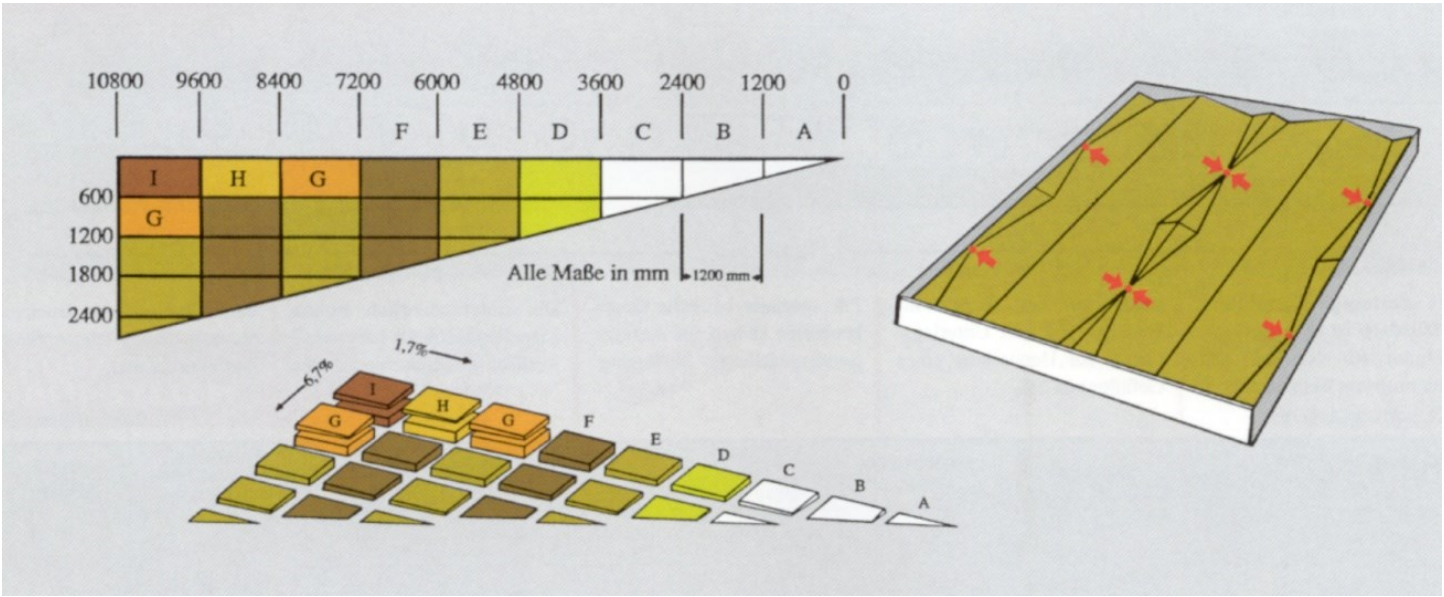
FLAT ROOFS – INCLINATION

How to provide inclination:
- with the loadbearing structure
- screed, lightweight screed
- special thermal insulation

Minimum 2 % (over lightweight structures, minimum 3 %)

Pointwise drainage – linear drainage is not allowed in Hungary!





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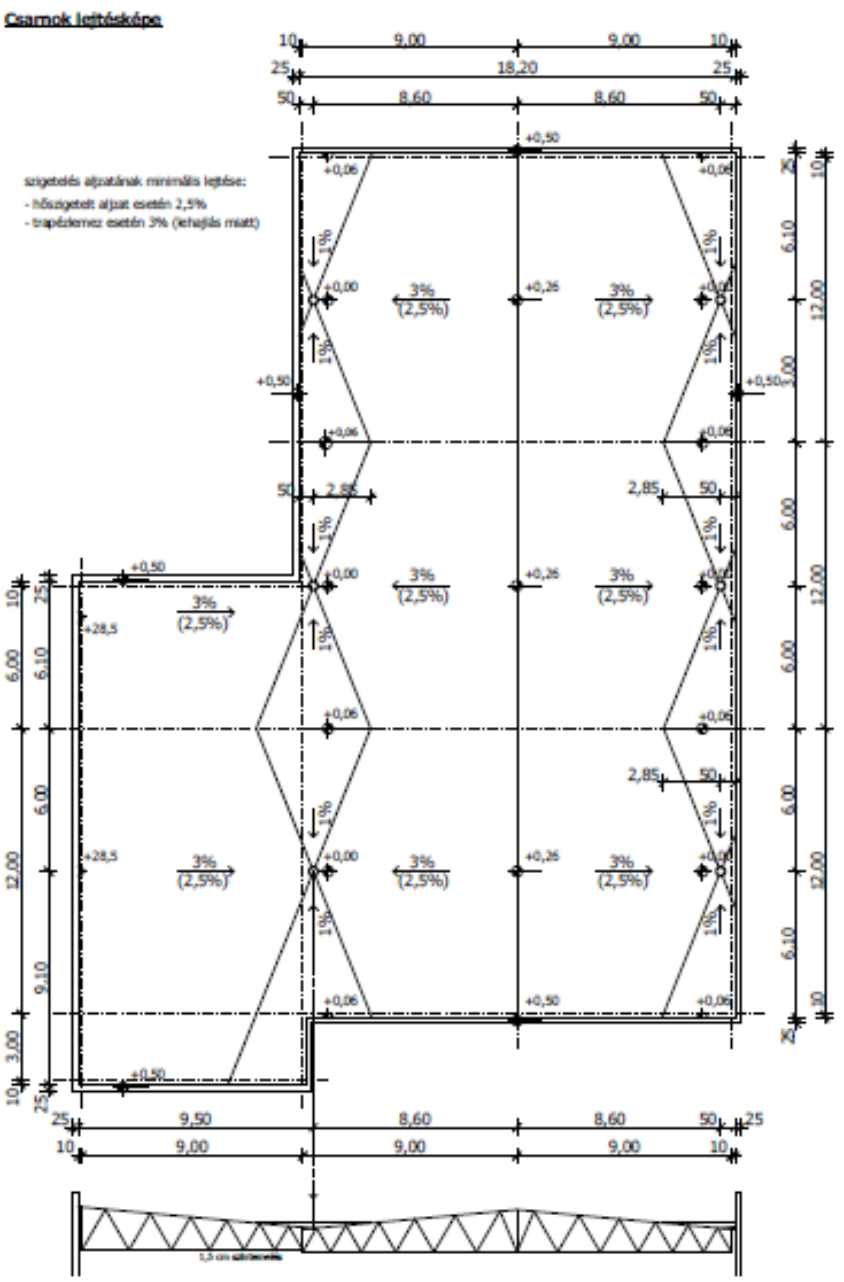

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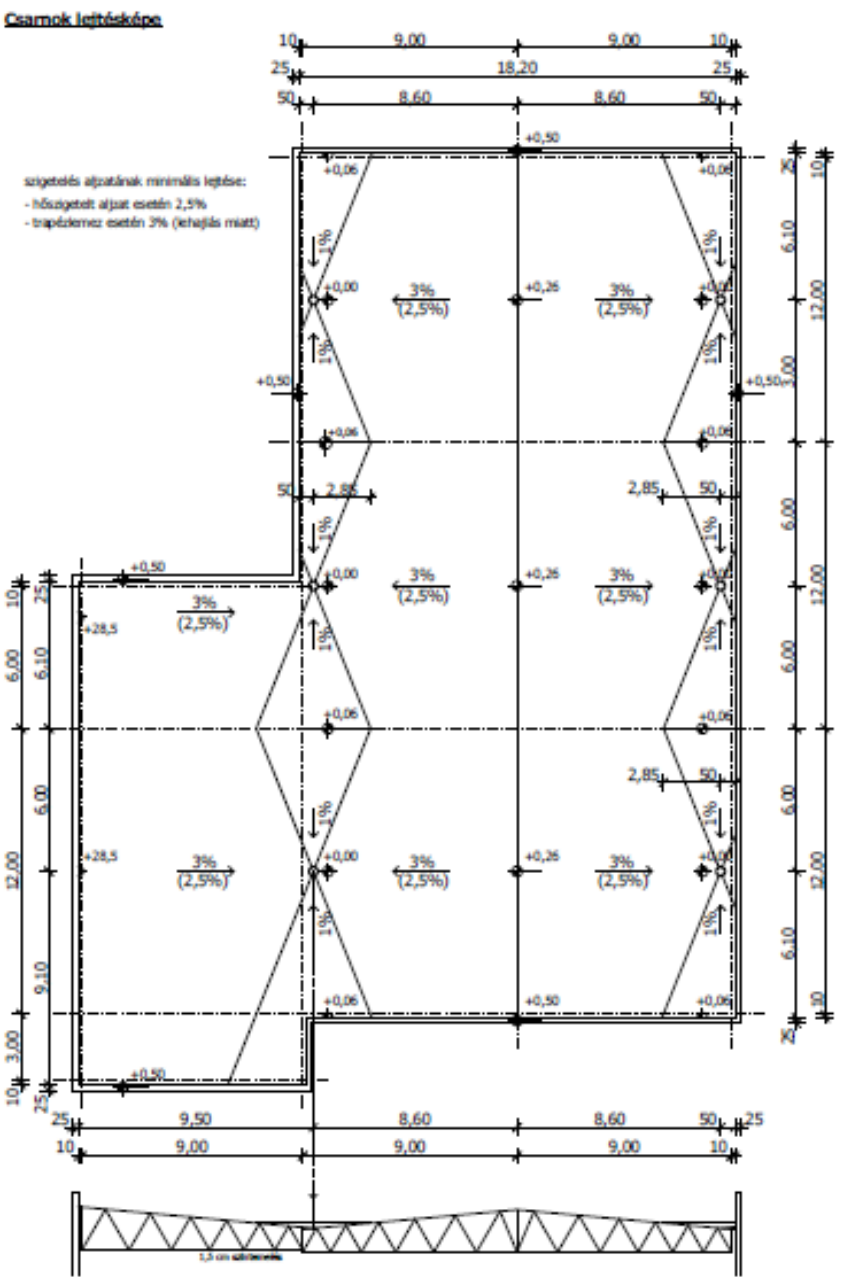


FLAT ROOFS – TYPICAL MISTAKES

- Ageing – especially at bituminous waterproofings (UV protection)
- Inadequate vapour barrier – condensation under the bottom level of the waterproofing
- Inadequate thermal insulation
- Inadequate inclination – water accumulation – ageing, plants
- Blocked rainwater outlets (gullies)
- Inadequate protection against root acid

