DESIGN AND APPLICATION OF RADON-PROOF COURSES

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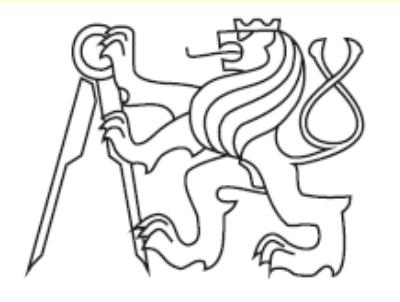

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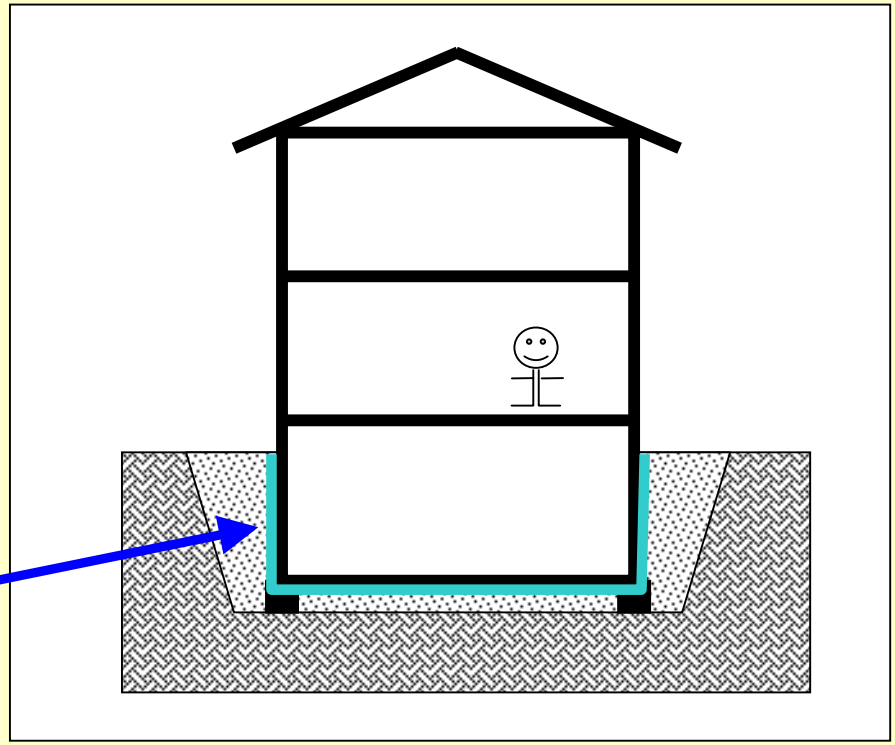
USAGE OF RADON-PROOF COURSES

Ensure air-tightness of the substructure – one of the basic principles of radon prevention

Radon barrier material placed over the entire surfaces of walls and floors in contact with the soil



FUNCTIONAL PROPERTIES OF RADON-PROOF COURSES

- **Barrier properties** against radon, water and moisture
- Ability to create **airtight joints** and pipe penetrations
- **Durability** corresponding to expected lifetime of a building
- Suitable **mechanical and physical properties**

Tensile strength
Elongation
Low temperature bending
Puncture and tear resistance
Thermal ageing
Resistance to soil chemicals and microorganisms

DESIGN PRINCIPLES

- Design = complex procedure

Barrier materials are exposed to:

Radon and/or hydrostatic pressure

Dead loads from the structure

Disruptive forces caused by ground movement, differential settlement and expansion or shrinkage of materials

Soil chemicals and microorganisms

- RPC fulfil also the function of waterproof courses – they are selected from standard waterproof materials
- Suitability for the particular application – avoiding material incompatibility

BARRIER PROPERTIES AGAINST RADON

Tested quantity

Barrier properties are verified by the **radon diffusion coefficient**

Radon diffusion coefficient usage

- Selection of radon barriers from great amount of standard tanking materials of different chemical composition
- Verification of air-tightness of joints and penetrations
- Design of radon barriers – calculation of the minimal thickness

