

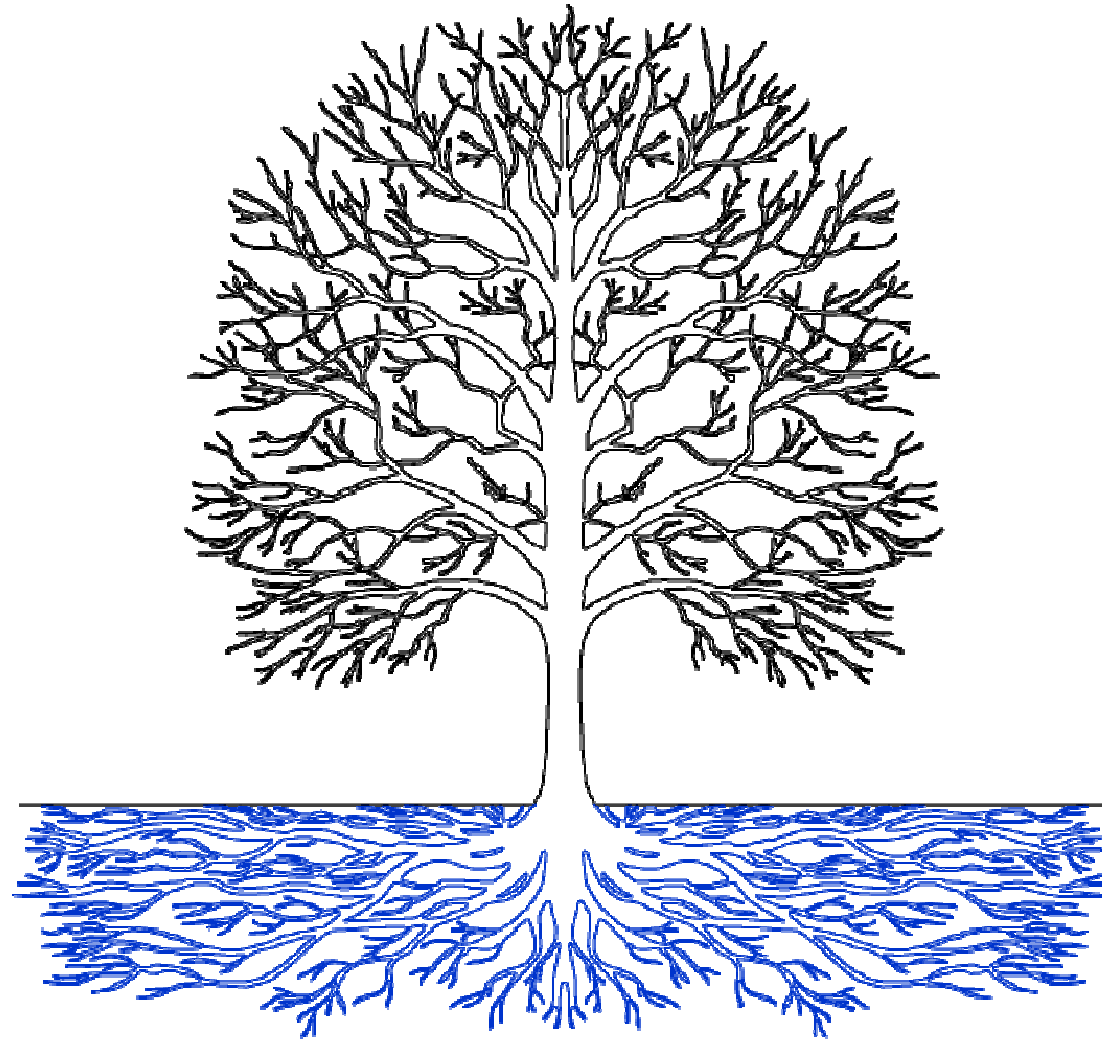


FOUNDATIONS I. BASIC PRINCIPLES

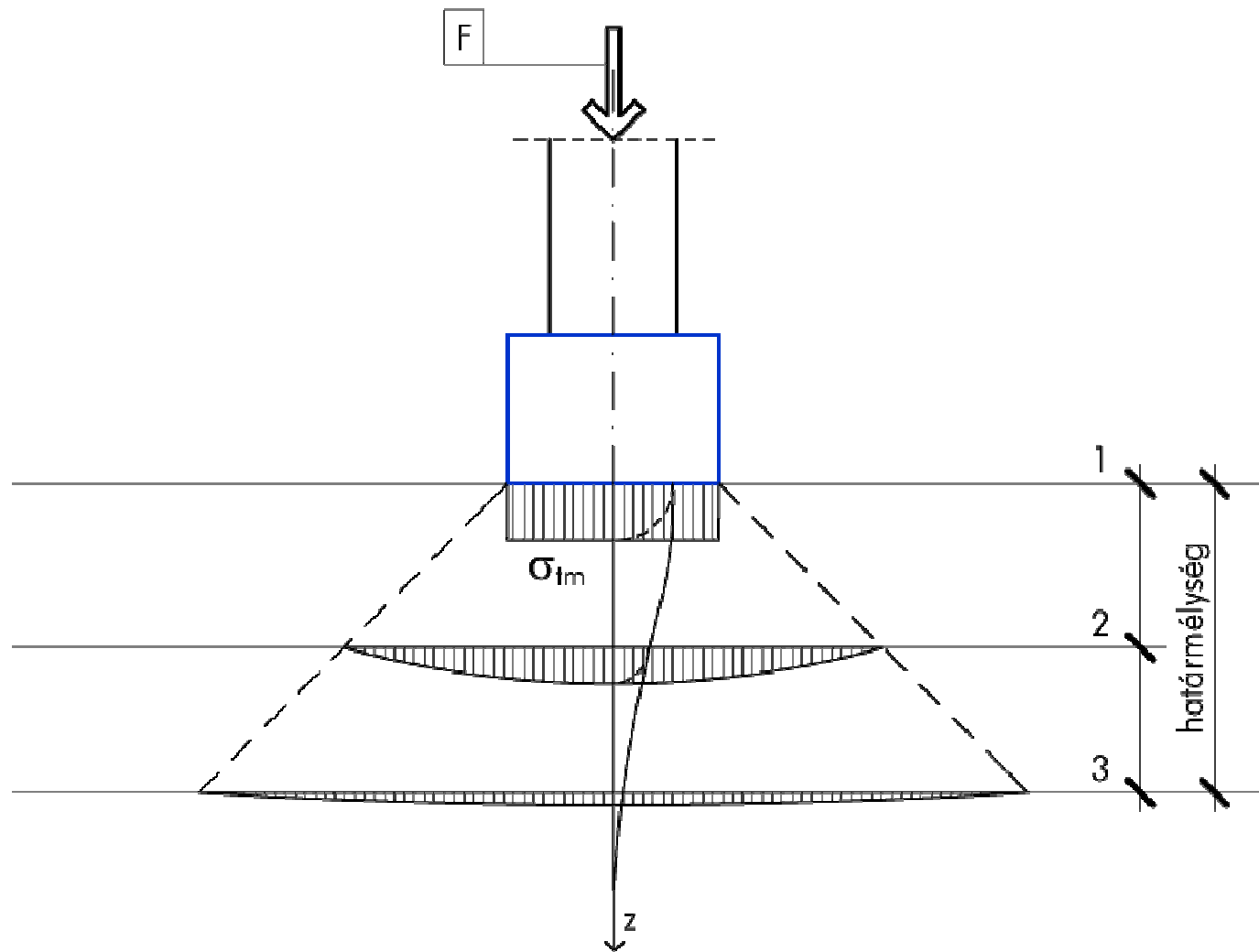
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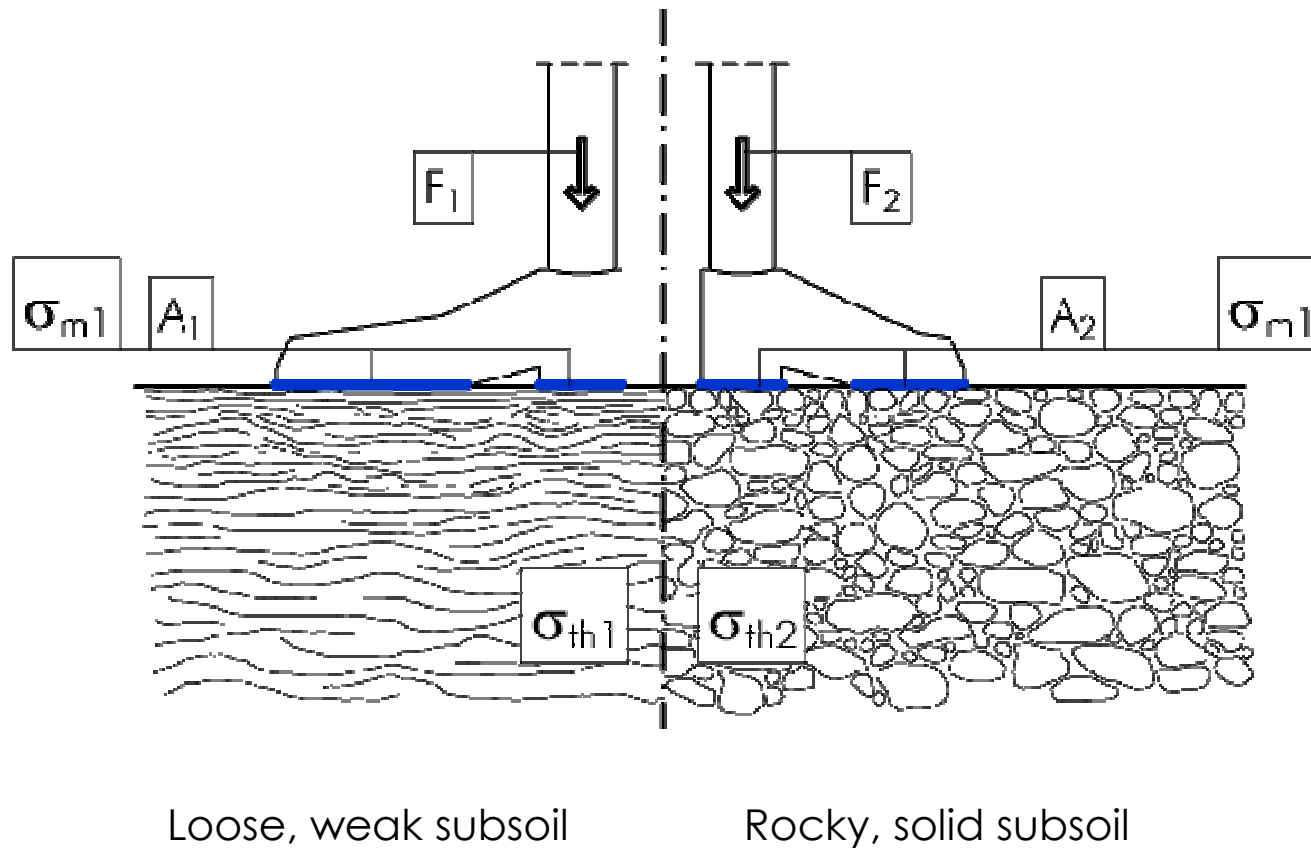
FOUNDATION OF THE PLANTS