FLAT ROOFS – INADEQUATE INCLINATION

GULLY ALTERNATIVES

GULLY ALTERNATIVES – SYPHONIC ROOF DRAINAGE

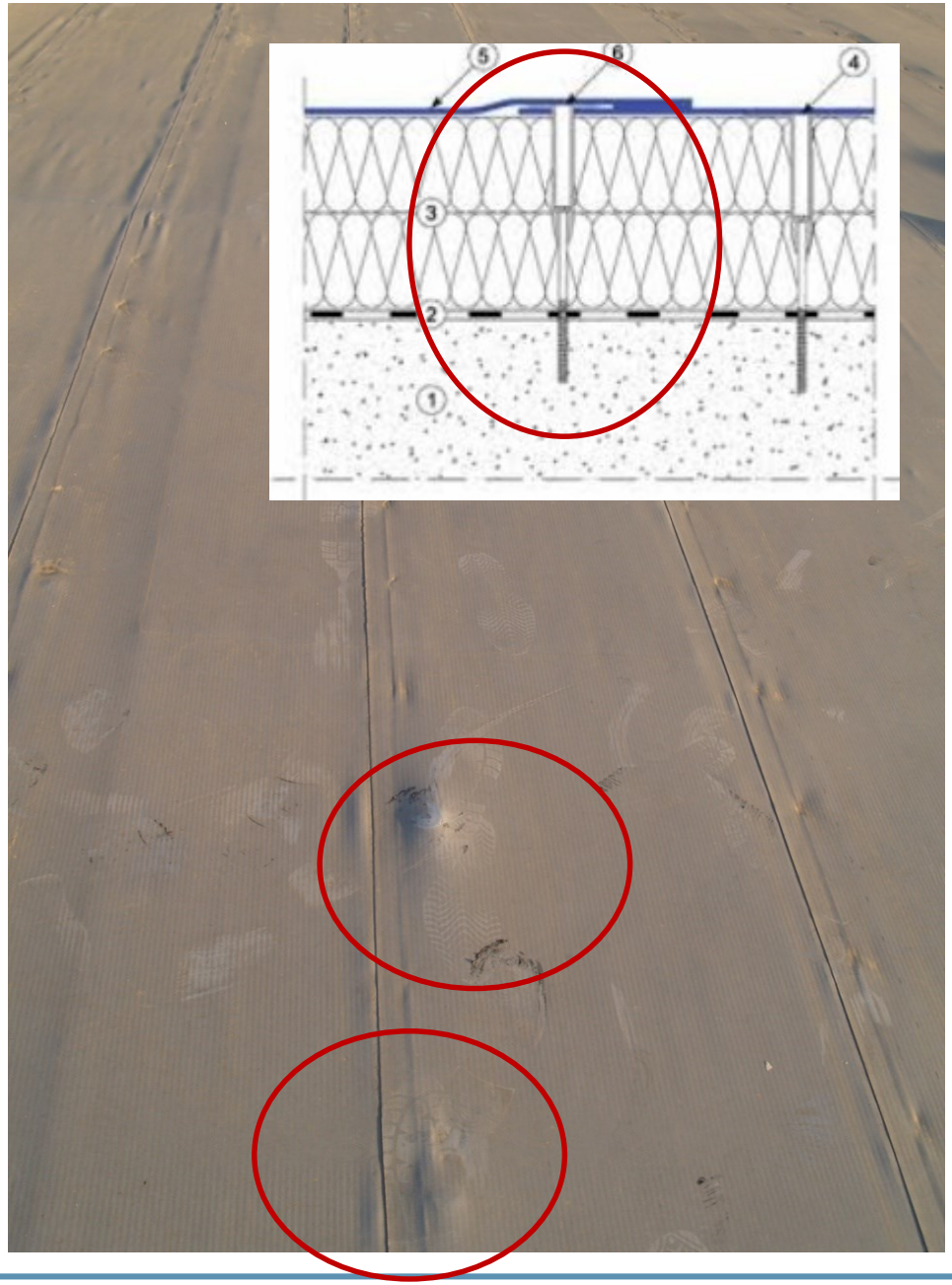
FLAT ROOFS – LACK OF VAPOUR BARRIER
CANNOT BE REPLACED WITH TECHNOLOGYCAL FOIL!

FLAT ROOFS – THERMAL INSULATION BOARD SHRINKING

FLAT ROOFS – FAILURE OF AUXILIARY STRUCTURES

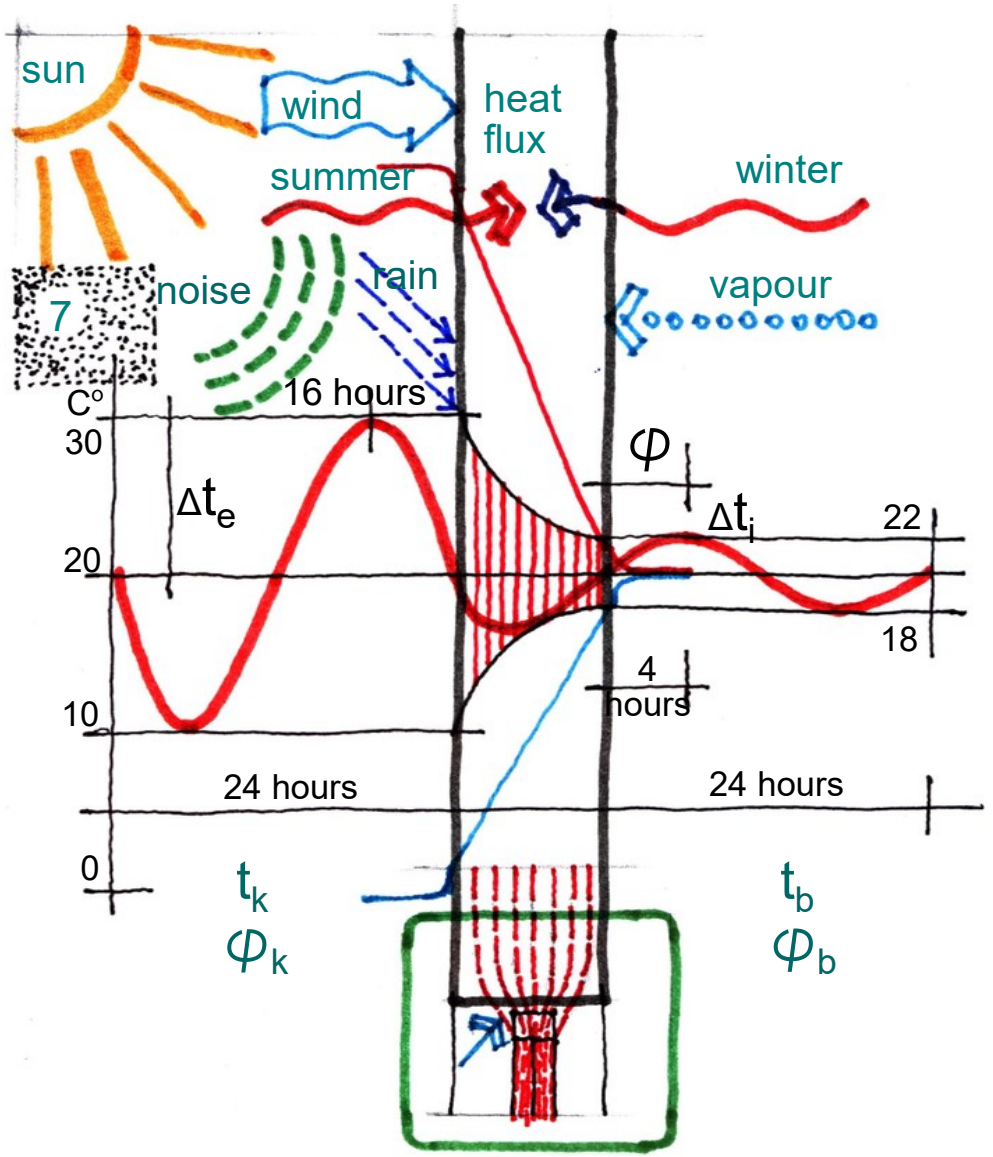
FLAT ROOFS – IMPROPER CRAFTMANSHIP

FLAT ROOF FAILURES



EXTERNAL DOORS, WINDOWS AND THEIR TYPICAL FAILURES

EXTERNAL DOORS AND WINDOWS - EXPOSURES

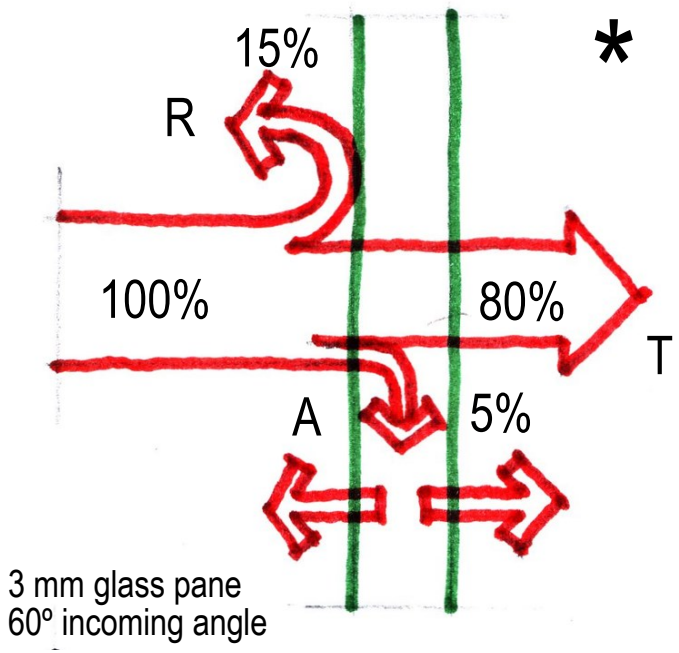


1. temperature difference/swing
2. vapour pressure difference
3. wind
4. solar radiation
5. rain
6. noise
7. dust, pollution

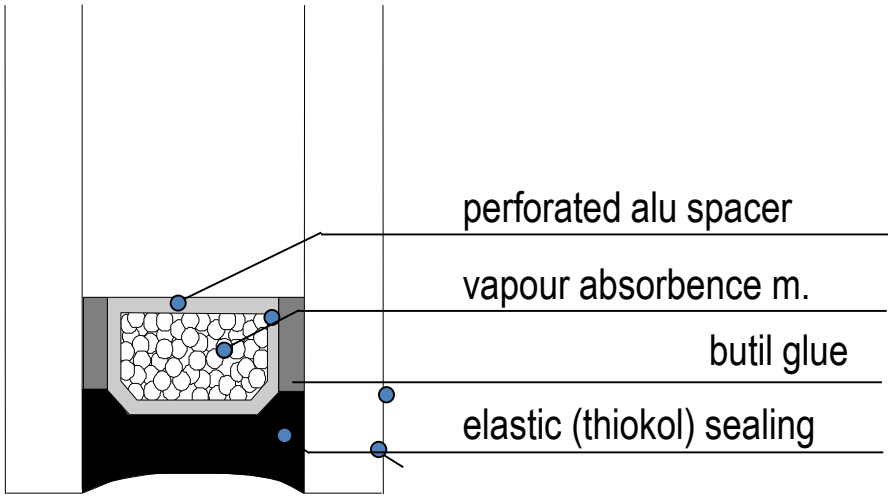
EXTERNAL DOORS AND WINDOWS – PERFORMANCE CRITERIAS

• resistance to wind load	frame A,B,C, surface pressure: 1,2,3,4,5,E
• resistant to snow load	A, B, C
• reaction-to-fire classification	A1, A2, B, C, D, E, F
• weatherproofness	1A, 2A… …9A, E
• hygieny, health and safety	related standard
• mechanical durability	ball 200, 300, 450, 700, 950 mm
• loadbearing capacity and security	declared value
• width and height	
• acoustics (sound insulation)	declared value
• thermal insulation criteria	declared value (1,6-2,0 W/m2K)
• radiation (daylight factor– g)	declared value
• air permeability	class 1, 2, 3, 4
• durability (general and determined)	
• operating force	class 1, 2
• mechanical durability (strenght)	1, 2, 3, 4
• ventilation (open ratio)	declared value (cv factor, characteristics, etc.)
• (bullet- and explosion proofness)	FB1- FB7, FSG; EPR1-4, EXR1-5
• resistace to repeated opening and closing	5000, 10 000, 20 000 times
• behaviour between different climates	in preparation…
• burglary resistance	class 1, 2, 3, 4, 5, 6