RADON DIFFUSION COEFFICIENT DETERMINATION

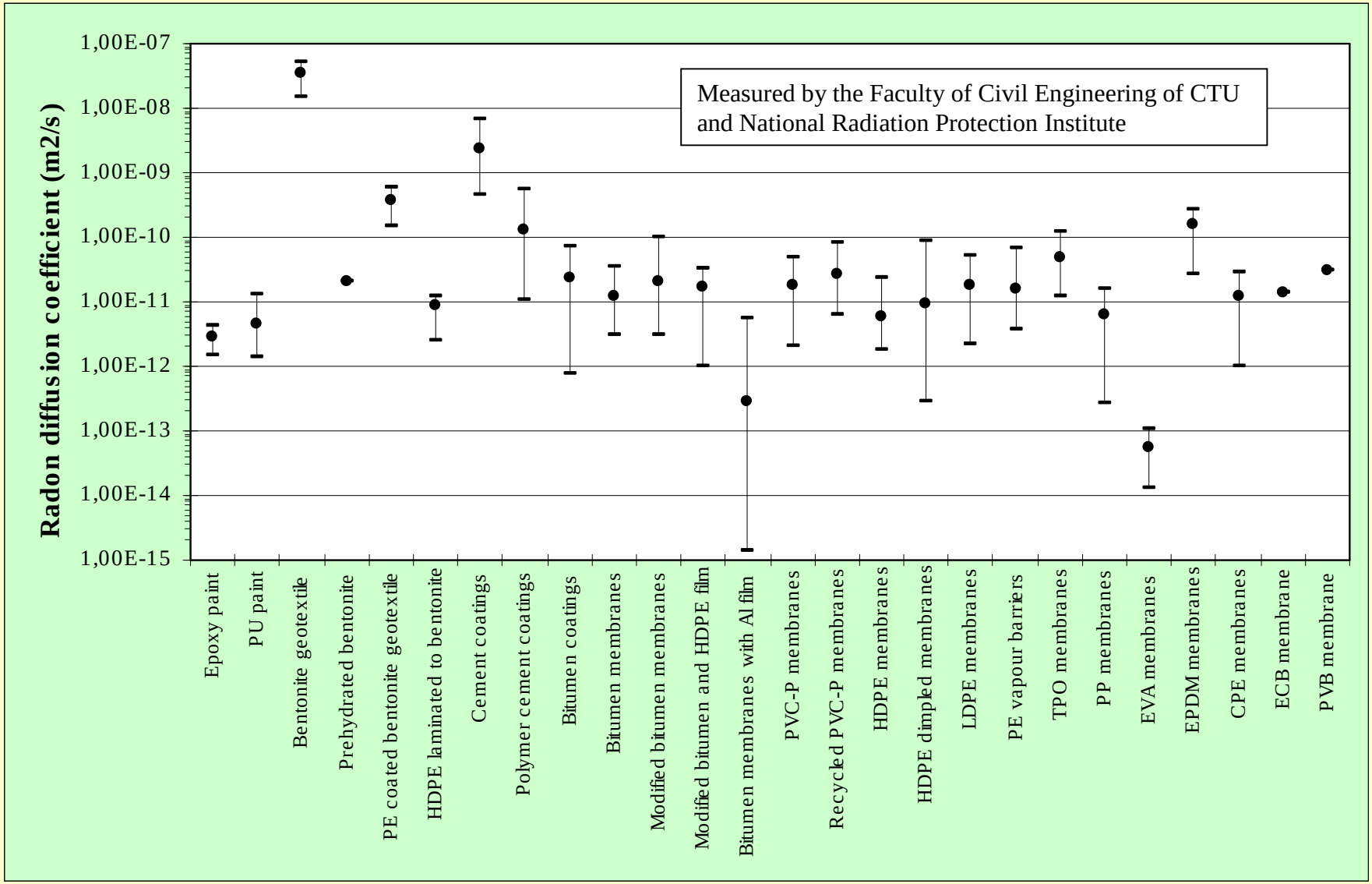
ISO 11665-10 standard introduces general assumptions and conditions under which the tests should be carried out:

- number of samples,
- minimal dimensions of samples,
- minimal radon concentration to which the samples are exposed,
- duration of the test,
- mathematical processing of measured data,
- accuracy with which radon concentrations and other important parameters are measured,
- total uncertainty of the radon diffusion coefficient determination.