DISTRIBUTION OF SOIL STRESS

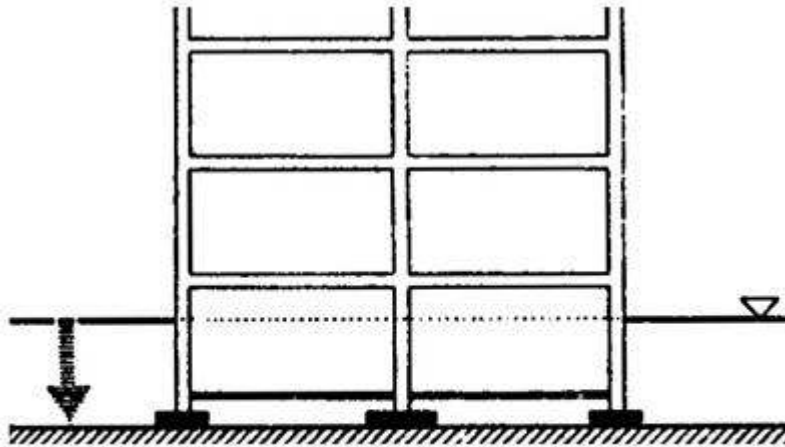


DIFFERENT SOIL CHARACTERISTICS

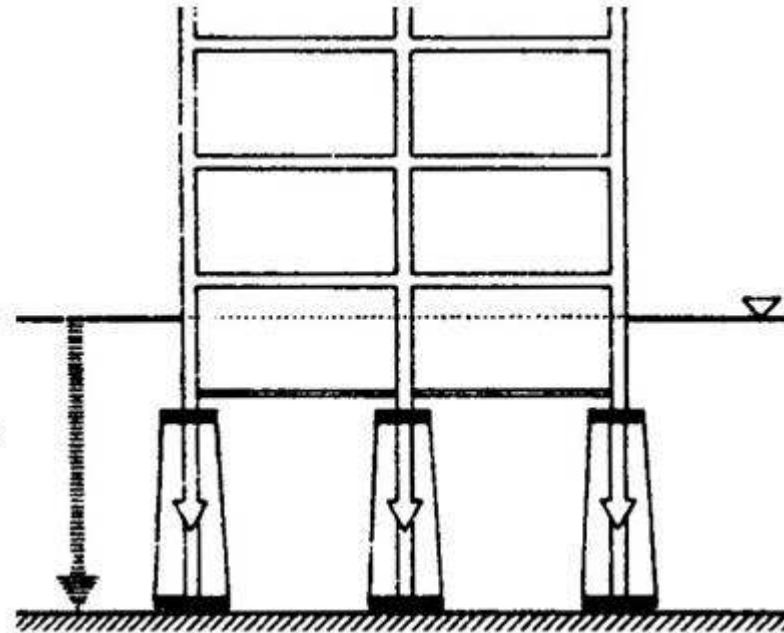


$$\begin{aligned} F_1 &= F_2 \\ A_1 &> A_2 \\ \sigma_{m1} &\approx \sigma_{m2} \\ \sigma_{th1} &< \sigma_{th2} \end{aligned}$$

CLASSIFICATION ON THE DEPTH OF THE FOUNDATION



Shallow foundation scheme



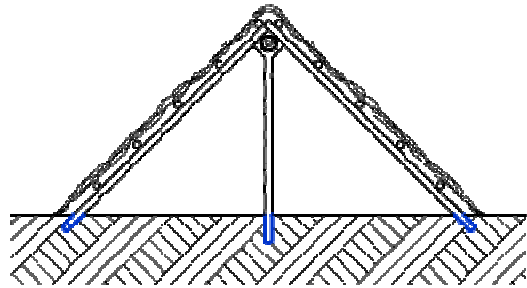
Deep foundation scheme

Deep foundations transfer the dead load of the building onto the loadbearing soil layers deep below the building.

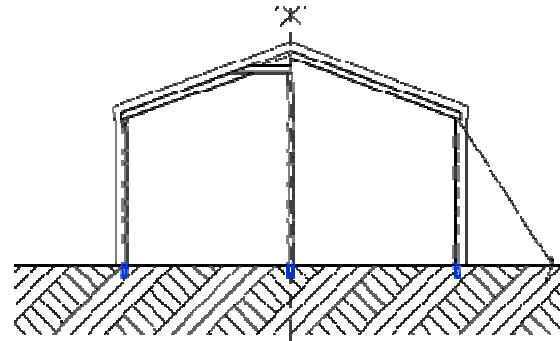


REVISION: HISTORY

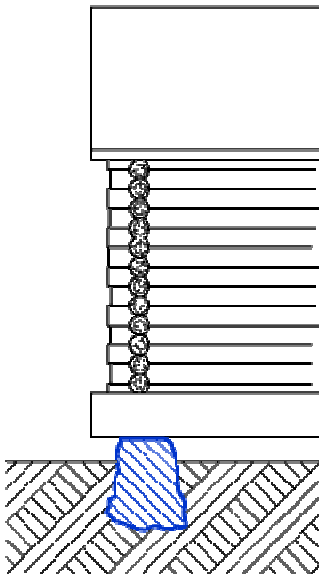
HISTORY OF FOUNDATIONS



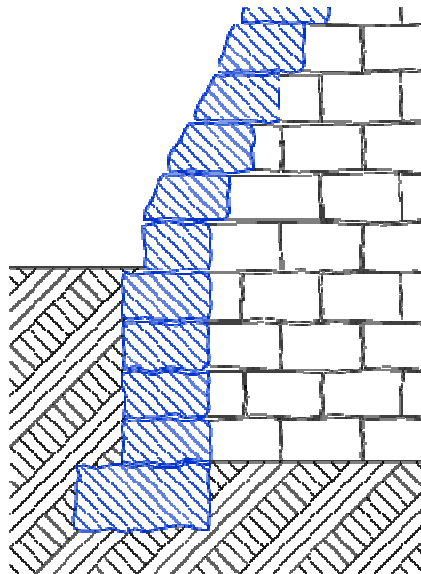
Leaf canopy



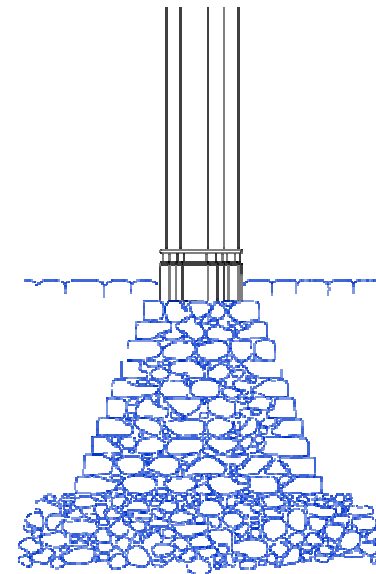
Yurt



Log house on rock basement



Ancient stone wall



Gothic church

HISTORY OF FOUNDATIONS – VERNACULAR BUILDINGS



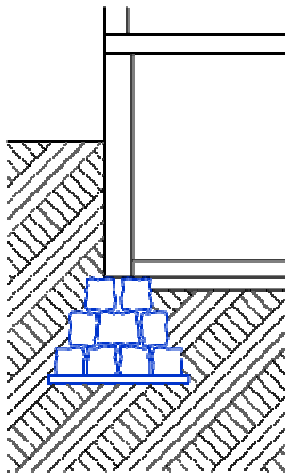
HISTORY OF FOUNDATIONS – VERNACULAR BUILDINGS



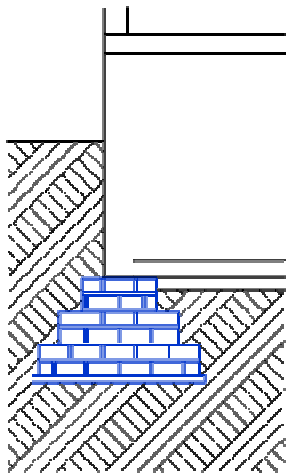
HISTORY OF FOUNDATIONS – VERNACULAR BUILDINGS