ENERGY BALANCE OF DOUBLE GLASING



edge of the double glass



energy balance of the glass

$T_{short\ wave} > T_{long\ wave} \rightarrow$

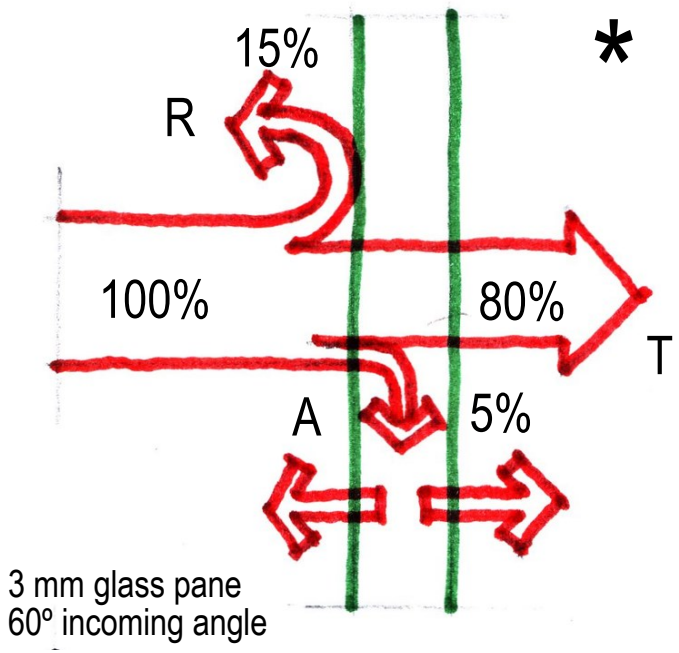
$\rightarrow$ glass house effect (overheating)

rolled glass – (was) cheap

float glas – high quality

Glass	U_g
single layer	5,8 W/m²K
double (4-12-4)	2,8 W/m²K
triple (4-12-4-12)	2,1 W/m²K

ENERGY BALANCE OF DOUBLE GLASING



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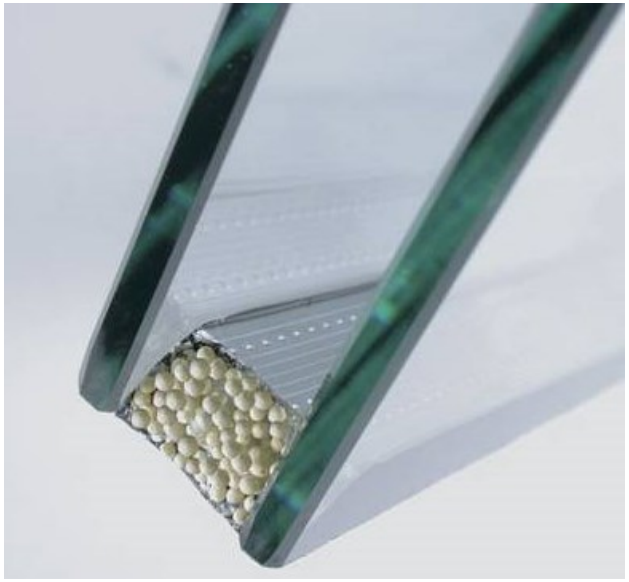

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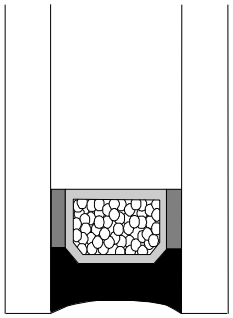
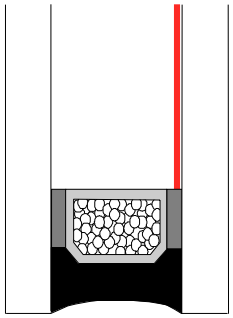
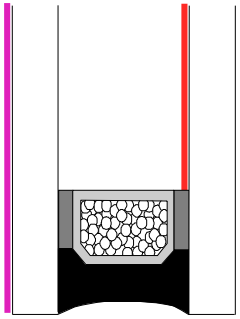
COATED GLASSES, TRIPLE GLASSES, MULTIFUNCTIONAL GLASS



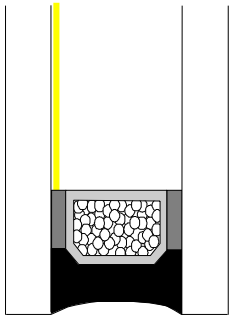
double
4 - 16 - 4



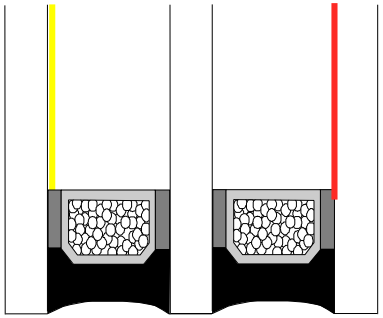
low-emission
coating



Solar coating



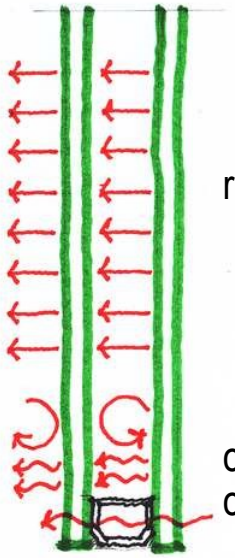
multifunctional
coating



triple glass pane with argon

4 - 10 - 4 - 10 - 4	0,8 W/m²K
4 - 12 - 4 - 12 - 4	0,7 W/m²K
4 - 14 - 4 - 14 - 4	0,6 W/m²K
4 - 16 - 4 - 16 - 4	0,6 W/m²K *

LOW EMISSION (LOW-E) GLASS



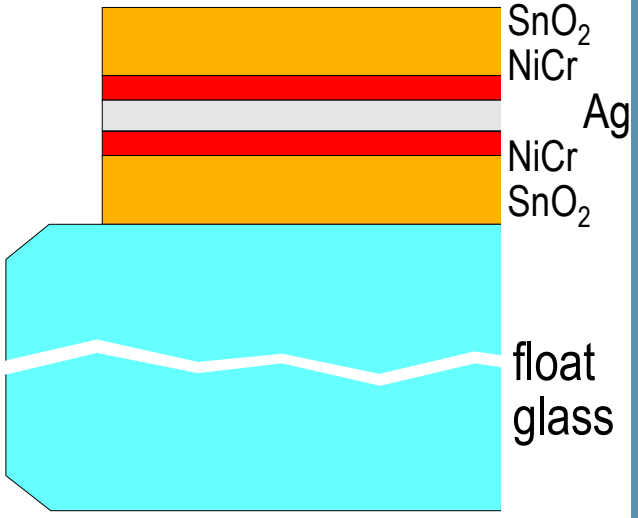
winter energy balance
of glass with no coating

radiation
67%

convection, thermal
conduction
33%

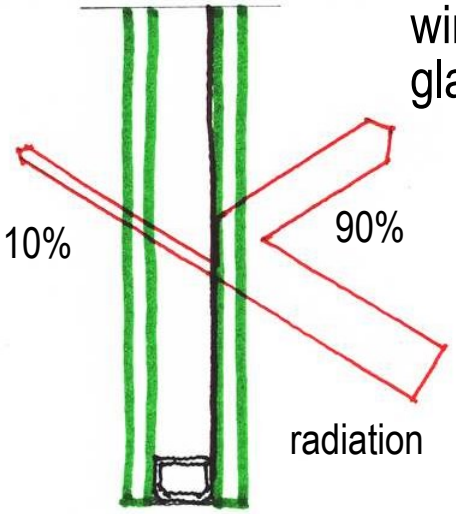
with no coating

In the gap U(W/m²K)	
air	2,78
argon	2,61



construction of single layer
low-e coating

thickness: 0,2 µ



winter energy balance of
glass with low-e coating

10%

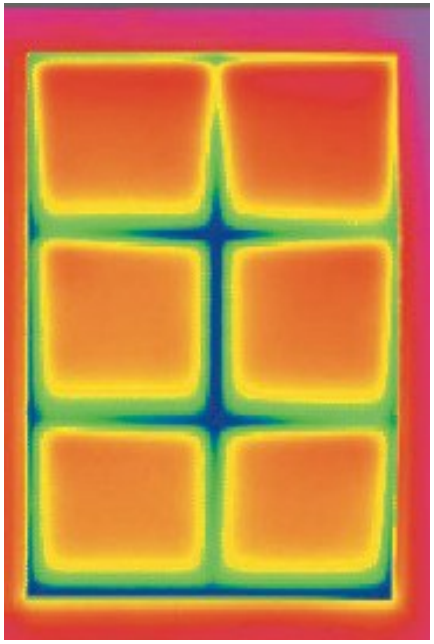
90%

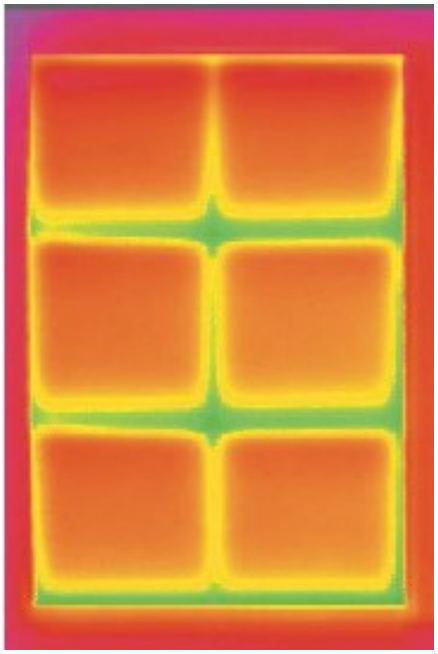
radiation

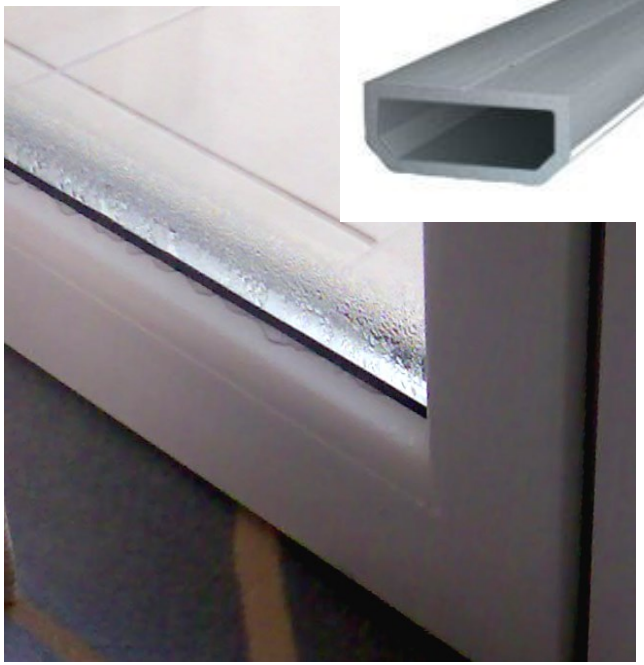
low-e coating

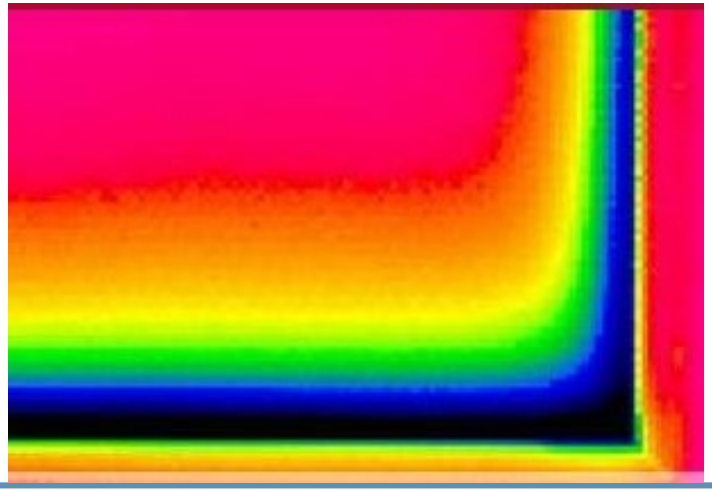
in the gap U(W/m²K)	
air	1,8
argon	1,3
cripton	1,1