Determination of the Rn diffusion coefficient in the Czech Republic

- Systematic testing started in 1995 according to the method developed by the Faculty of Civil Engineering in cooperation with the National Radiation Protection Institute
- The Czech test method is accredited by the Czech Accreditation Institute
- Up to now more than 400 materials obtained throughout Europe have been tested
- The tests of radon diffusion coefficient are required by the Czech technical standard ČSN 73 0601 „Protection of buildings against radon from the soil“

Summary of radon diffusion coefficient measurements



Application of the radon diffusion coefficient for the design of radon barriers

1. Limit for the maximal value of D

Applied for example in Ireland (max D = 12.10^{-12} m^2/s)

2. Limit for the minimal thickness of the membrane

Applied for example in Germany ($d \geq 3l$)

3. Calculation of the membrane thickness in dependence on the soil and building characteristics

Applied for example in Czech Republic

Verification of the air-tightness of joints by the radon diffusion coefficient

SBS modified bitumen membrane	$(7{,}1 \pm 0{,}2).10^{-12}$
Overlap joint sealed by torching	$(8{,}6 \pm 1{,}0).10^{-12}$
Self-adhesive overlap joint	$1{,}2.10^{-8}$ - $1{,}7.10^{-11}$

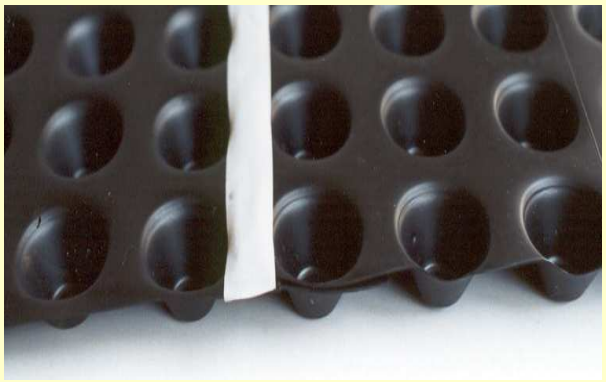
SBS modified bitumen membrane + AL	$(4{,}9 \pm 0{,}5).10^{-14}$
Overlap joint sealed by torching	$(5{,}1 \pm 0{,}5).10^{-14}$
Self-adhesive overlap joint	$(4{,}3 \pm 0{,}4).10^{-10}$

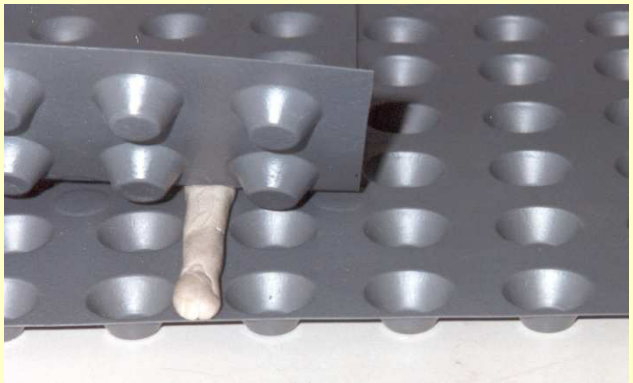
Joints of self-adhesive membranes should be sealed by torching.

Verification of the air-tightness of joints by the radon diffusion coefficient

HDPE dimpled membrane	$(4{,}1 \pm 0{,}1).10^{-12}$
Overlap joint sealed by self adhesive tape	$(7{,}4 \pm 0{,}7).10^{-10}$

According to CSN 73 0601 it is not permitted to apply dimpled membranes for radon barriers





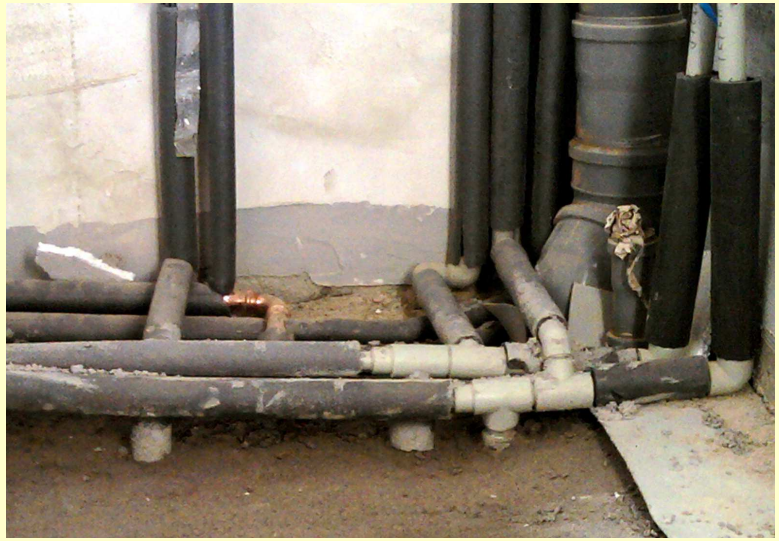
Air-tightness of services penetrations

Factors influencing the air-tightness

- Position of the penetration (corners, wall/floor joints should be avoided)
- Applicability of details
- Correct sequence of trades