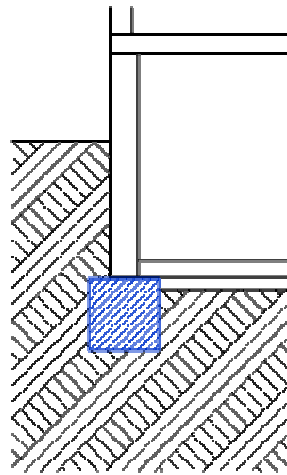
HISTORY OF FOUNDATIONS - MATERIALS



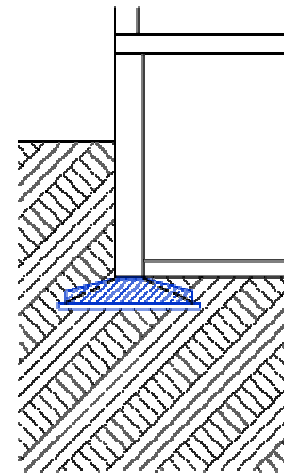
Stone



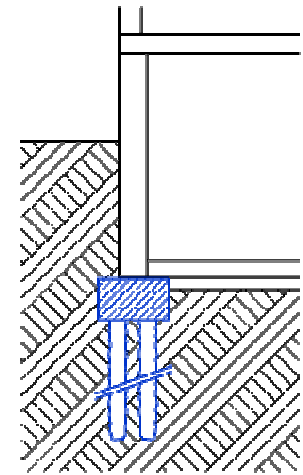
Brick



Concrete



Reinforced
concrete



Deep
foundation

Shallow foundations

HISTORY OF FOUNDATIONS – STONE FOUNDATIONS



HISTORY OF FOUNDATIONS – CONCRETE AND RC FOUNDATIONS





CLASSIFICATION OF SOILS

CLASSIFICATION OF SOIL BY LAYERS



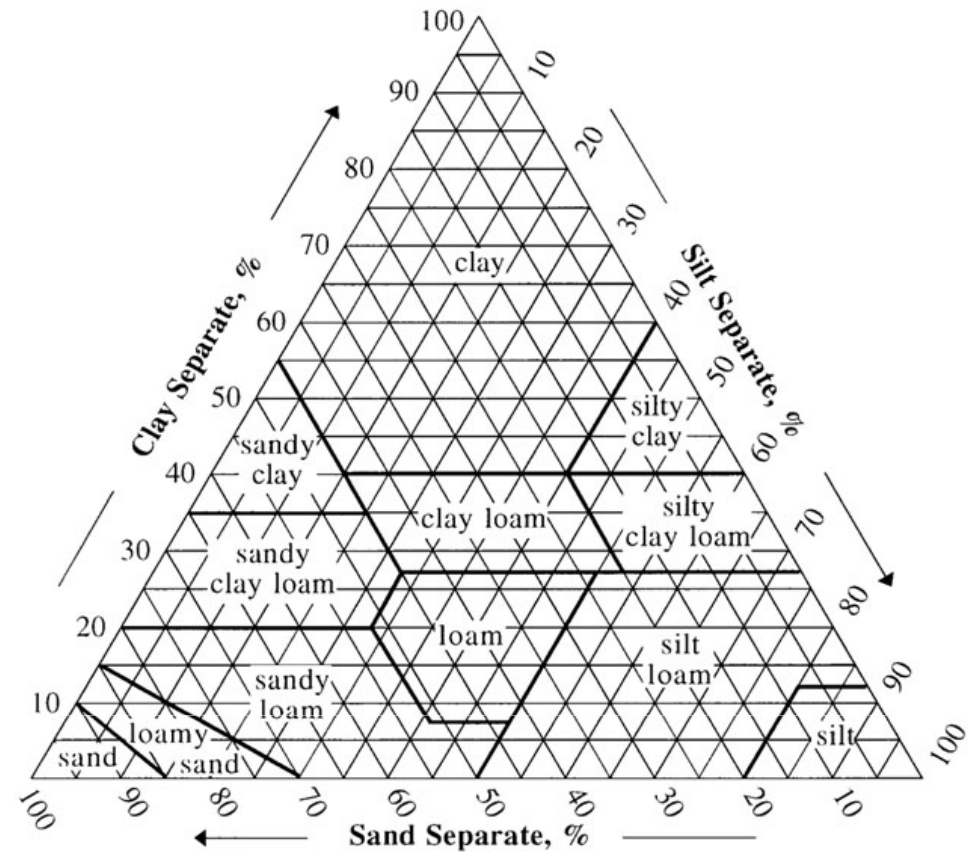
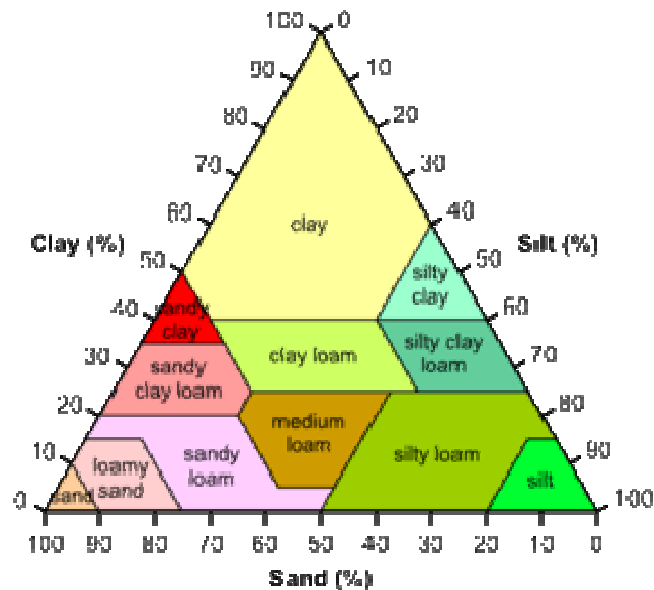
Plants

Topsoil (organic, not suitable for foundation)

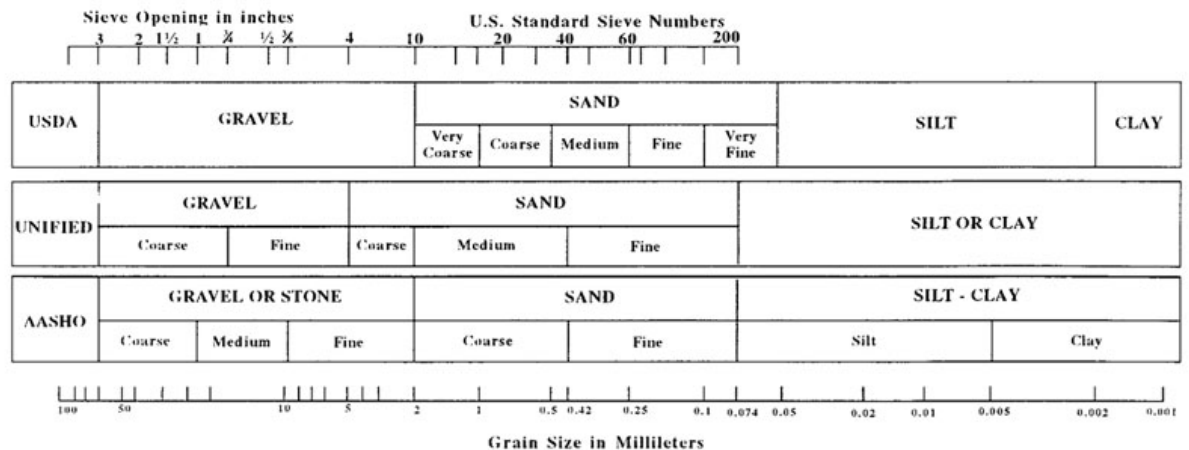
Subsoil (usually suitable for foundation)

Soil is a natural body consisting of layers (soil horizons) of mineral constituents of variable thicknesses, which differ from the parent materials in their morphological, physical, chemical, and mineralogical characteristics.

CLASSIFICATION OF SUBSOILS BY PARTICLE SCALES



COMPARISON OF PARTICLE SIZE SCALES



CLASSIFICATION OF SUBSOIL - CLAY



Clay is a naturally occurring material composed primarily of fine-grained minerals, which show plasticity through a variable range of water content, and which can be hardened when dried and/or fired. Clay deposits are mostly composed of clay minerals (phyllosilicate minerals), minerals which impart plasticity and harden when fired and/or dried, and variable amounts of water trapped in the mineral structure by polar attraction.

CLASSIFICATION OF SUBSOIL - SAND



Sand is a naturally occurring granular material composed of finely divided rock and mineral particles sand particles range in diameter from 0.0625 (or $\frac{1}{16}$ mm, or 62.5 micrometers) to 2 millimeters. An individual particle in this range size is termed a **sand grain** (the next larger size class above sand is gravel, with particles ranging from 2 mm up to 64 mm).

CLASSIFICATION OF SUBSOIL - ROCK



In geology, **rock** is a naturally occurring solid aggregate of minerals and/or mineraloids. The Earth's outer solid layer, the lithosphere, is made of rock. In general rocks are of three types: igneous, sedimentary (f.i. sandstone), and metamorphic (f.i. marble).

CLASSIFICATION OF SUBSOIL - ROCK



Rock subsoil – the picture is taken from a garage door – the car ramp is under construction

CLASSIFICATION OF SUBSOIL - LOESS



Loess is an aeolian sediment formed by the accumulation of wind-blown silt and lesser and variable amounts of sand and clay. Most important features are:

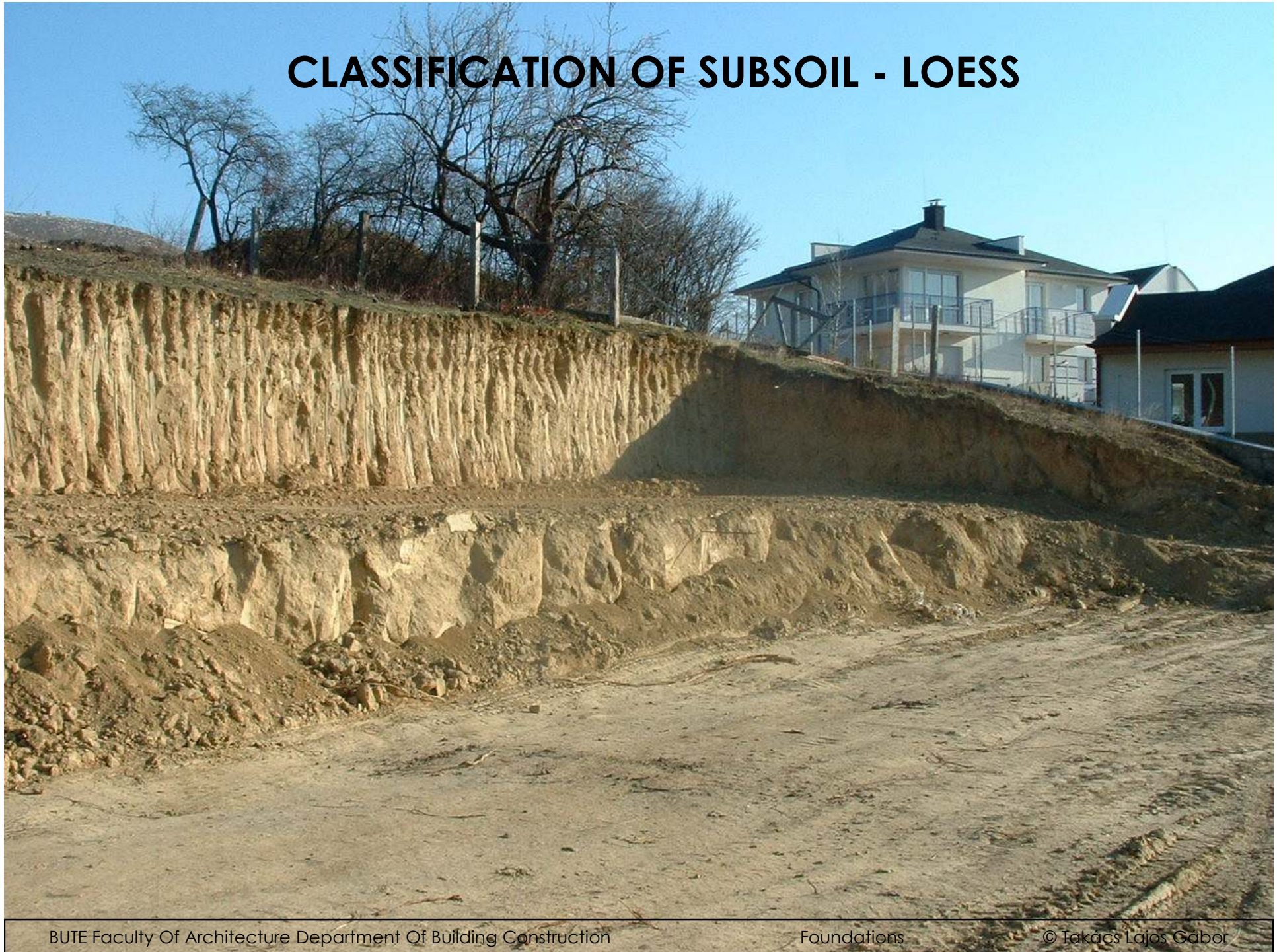
- Homogenous, porous, friable, pale yellow coloured or buff, slightly coherent,
- typically non-stratified and often calcaerous,
- often stands in either steep or vertical faces,
- loess will erode very readily,
- dangerous settlements when get wet.