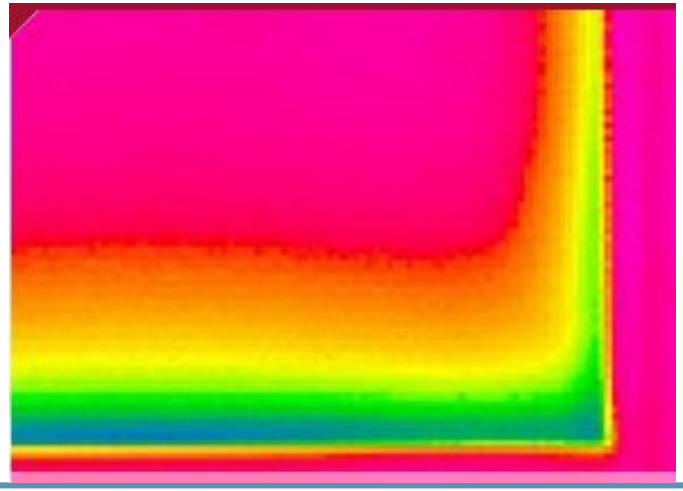
ALUMINIUM VS. PLASTIC SPACERS OF TRIPLE GLASING





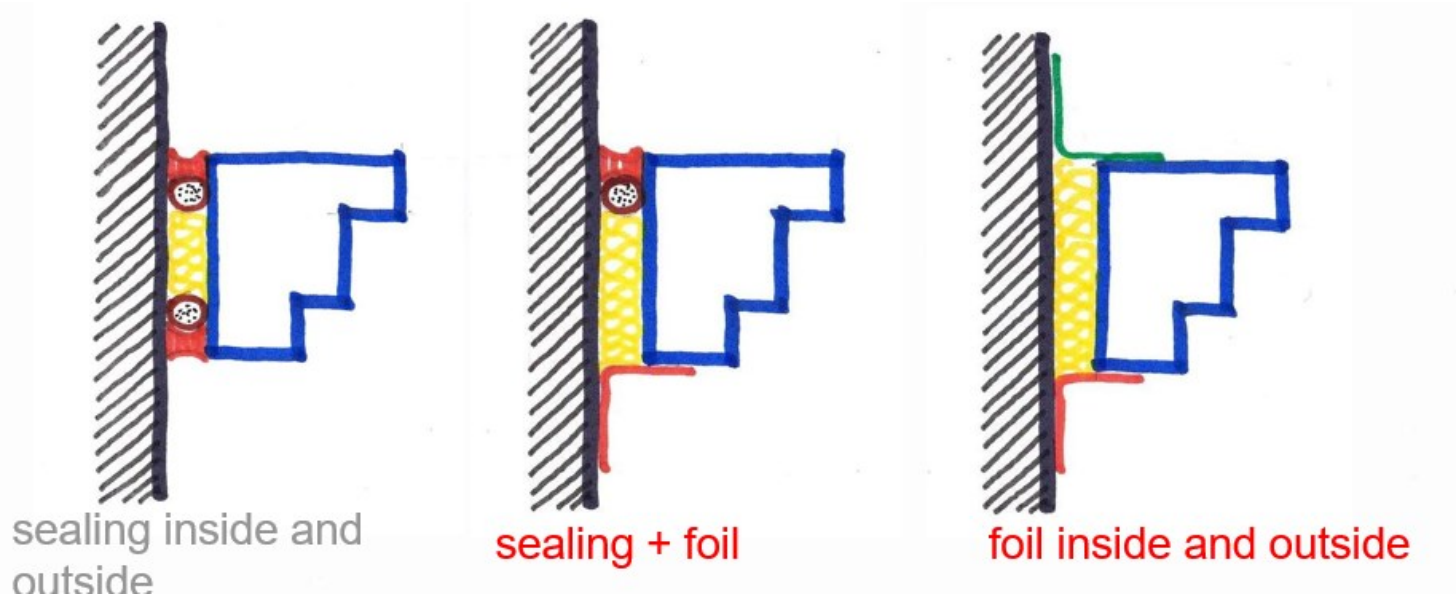


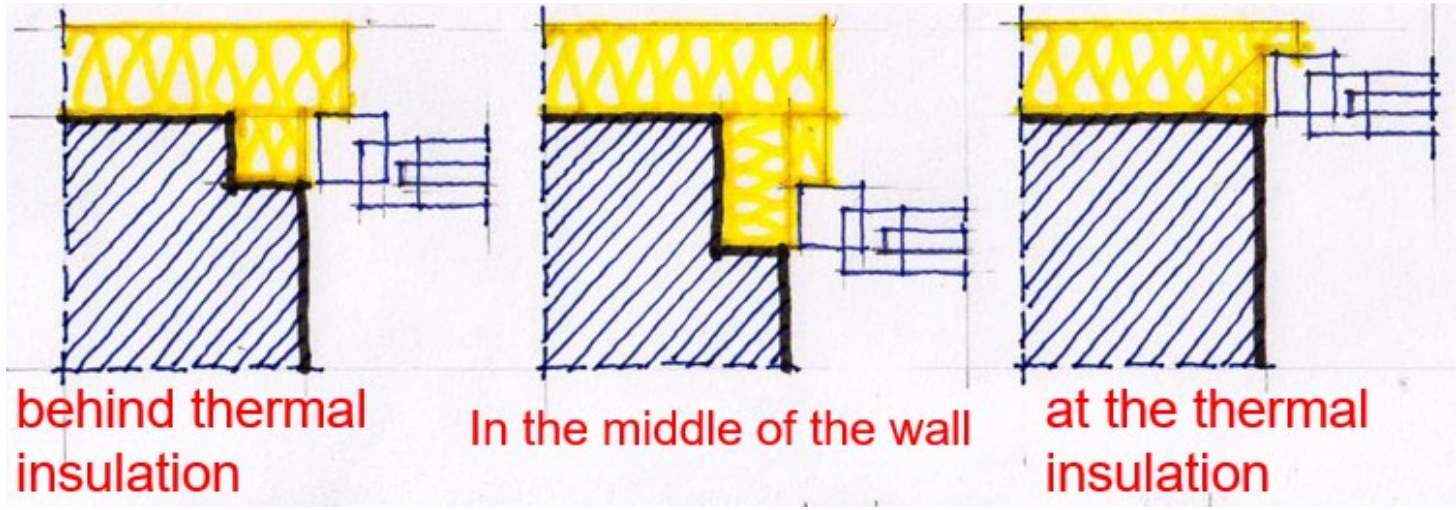




ALUMINIUM VS. PLASTIC SPACERS OF TRIPLE GLASING

DOORS, WINDOWS - INSTALLATION





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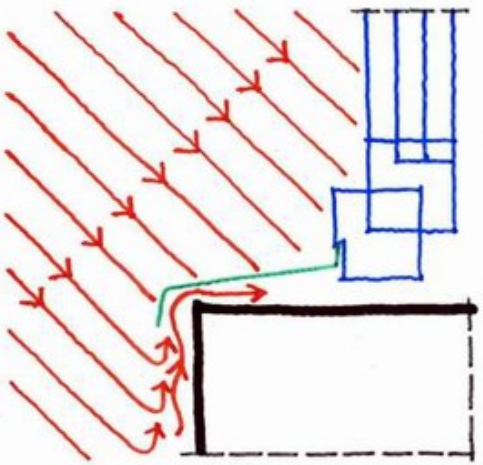
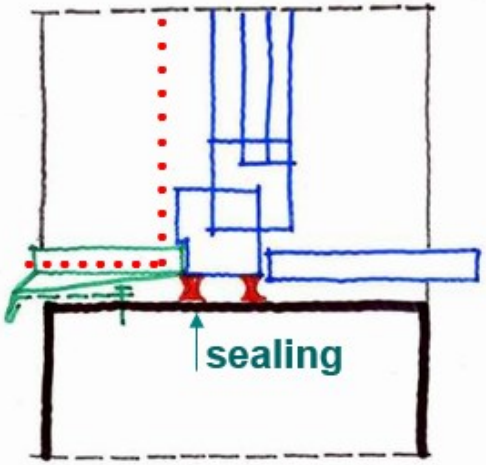
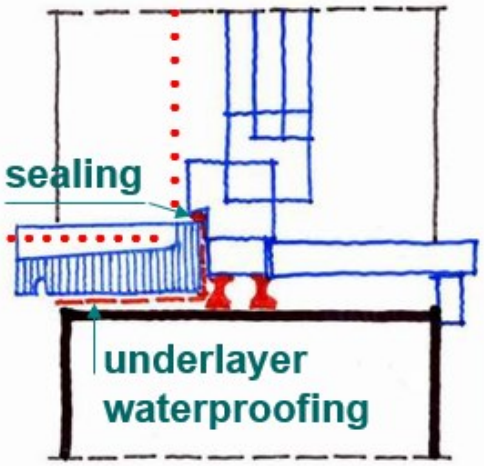