Air-tightness of services penetrations

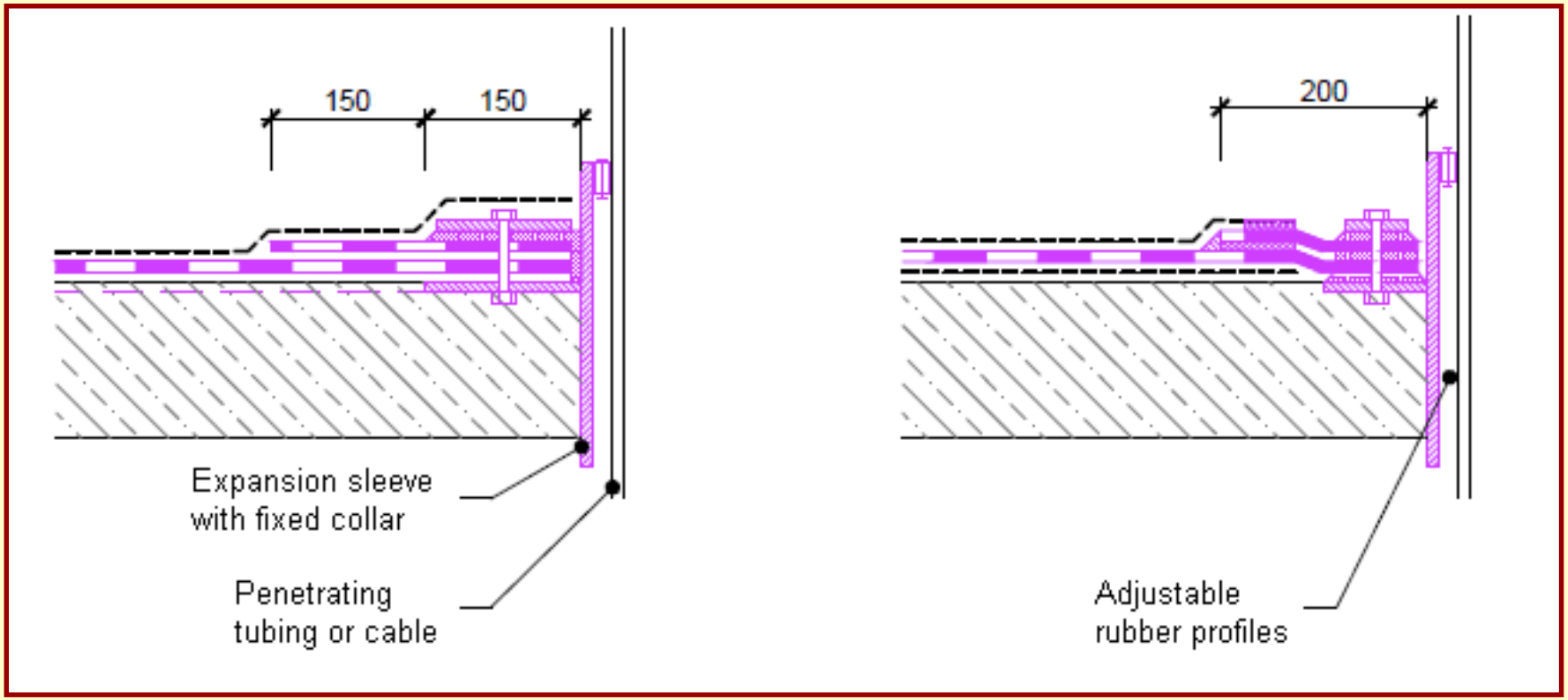
Examples of inapplicable sealing around pipe penetrations