CLASSIFICATION OF SUBSOIL - LOESS



Loess reefs in Hungary

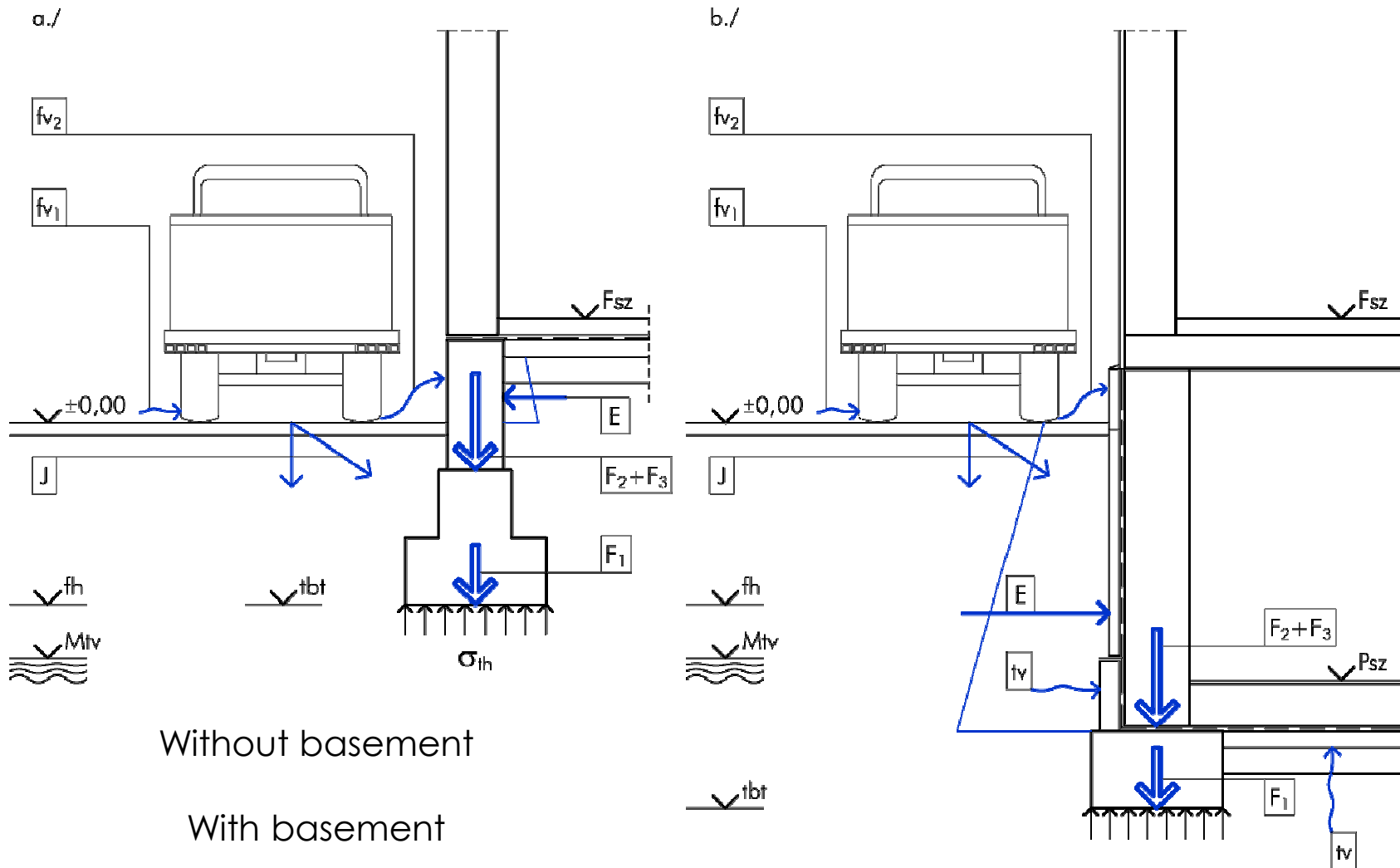
CLASSIFICATION OF SUBSOIL - LOESS





INFLUENCES ON FOUNDATIONS

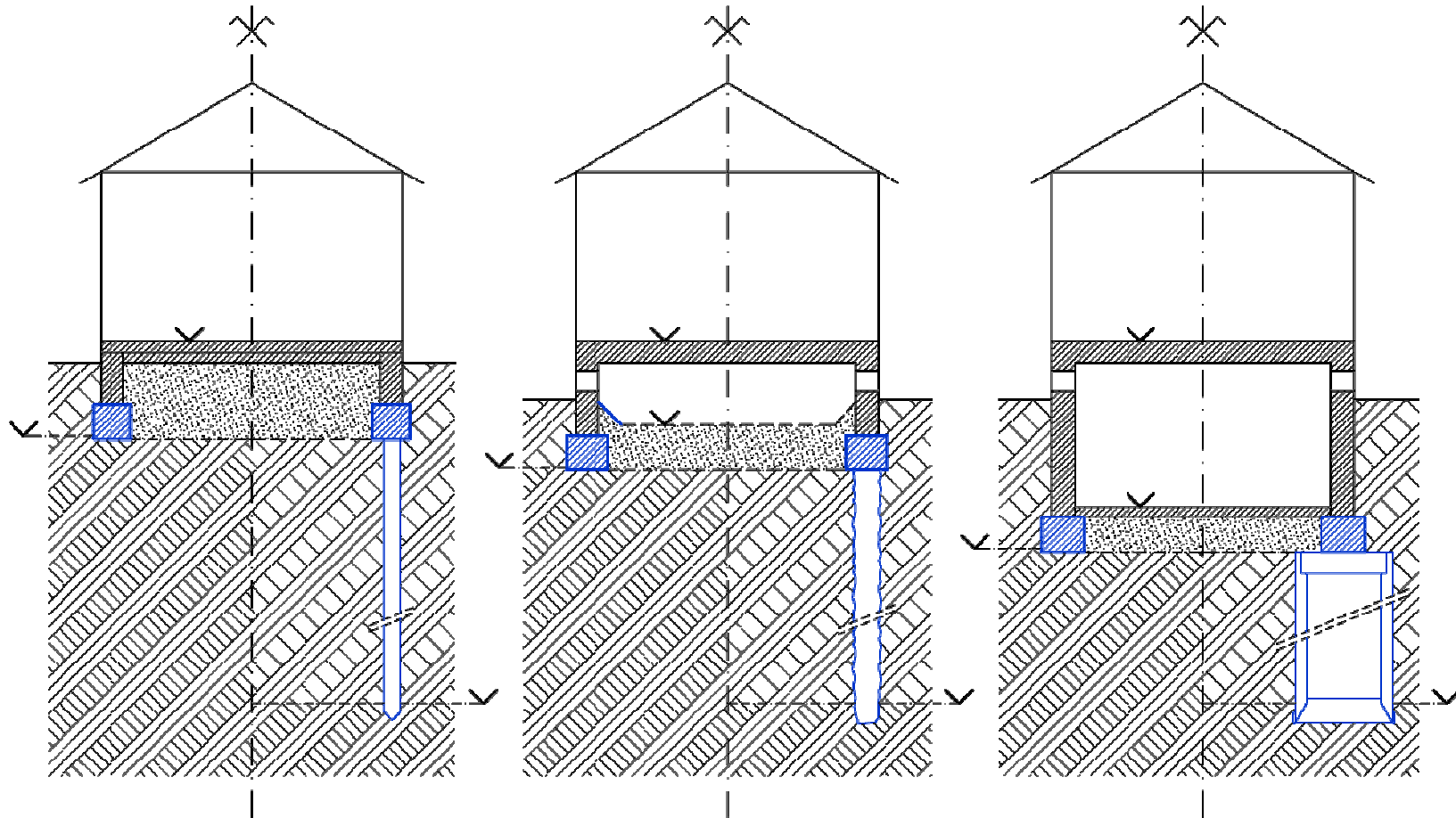
INFLUENCES TO FOUNDATION SYSTEMS





REQUIREMENTS, SOLUTIONS

CONSTRUCTIONS BELOW GROUND FLOOR



Without basement
(floor construction is
on a soil backfill)

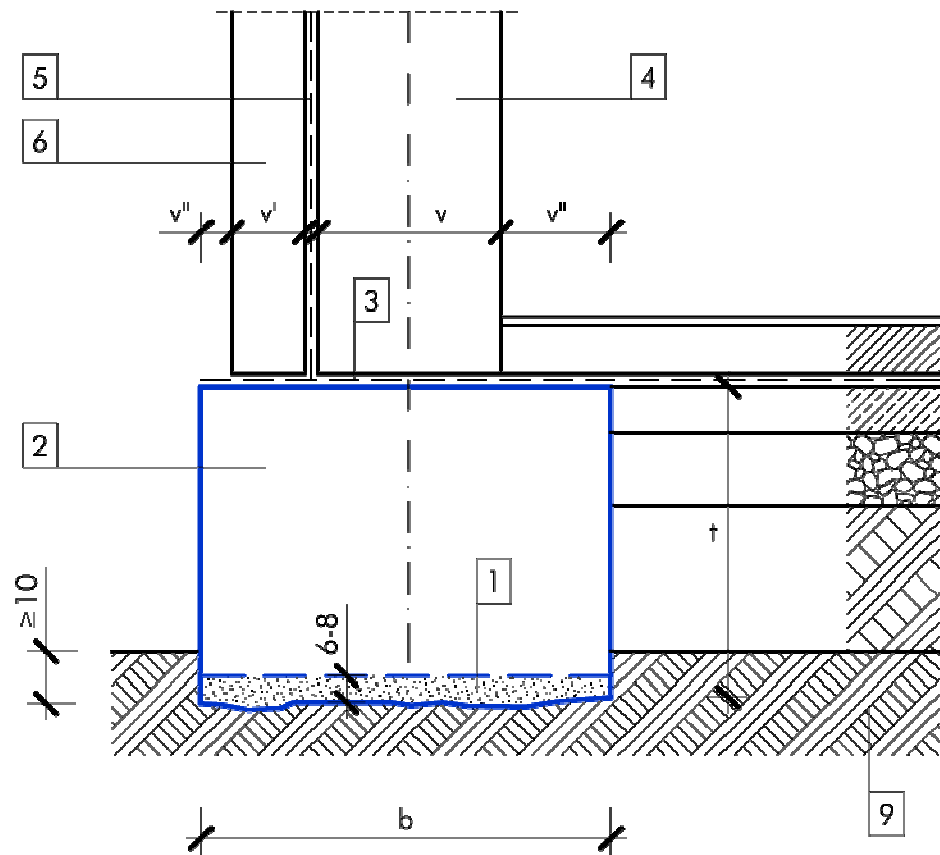
With crawl space
(ventilation, pipes etc.)