precipitation
pushed up by wind

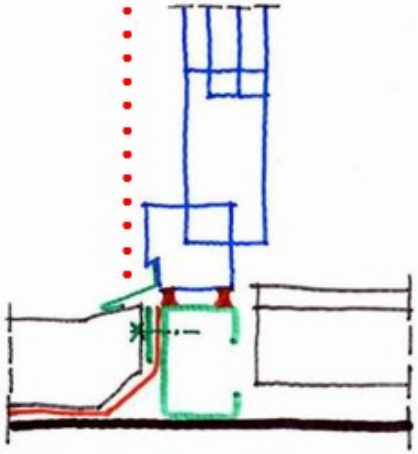


window flashing

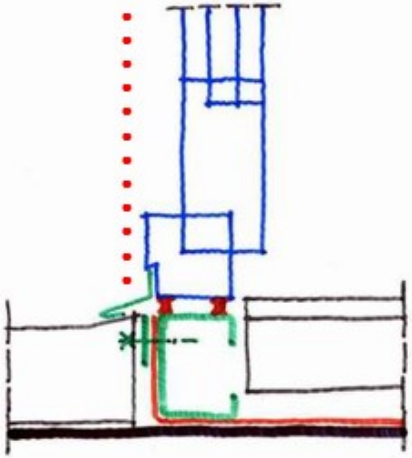


artificial stone

*

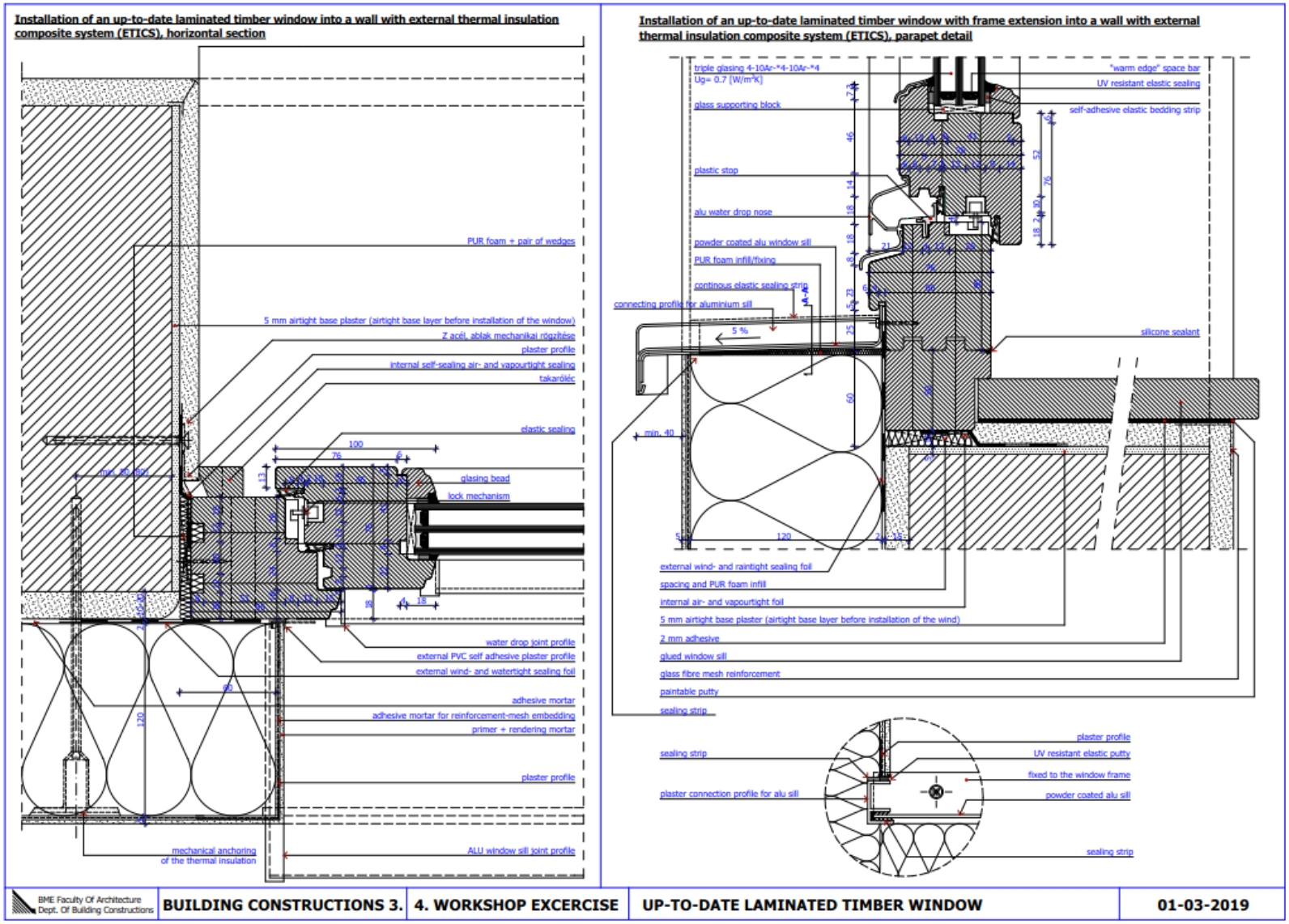


waterproofing



balcony

DOOR, WINDOWS - INSTALLATION



DOOR, WINDOWS – INSTALLATION

DOOR, WINDOWS - INSTALLATION

EXTERNAL DOORS AND WINDOWS

Important features:

- Moving parts – sash
- Joints

Typical problems:

- Missing lintel – deformation
- Improper installation – missing external wind-and raintight foil, missing vapour barrier
- Thermal bridge – poor thermal insulation around the door or window
- Mechanical failure – lack of maintenance
- Failure of finishing (especially at timber windows)
- Missing connection to the waterproofing – water penetration

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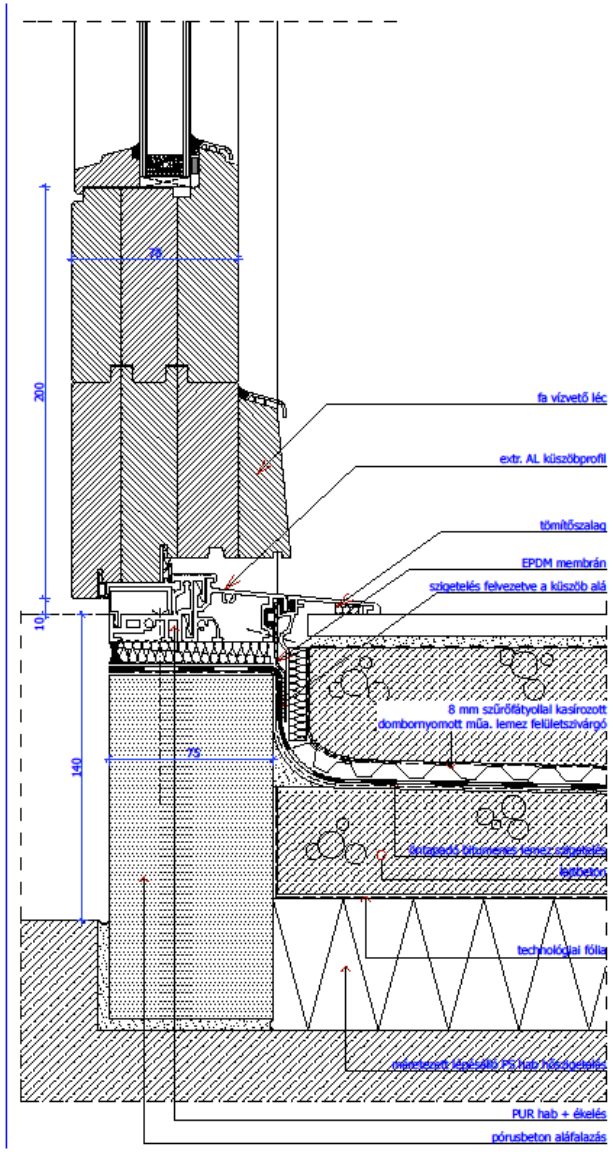
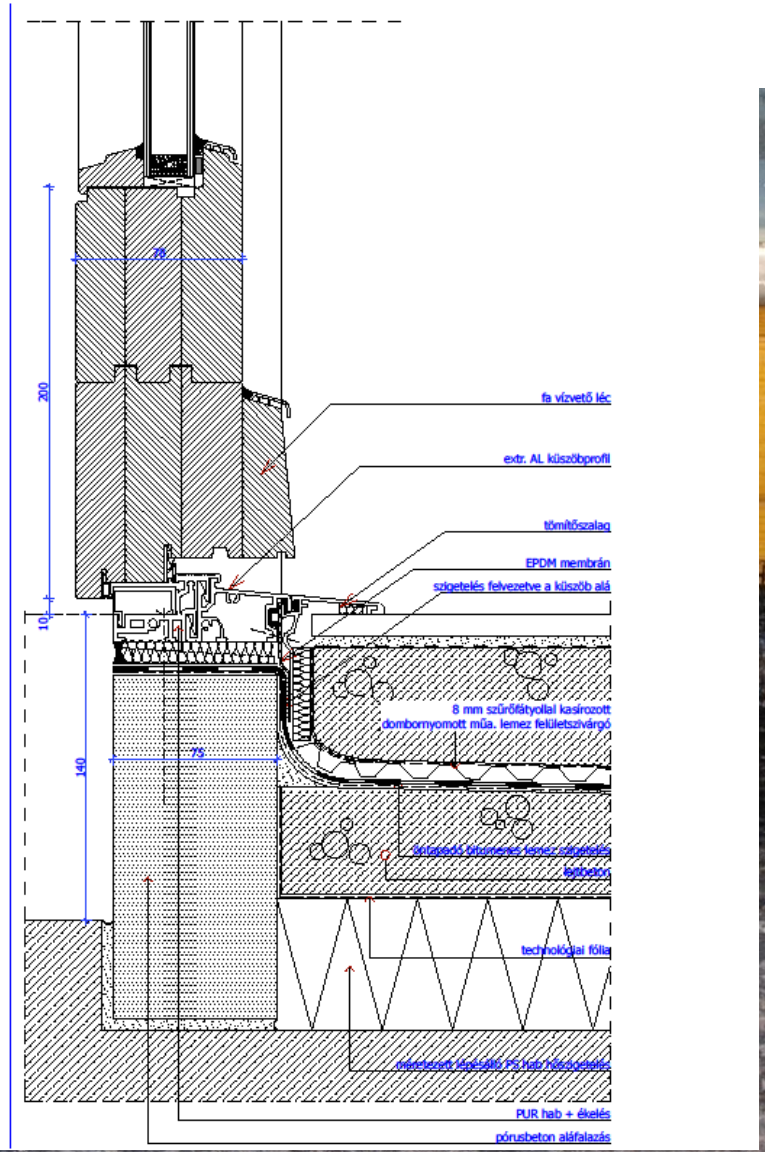
DEWATERING PROBLEMS