Air-tightness of services penetrations

Examples of details – with dilatation movements

Bitumen membranes

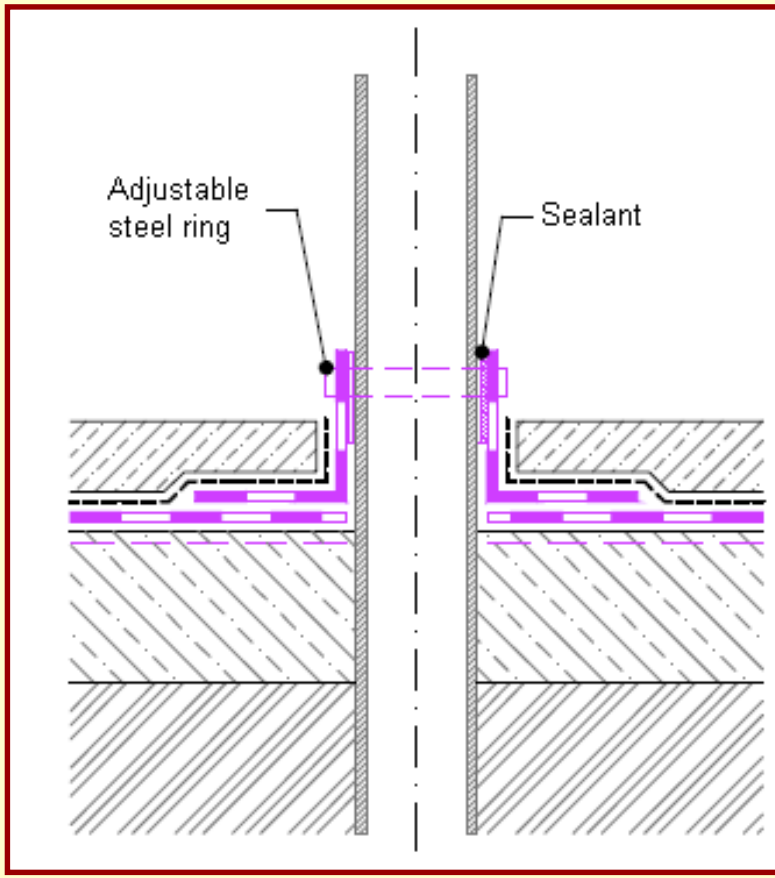


Polymeric membranes

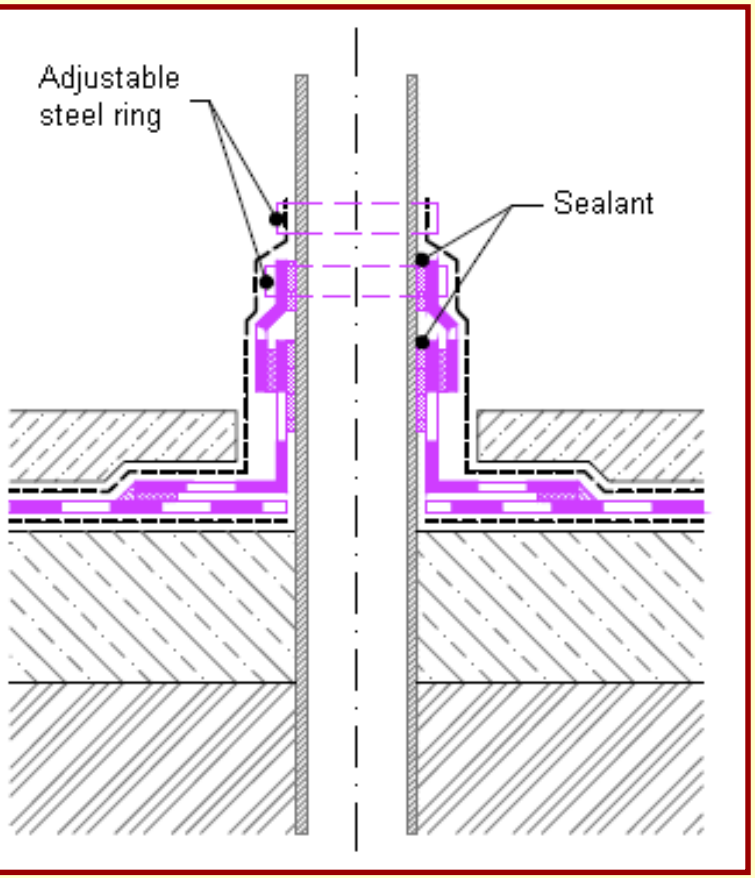
Air-tightness of services penetrations