With basement
(storage, rooms)

VAULTED CRAWL SPACE (XVIII. CENTURY)



MAIN PARTS OF THE FOUNDATION



1: Equalizing concrete layer

2: Foundation strip

3: Horizontal waterproofing

4: Basement wall

5: Vertical waterproofing

6: Supporting or protecting wall of the waterproofing

7: top level of the foundation

8: bottom level of the foundation

9: loadbearing soil

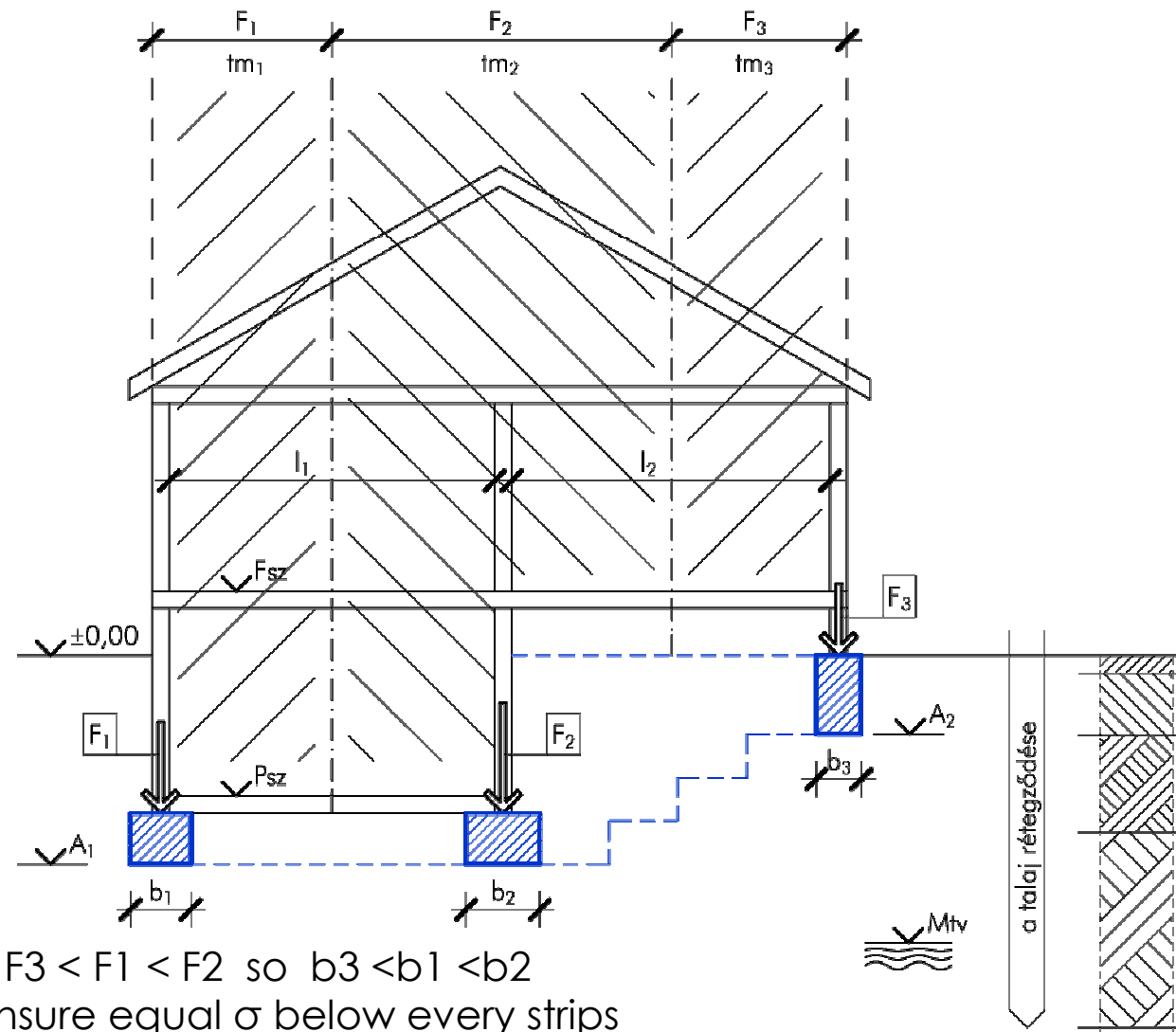
P_v

7

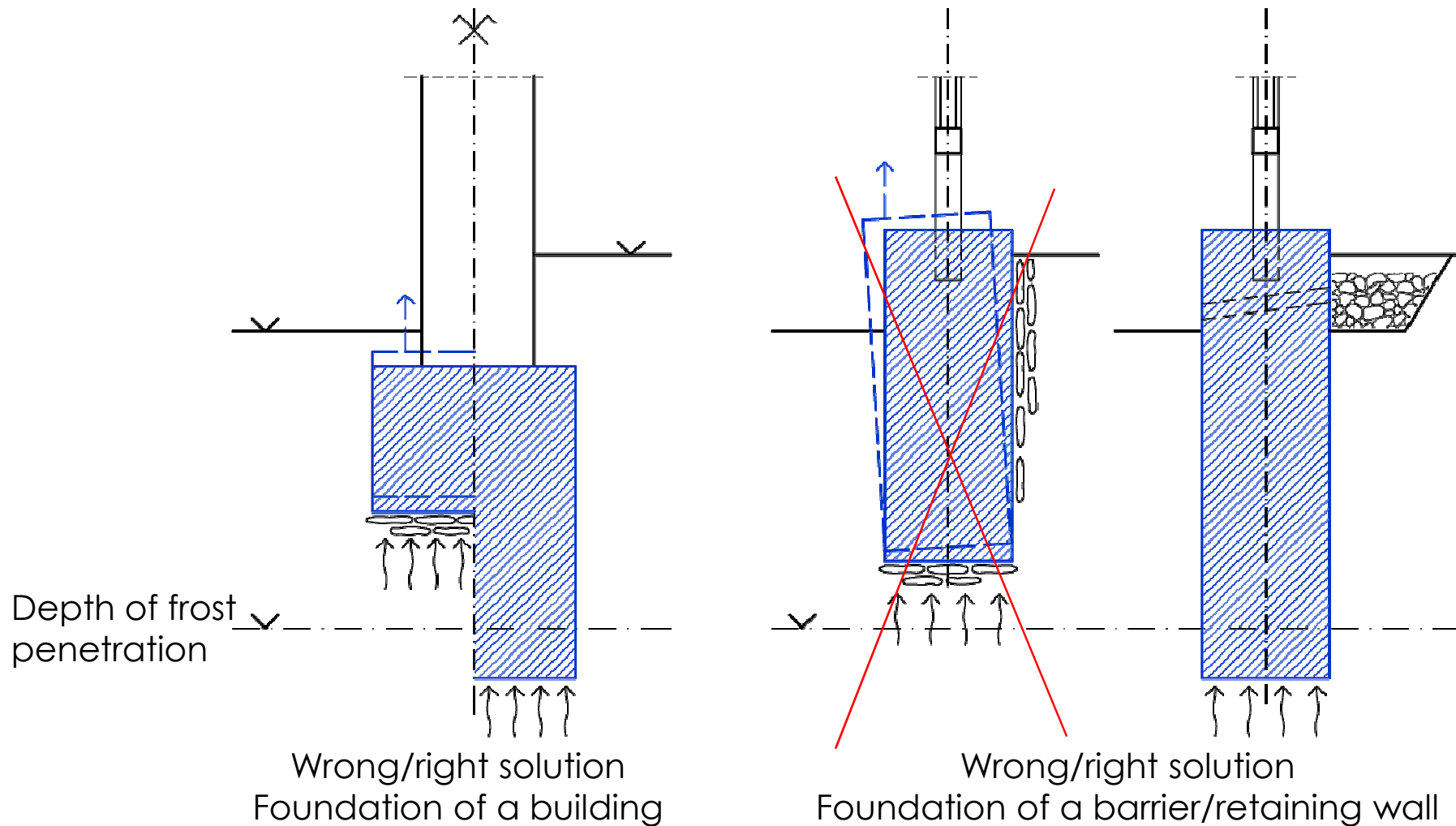
8

M_{iv}

RELATIONSHIP BETWEEN THE LOADBEARING STRUCTURE AND THE FOUNDATION

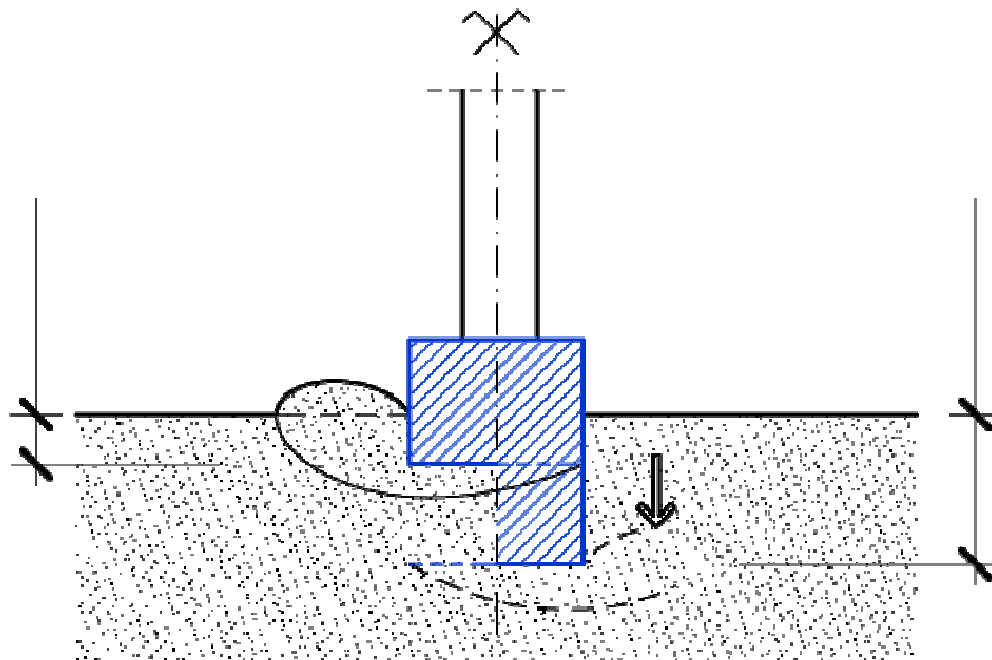


FROST PENETRATION, FROST HEAVING



Frost heaving is the process by which the freezing of water-saturated soil causes the deformation and upward thrust of the ground surface or a building.