EXTERNAL DOOR CONNECTION TO THE WATERPROOFING

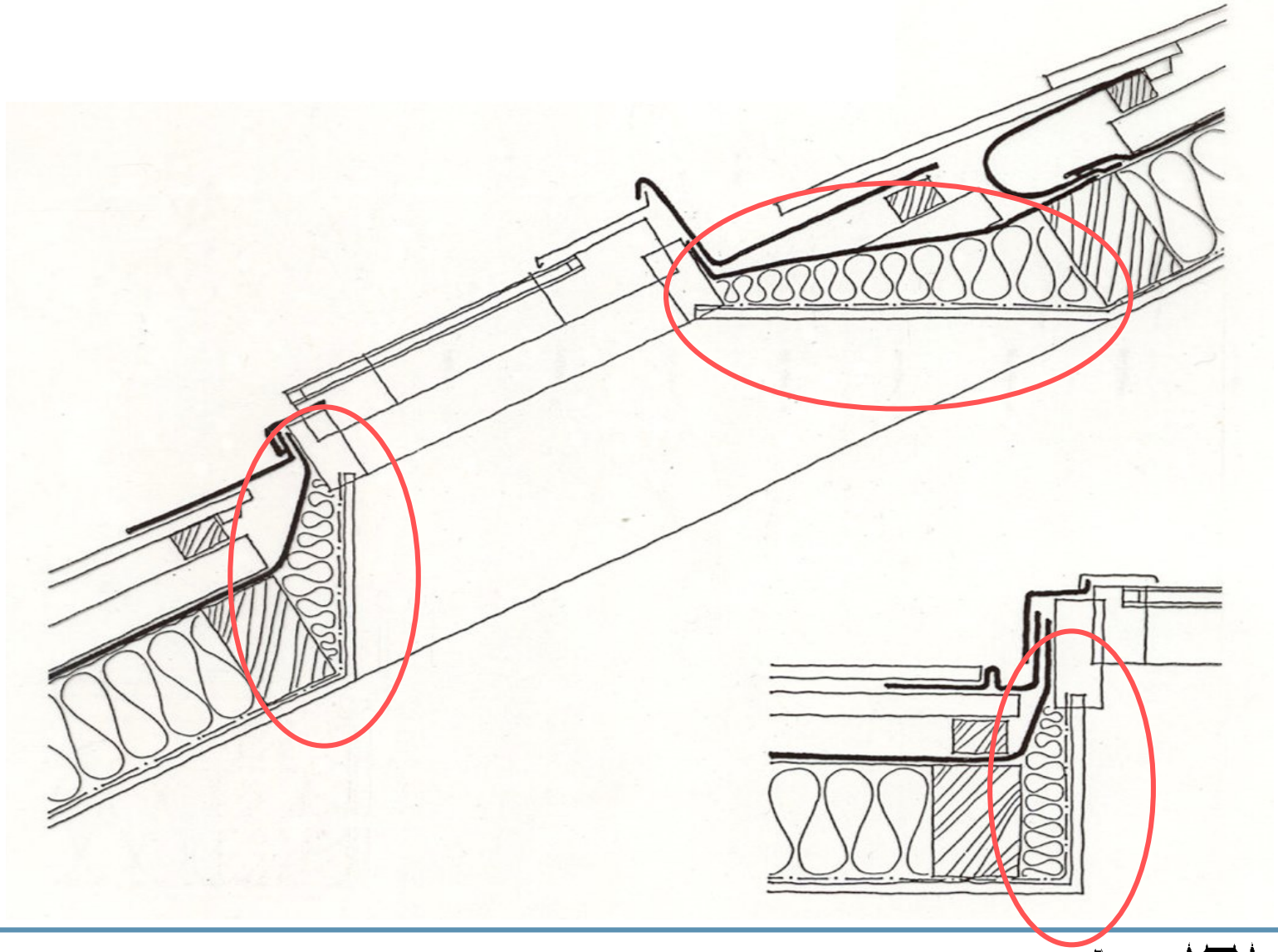


EXTERNAL DOOR CONNECTION TO THE WATERPROOFING



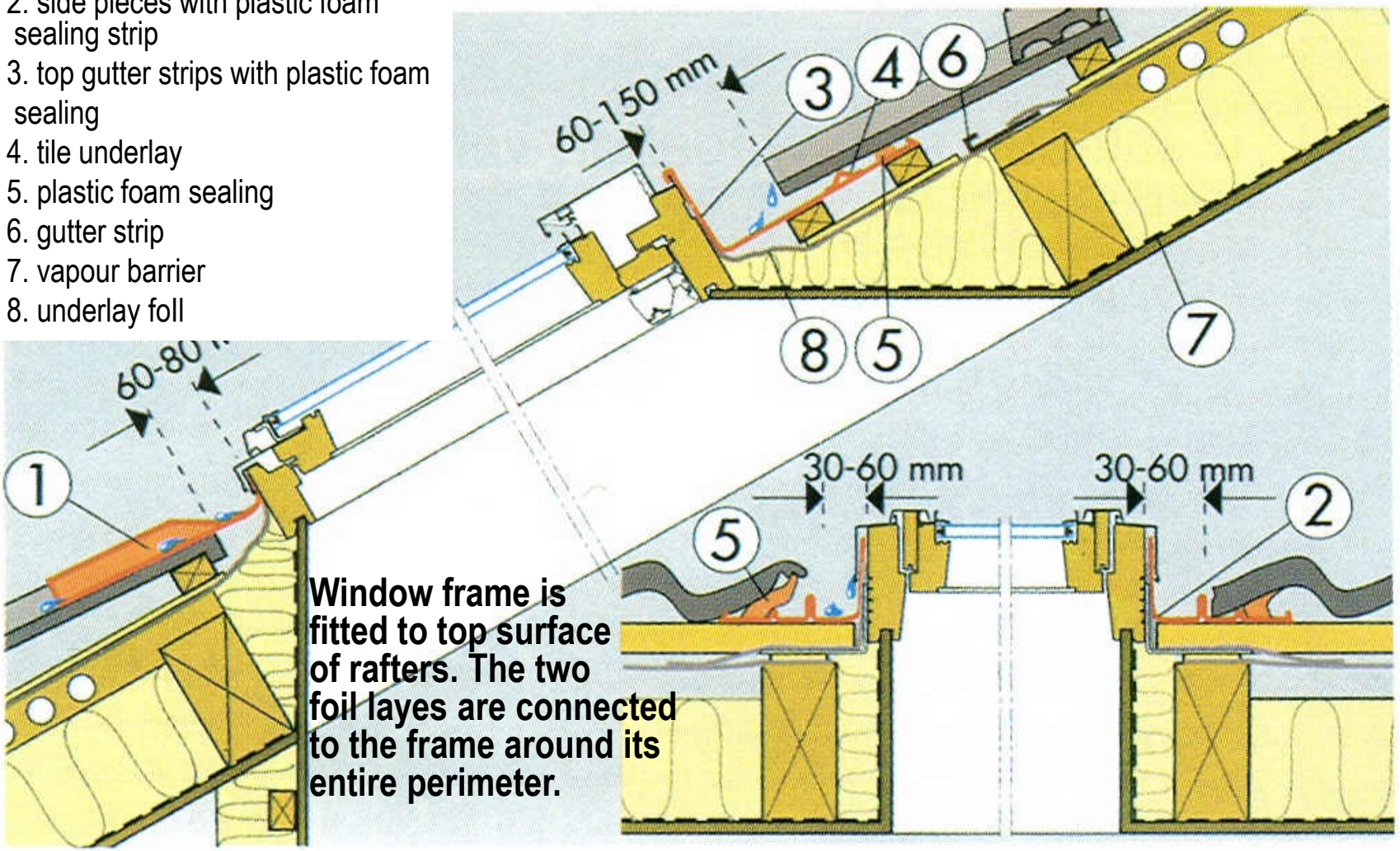
EXTERNAL DOOR CONNECTION TO THE WATERPROOFING

SKYLIGHT WINDOWS – CONNECTION OF THE UNDERLAYER FOIL



SKYLIGHT WINDOWS – CONNECTION OF THE UNDERLAYER FOIL

1. Ribbed lead sheet bottom part
2. side pieces with plastic foam sealing strip
3. top gutter strips with plastic foam sealing
4. tile underlay
5. plastic foam sealing
6. gutter strip
7. vapour barrier
8. underlay foll

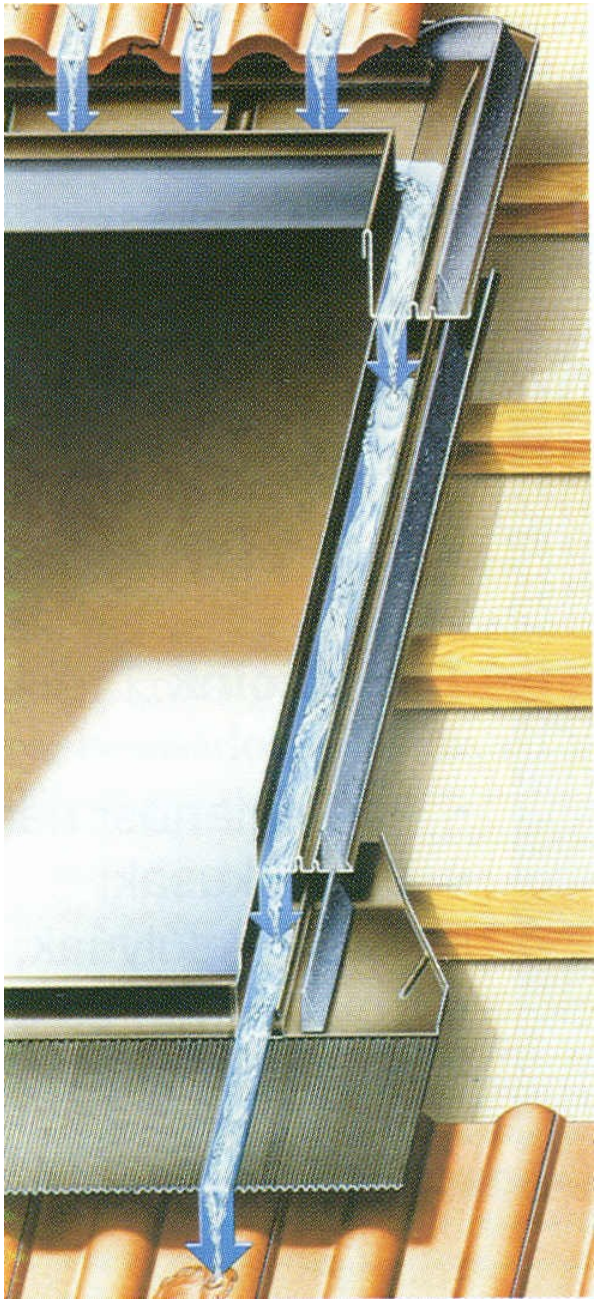


Window frame is fitted to top surface of rafters. The two foil layes are connected to the frame around its entire perimeter.