Examples of details – without dilatation movements

Bitumen membranes



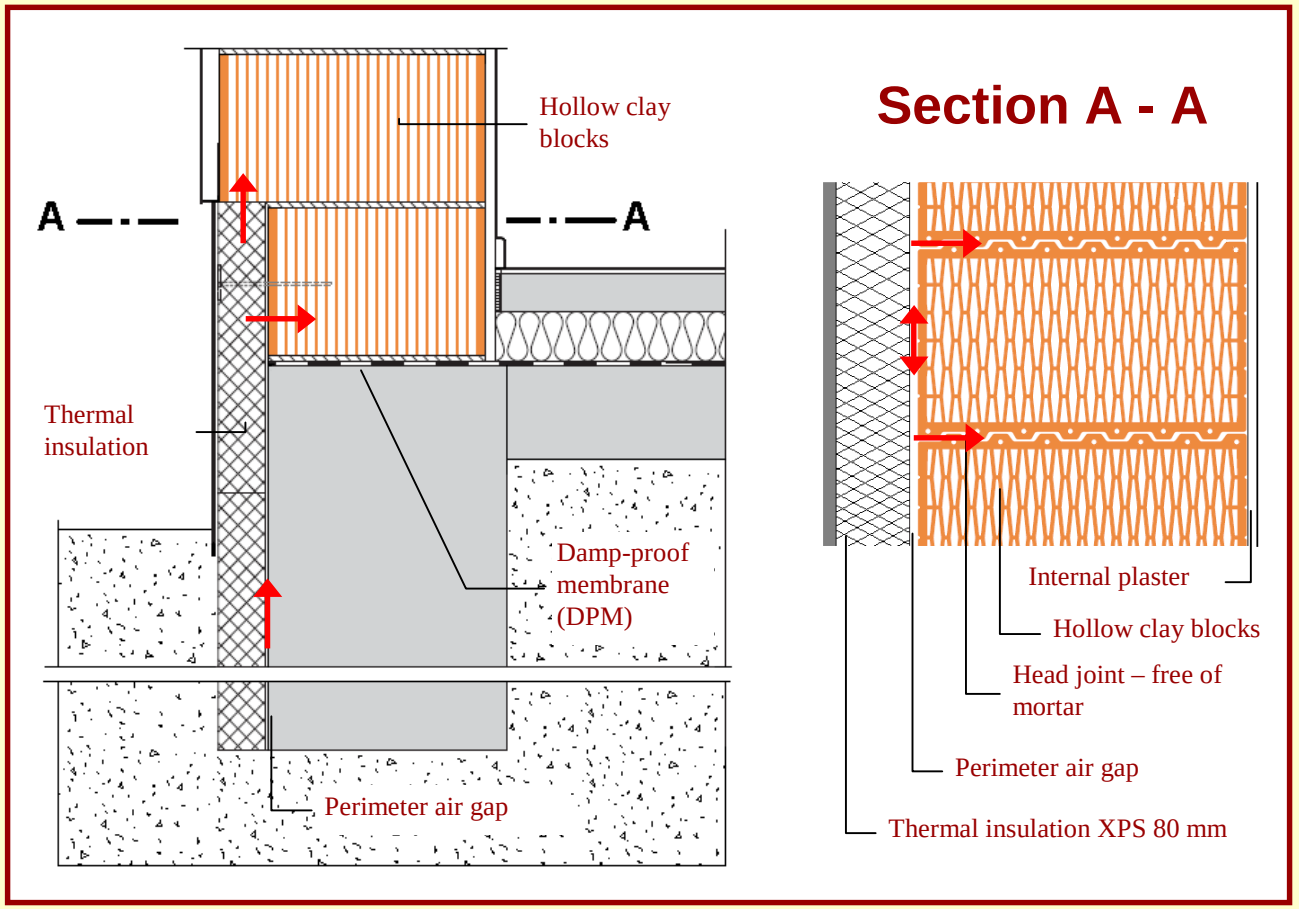
Polymeric membranes



Verification of the air-tightness of services penetrations by the radon diffusion coefficient