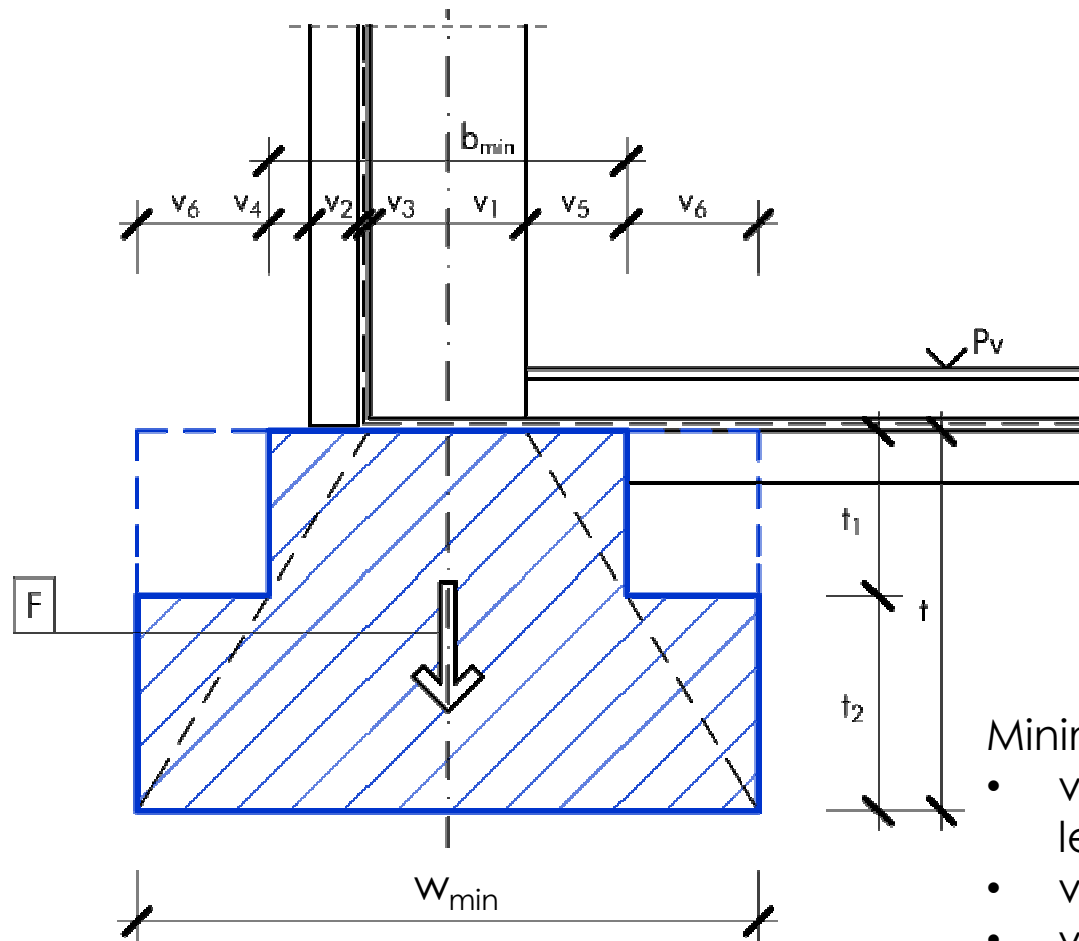
MINIMUM DEPTH OF FOUNDATION



Minimum depth of foundation:

- Frost level (80-100 cm)
- 10 cm below the level of the loadbearing soil
- 40-50 cm.

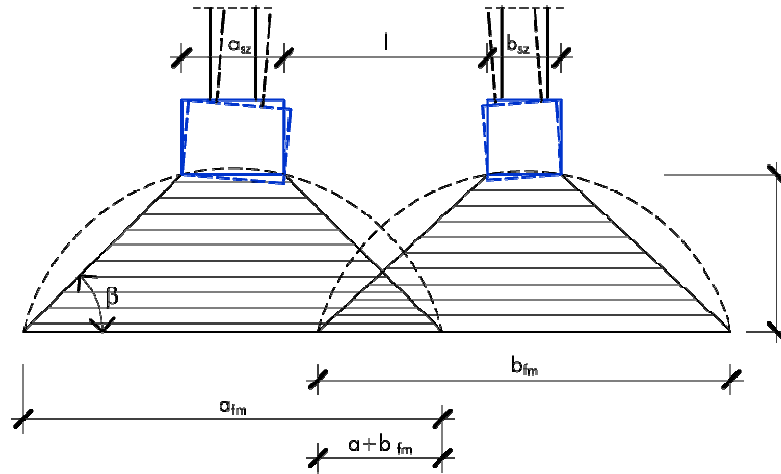
MINIMUM WIDTH OF FOUNDATION



Minimum width of foundation (W_{min}):

- $v_1+v_2+v_3$: constructions on the top level of the foundation;
- v_5 : overlapping of the waterproofing
- v_4, v_6 : tolerance (min. 5 cm),

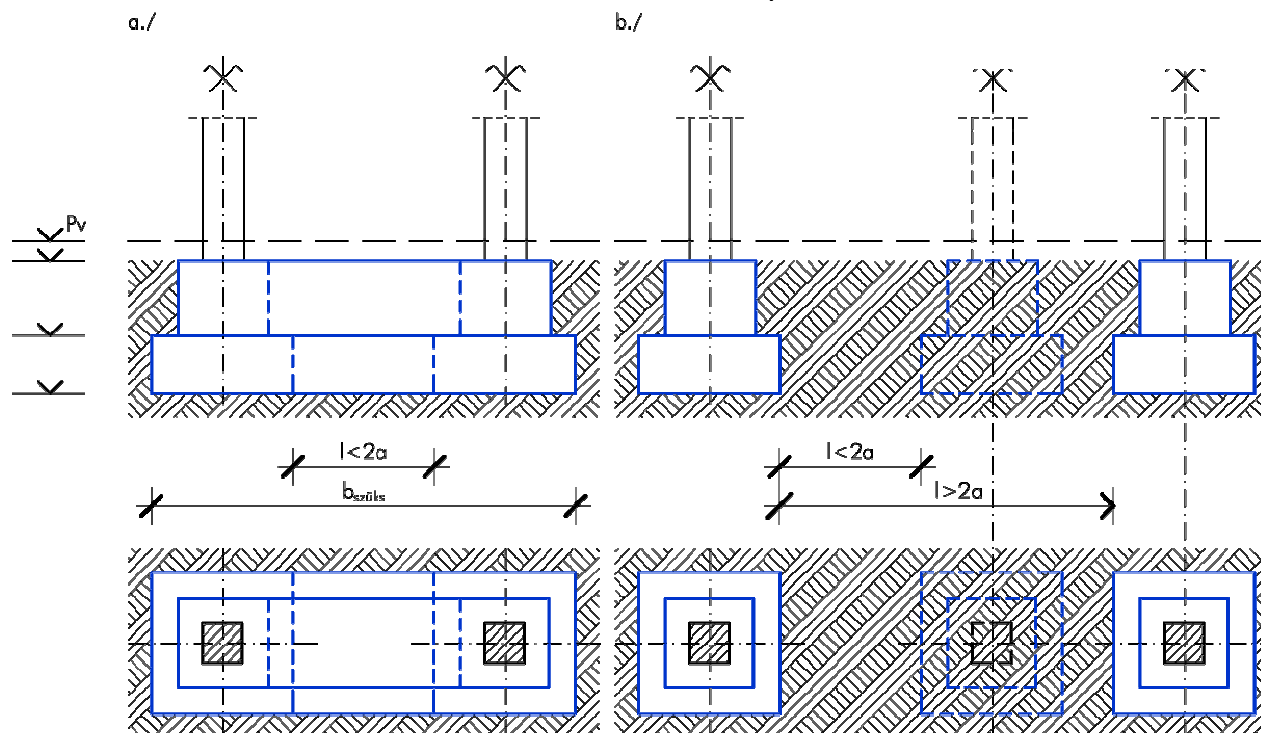
AVOIDANCE OF BULB PRESSURE



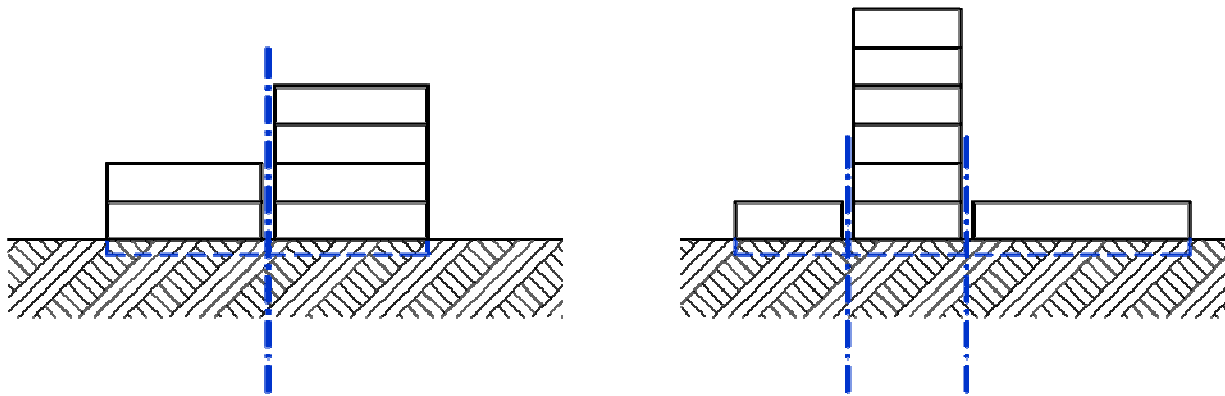
If $a > b$ then the critical level is $2 \cdot a$; bulb pressure hazard:

- at strip foundation $2 \cdot a$
- at pad foundation $1 \cdot a$

8.1 Avoidance of bulb pressure in case of pad foundation

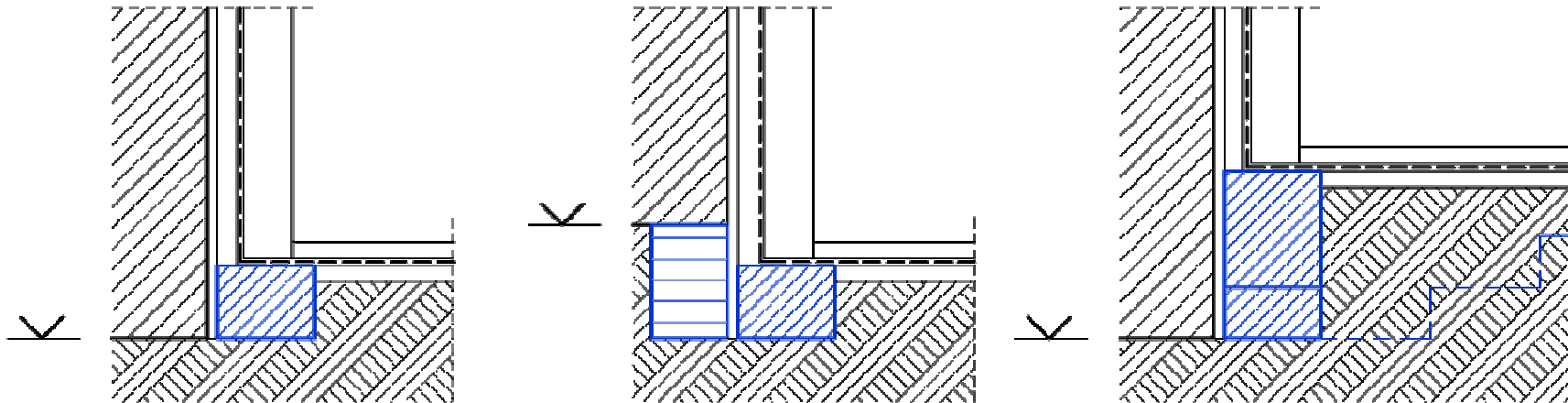


DILATATION



When the dead load or the mass of the parts of the building are different, dilatation of foundation is obligatory

FOUNDATION CLOSE TO ADJACENT BUILDINGS

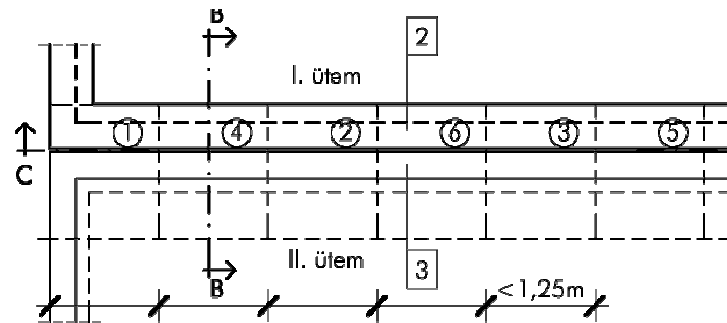


Bottom level of foundation
of old and new buildings
are the same

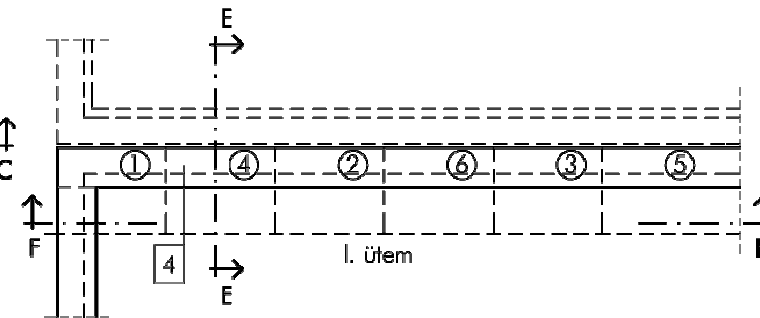
Bottom level of
foundation of the new
building is deeper
- discontinuous underpin

Bottom level of
foundation of the new
building is higher

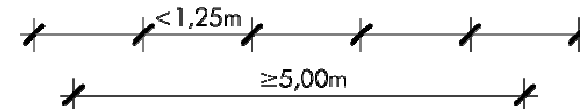
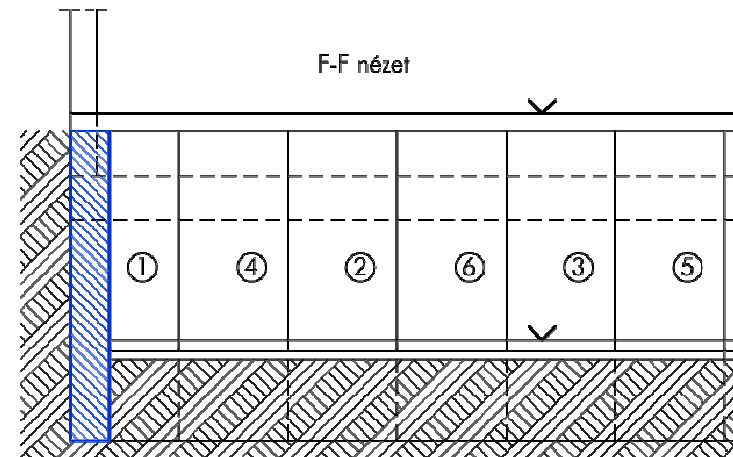
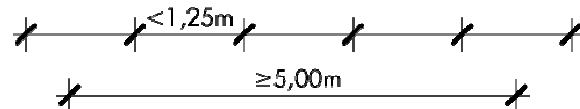
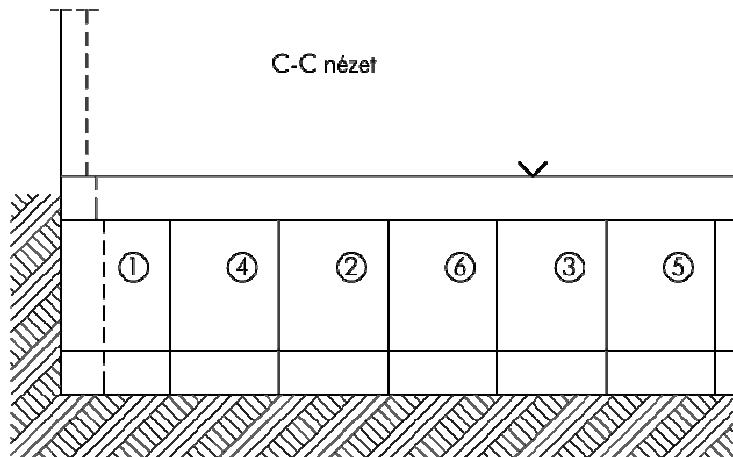
FOUNDATION CLOSE TO ADJACENT BUILDINGS



Phase I.



Phase II.



Bottom level of foundation of the new building is deeper
- discontinuous underpin