SKYLIGHT WINDOWS – INSTALLATION

↑protection of bottom edge with ribbed lead sheet

gutter strips around the window frame →



SKYLIGHT WINDOWS – VAPOUR BARRIER - CONTINUITY

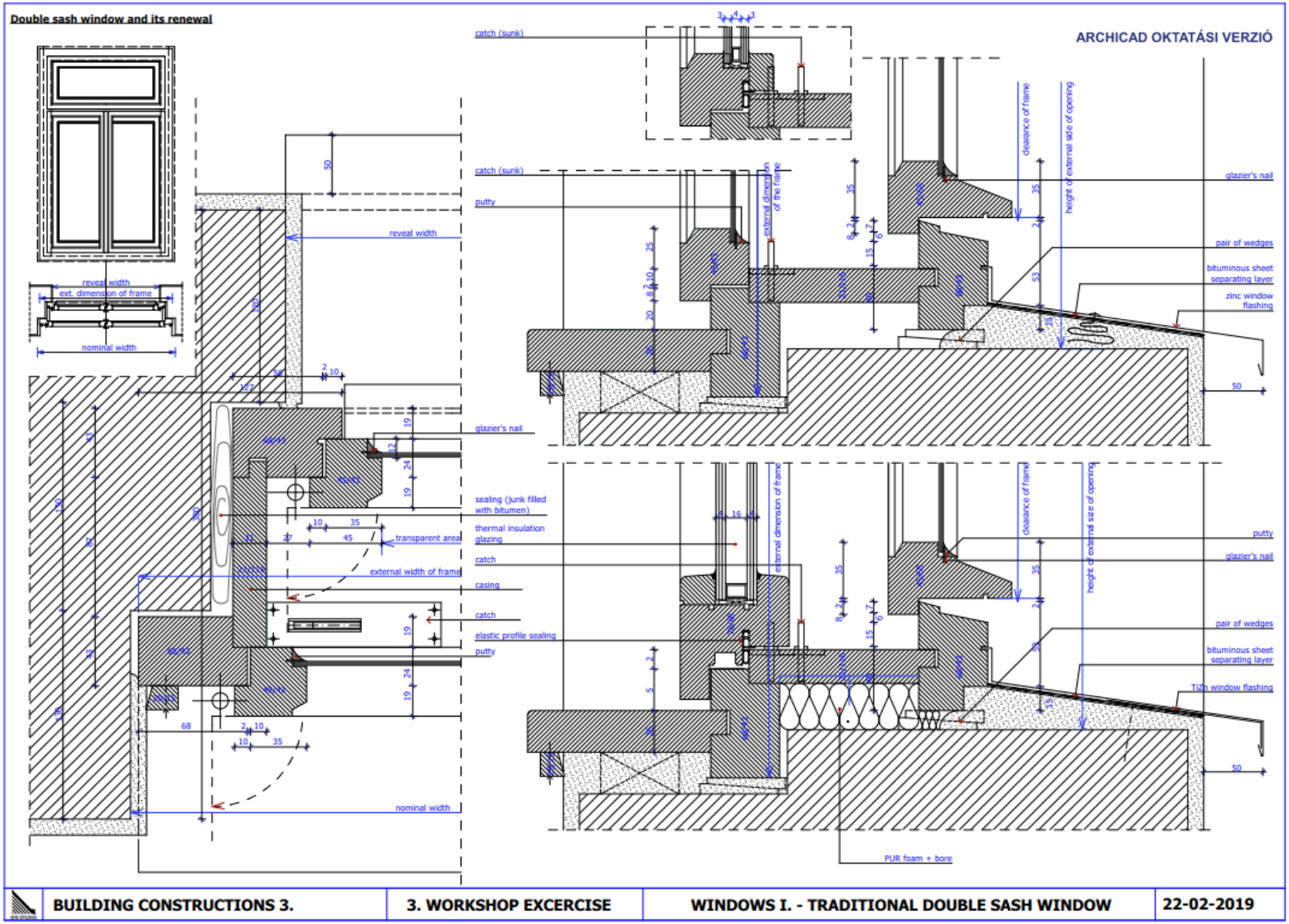
SKYLIGHT WINDOWS – THERMAL INSULATION - CONTINUITY

SKYLIGHT WINDOWS – IMPROPER INSTALLATION

SKYLIGHT WINDOWS – IMPROPER INSTALLATION

Vapour condensation „open sky” problem (overcooling problem) – must be compensated with local heating unit!

TRADITIONAL DOUBLE SASH WINDOW AND ITS RECONSTRUCTION



TRADITIONAL DOUBLE SASH WINDOW - FAILURES

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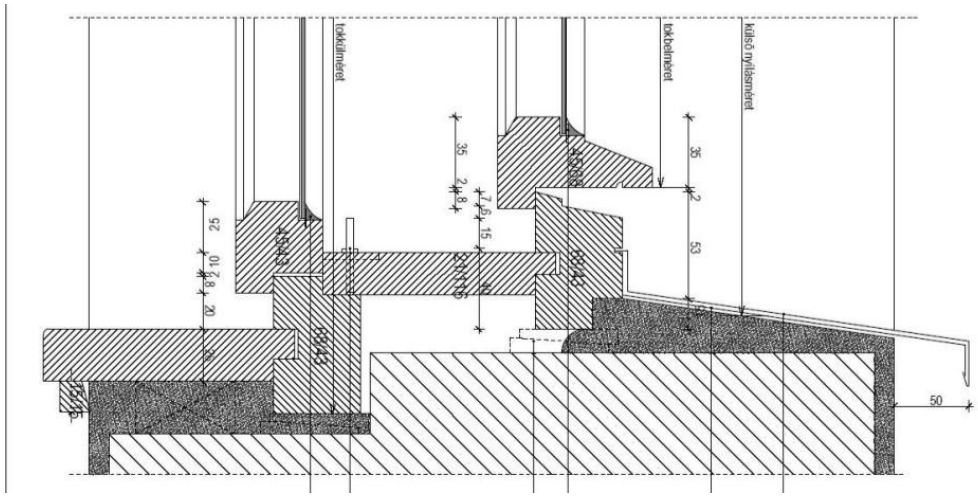
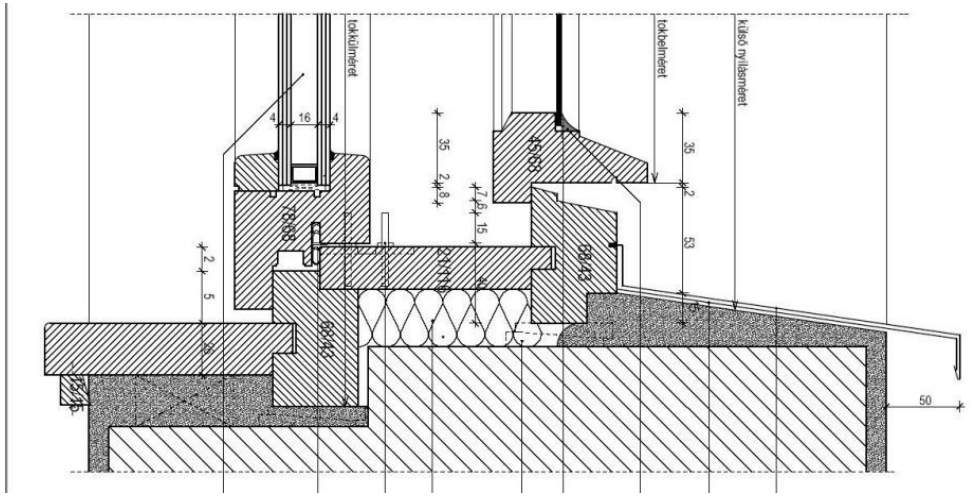
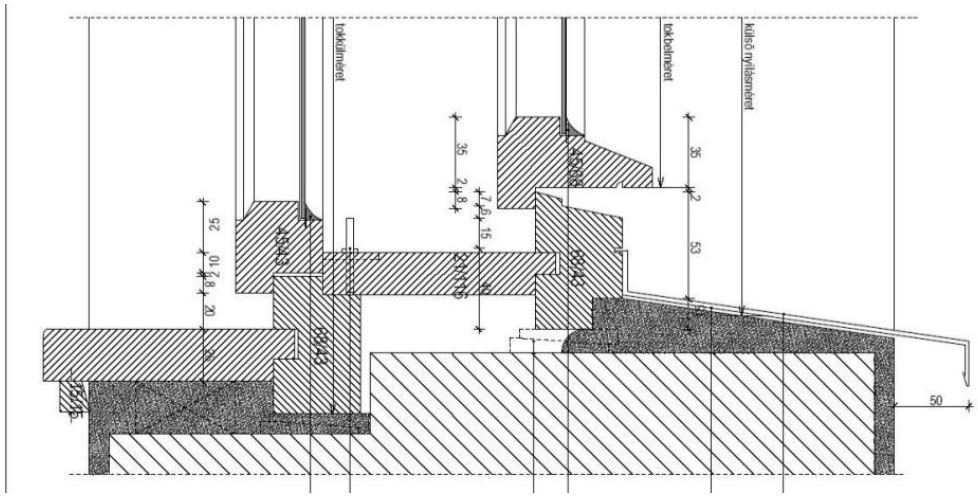
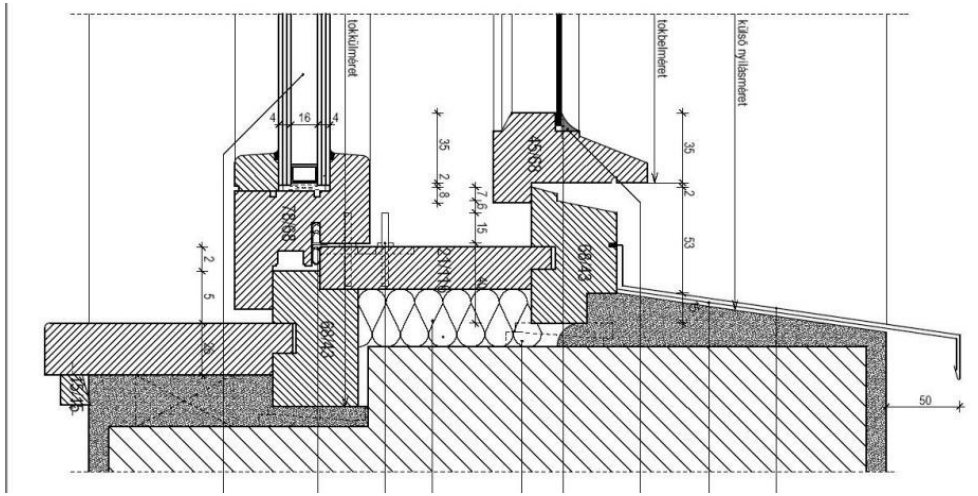


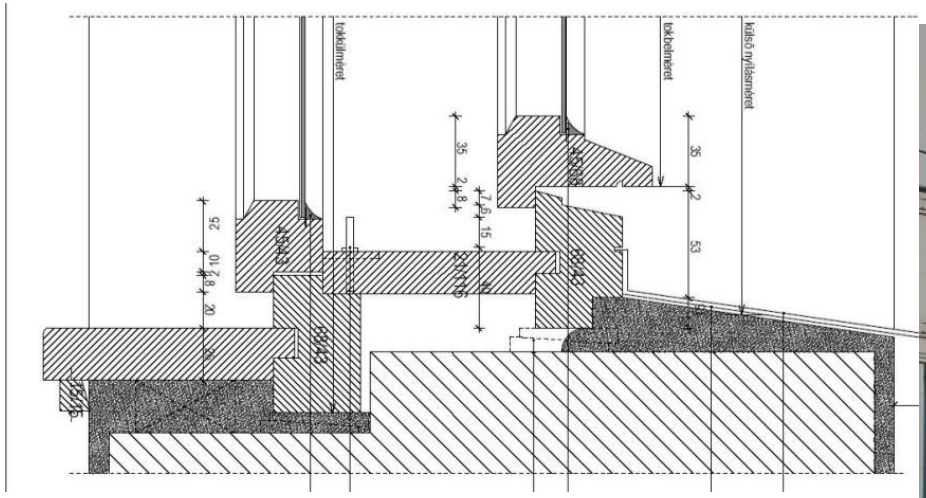


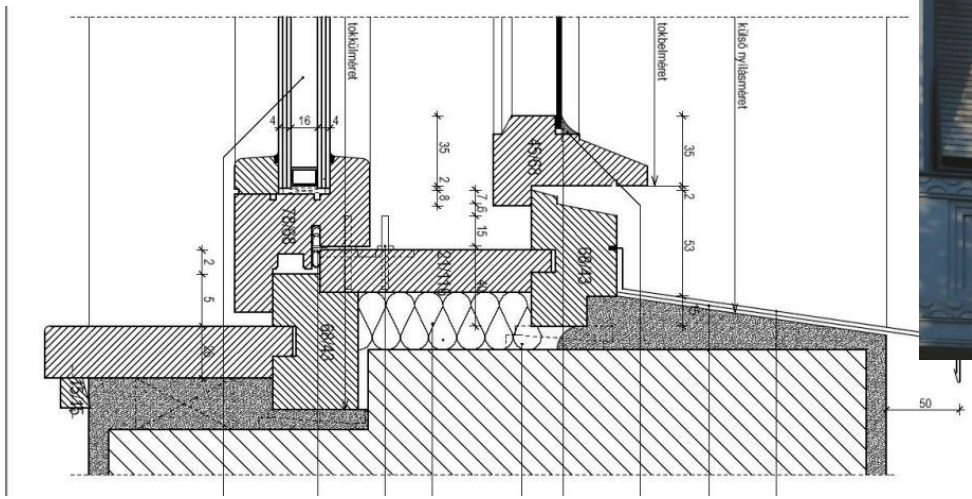
TRADITIONAL DOUBLE SASH WINDOW - FAILURES