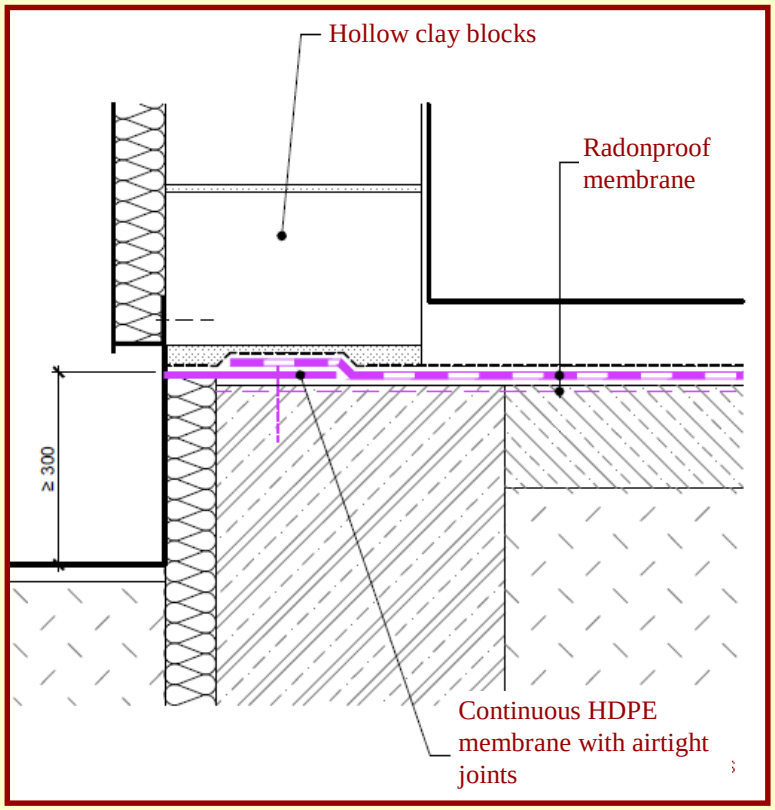
Eliminating radon bridges

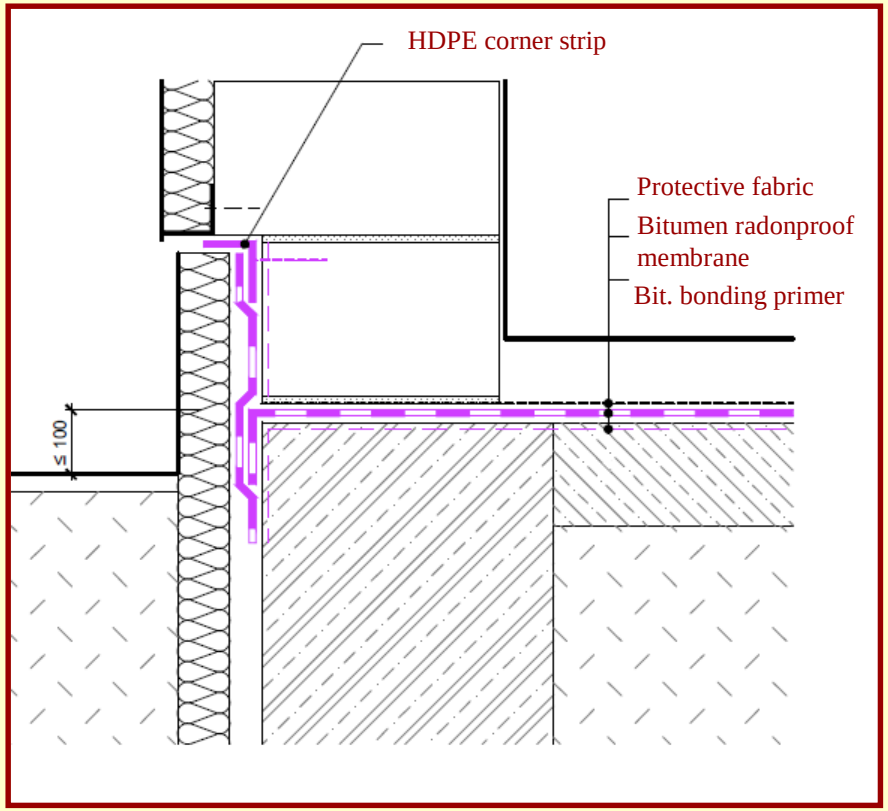
Radon transport through an air gap between perimeter thermal insulation and foundations



Eliminating radon bridges

Interrupting an air gap between perimeter thermal insulation and foundations





THANK YOU FOR YOUR ATTENTION