REPLACEMENT OF TRADITIONAL DOUBLE SASH WINDOW TO SINGLE SASH UP-TO-DATE CONSTRUCTION INCREASING THERMAL BRIDGE EFFECT





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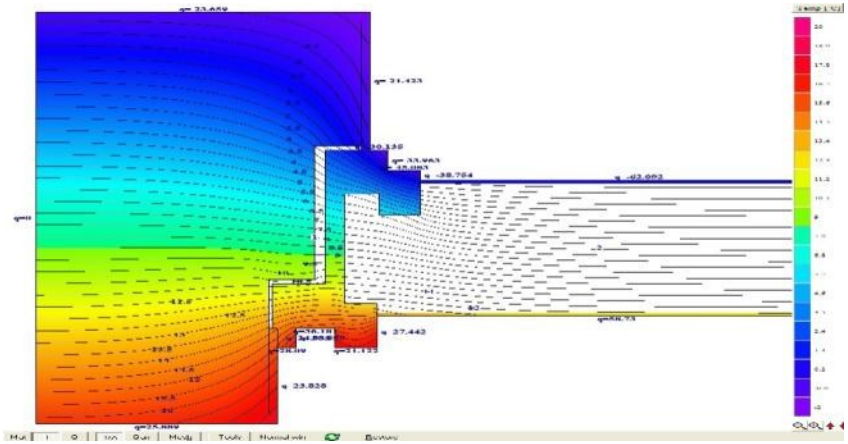

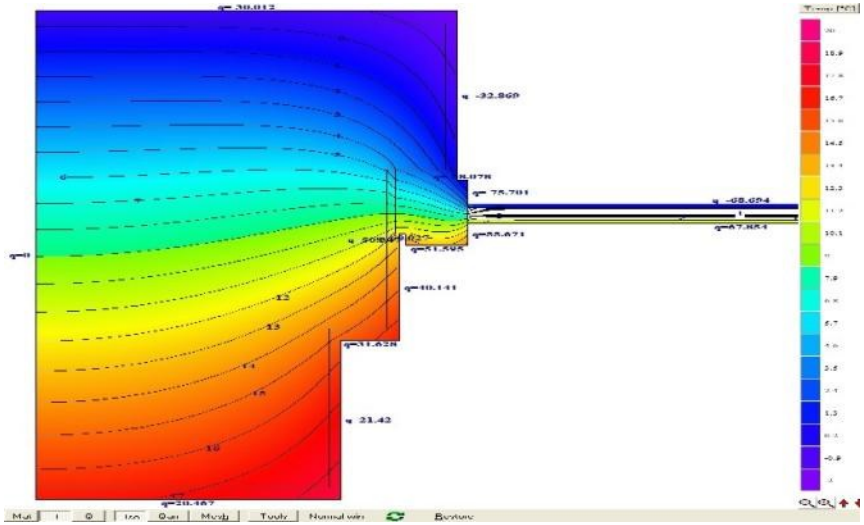

INTERNAL DOORS

FAILURES OF INTERNAL DOORS

No external exposures (wind, rain)
Mechanical exposures – especially in public buildings

Performance criterias:

- Operating forces (accessibility)
- Repeated opening and closing cycles
- Behavior between different climatic conditions
- Airborne sound insulation performance
- Durability (mechanical resistance)

Typical problems

- Missing lintel – deformation
- Improper installation

IMPROPER INSTALLATION

FAILURES OF INTERNAL DOORS

Performance criterias:

- Operating forces (accessibility)
- Repeated opening and closing cycles
- Behavior between different climatic conditions
- Airborne sound insulation performance
- Durability (mechanical resistance)

Typical problems

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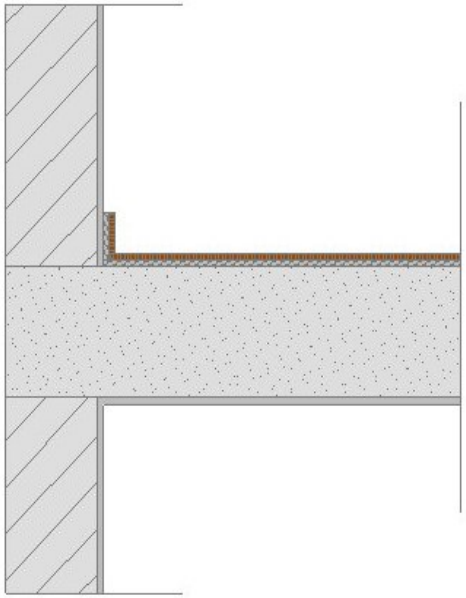
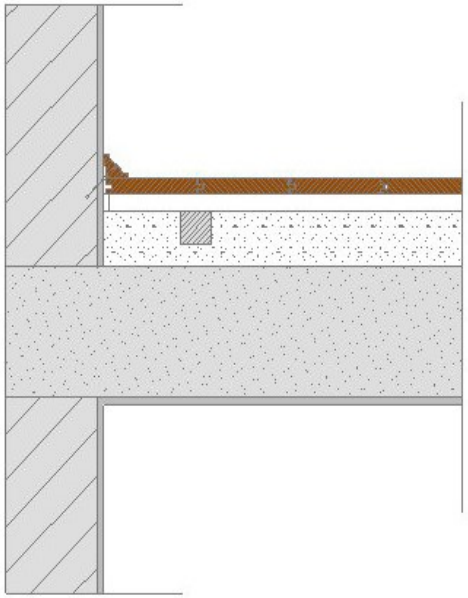
FLOOR STRUCTURES, FLOOR COVERINGS

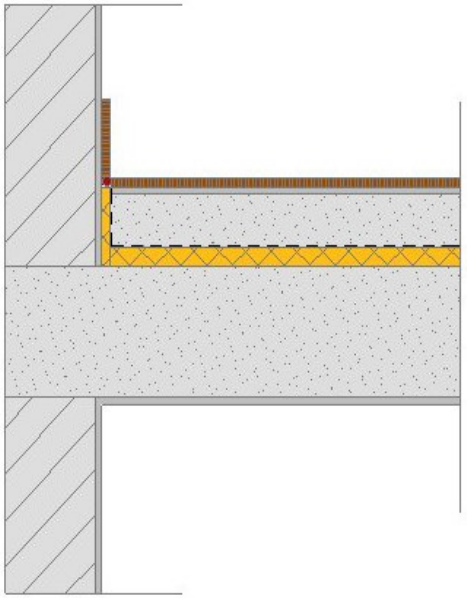
FLOOR STRUCTURE ALTERNATIVES



Contact floor
(hard, soft)



elastic

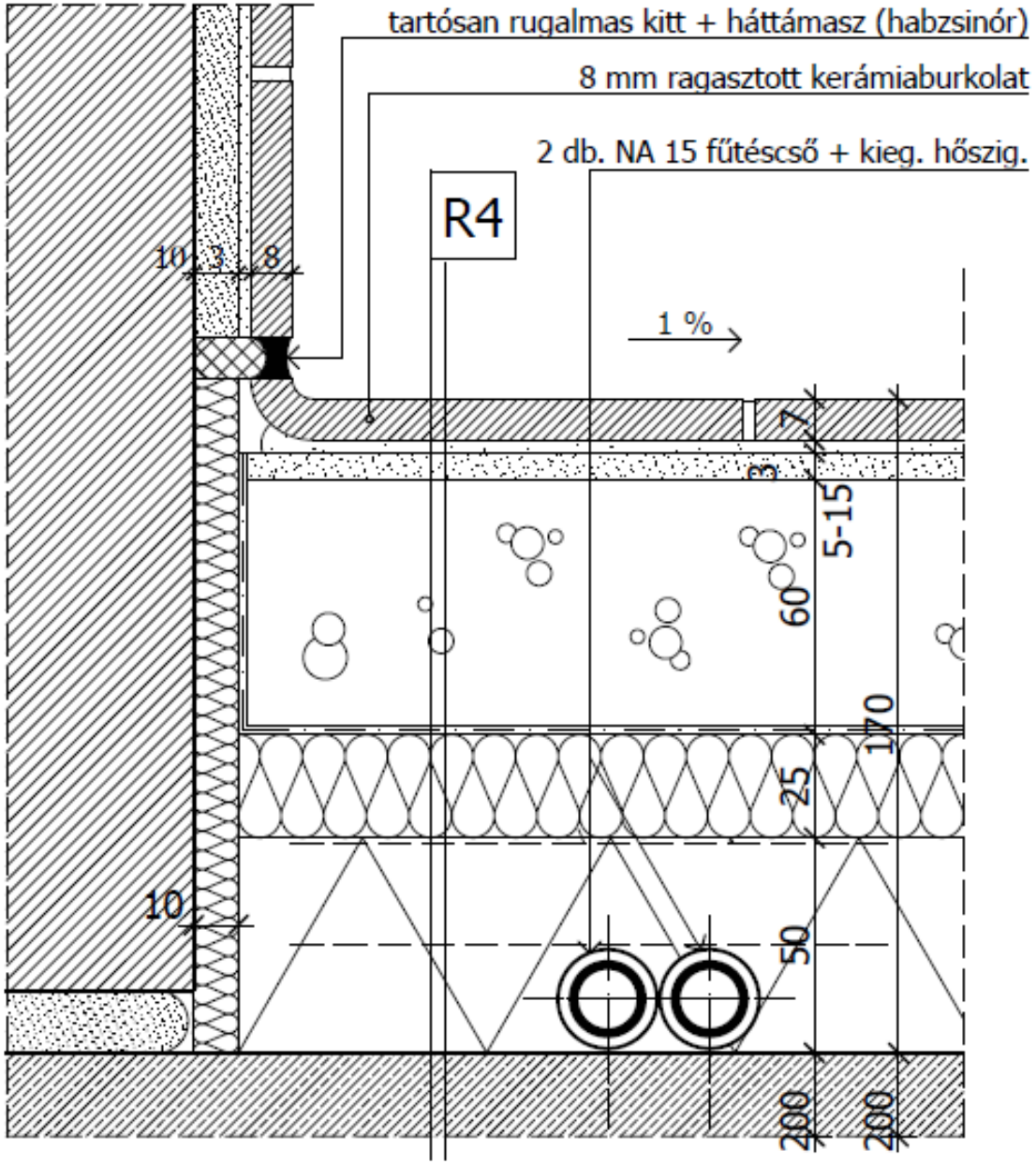


Floating floor

FLOATING FLOOR STRUCTURE

Layers are:

- Floor covering
- Adhesive
- Self-levelling layer
- Screed
- Technological layer
- Acoustic insulation
- Installation layer (electricity, HVAC)
- Floor slab



HVAC AND ELECTRIC INSTALLATIONS IN THE FLOOR LAYERS

HVAC AND ELECTRIC INSTALLATIONS IN THE FLOOR LAYERS …

HVAC AND ELECTRIC INSTALLATIONS IN THE FLOOR LAYERS …

FLOOR COVERING FAILURES

Typical failures are:

- Frost damage
- Mechanical damage
- Improper anti-slippery performance