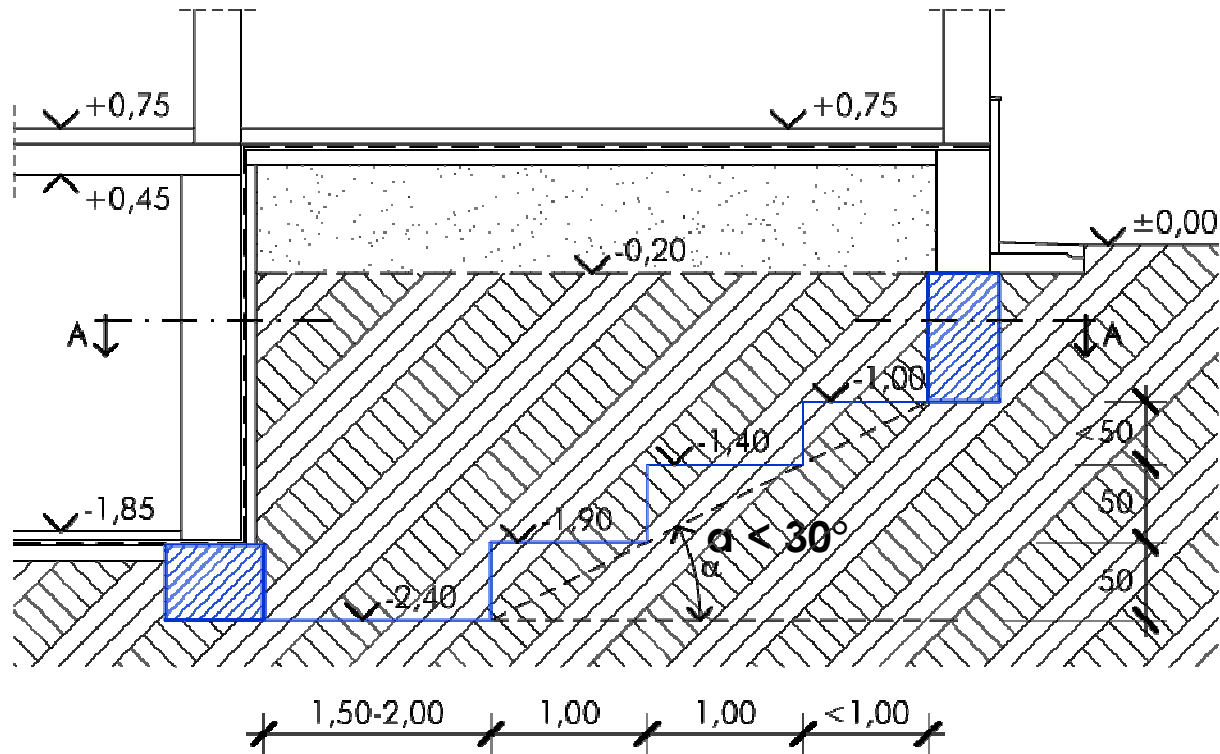
UNDERPIN MADE OF CONCRETE



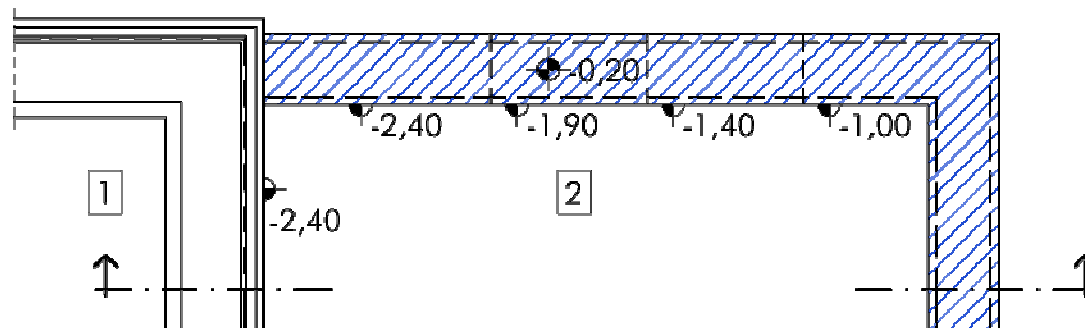
UNDERPIN MADE OF CONCRETE



AVOIDING INEQUAL SETTLEMENTS



A-A metszet

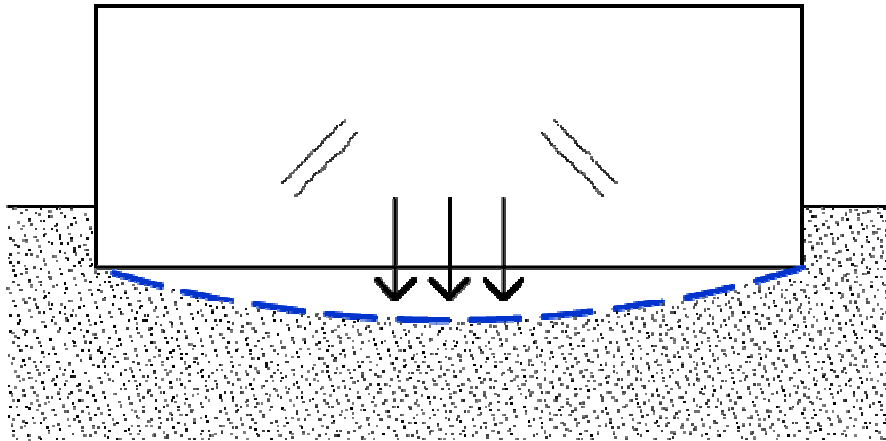


Strip foundation at different floor levels

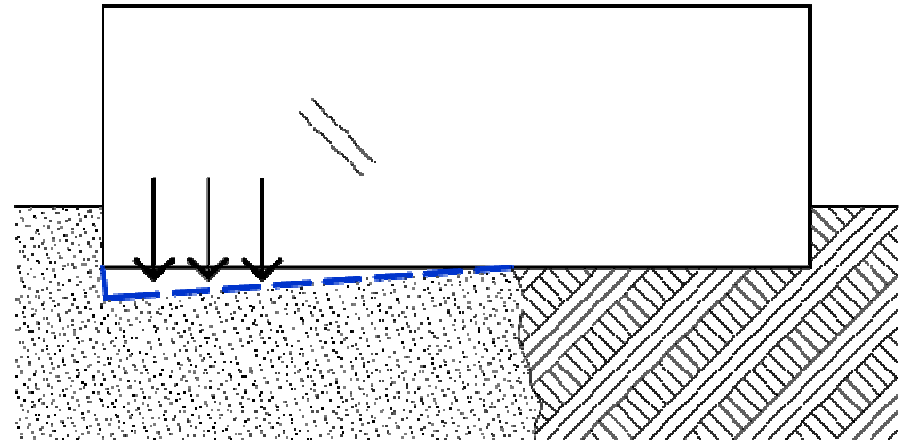


INEQUAL SETTLEMENT OF SUBSOIL AND CONSEQUENCES

INEQUAL SETTLEMENT OF SUBSOIL



The building is too long or leakage in the public utilities (sewage and rainwater pipes, water main etc.)



Inhomogen soil with different σ_H

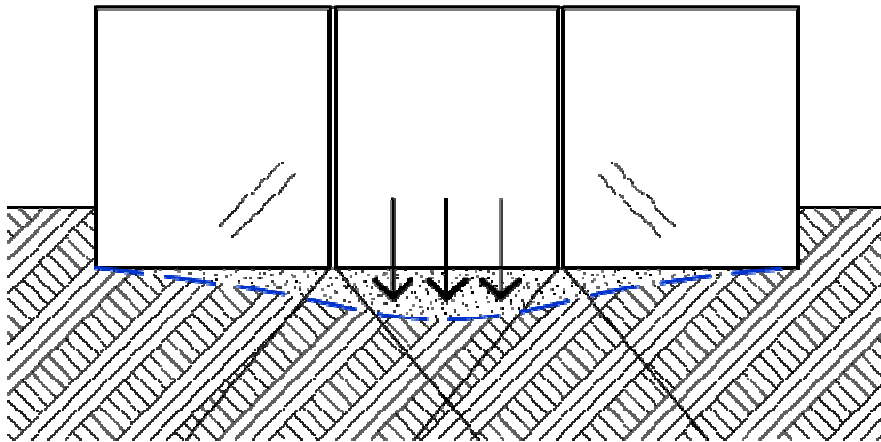
INEQUAL SETTLEMENT OF SUBSOIL



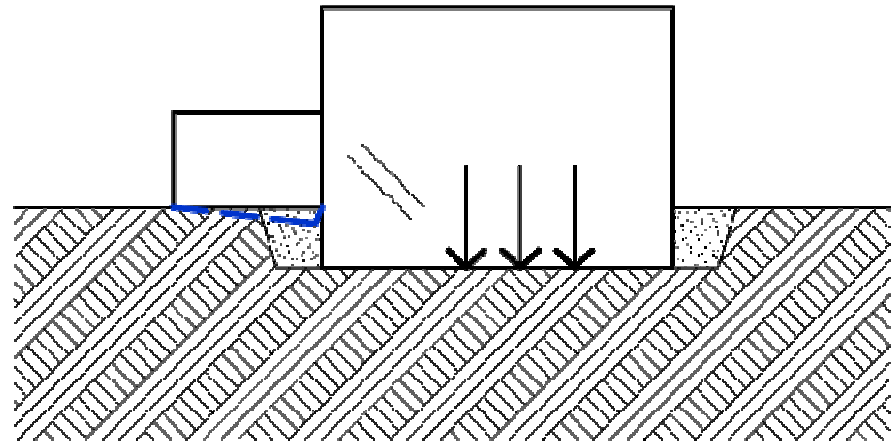
INEQUAL SETTLEMENT OF SUBSOIL



INEQUAL SETTLEMENT OF SUBSOIL



Lock-up in a plot between two existing building which was not covered with building

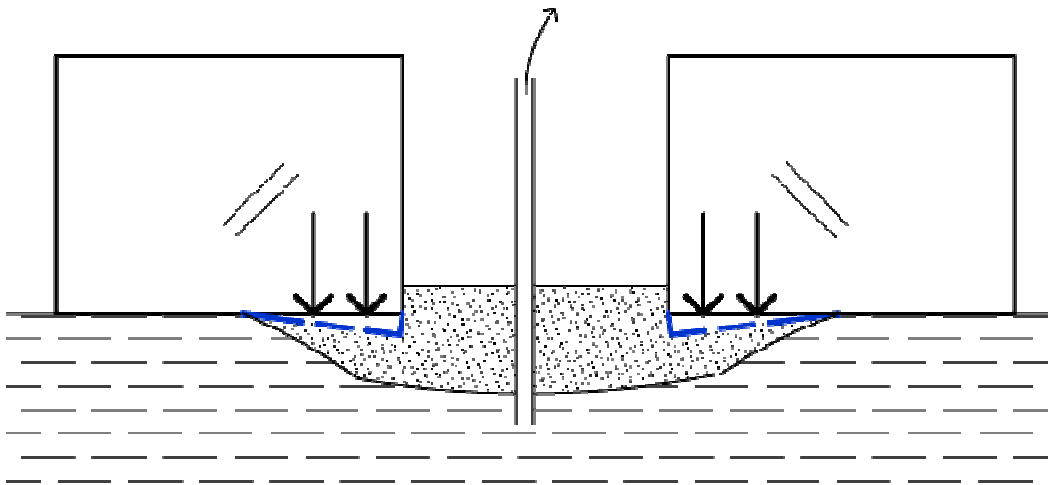


New building on a soil backfill side-by-side an existing building

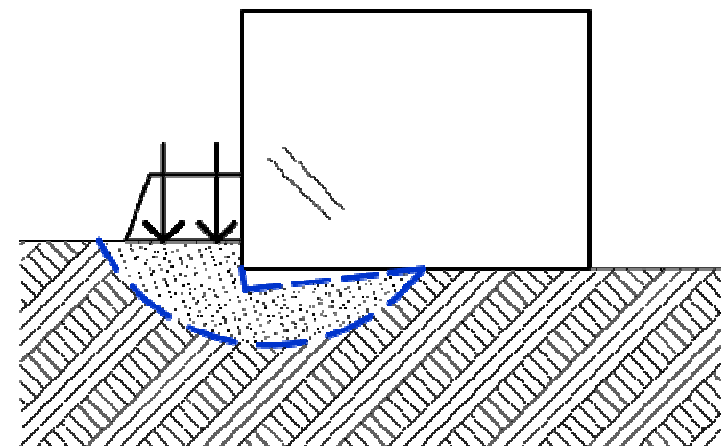
INEQUAL SETTLEMENT OF SUBSOIL



INEQUAL SETTLEMENT OF SUBSOIL

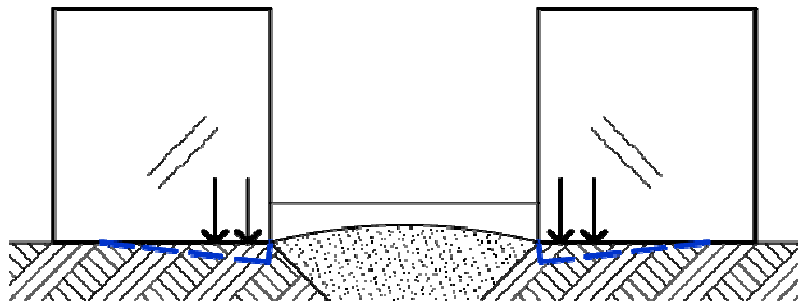


Dewatering between two buildings
(subsoil water)



Increasing the stress below the
existing building with a new
adjacent building

INEQUAL SETTLEMENT OF SUBSOIL



Settlement caused by excavation works (can cause even building collapse!)



COLLAPSE OF A BUILDING BECAUSE OF IMPROPER EXCAVATION



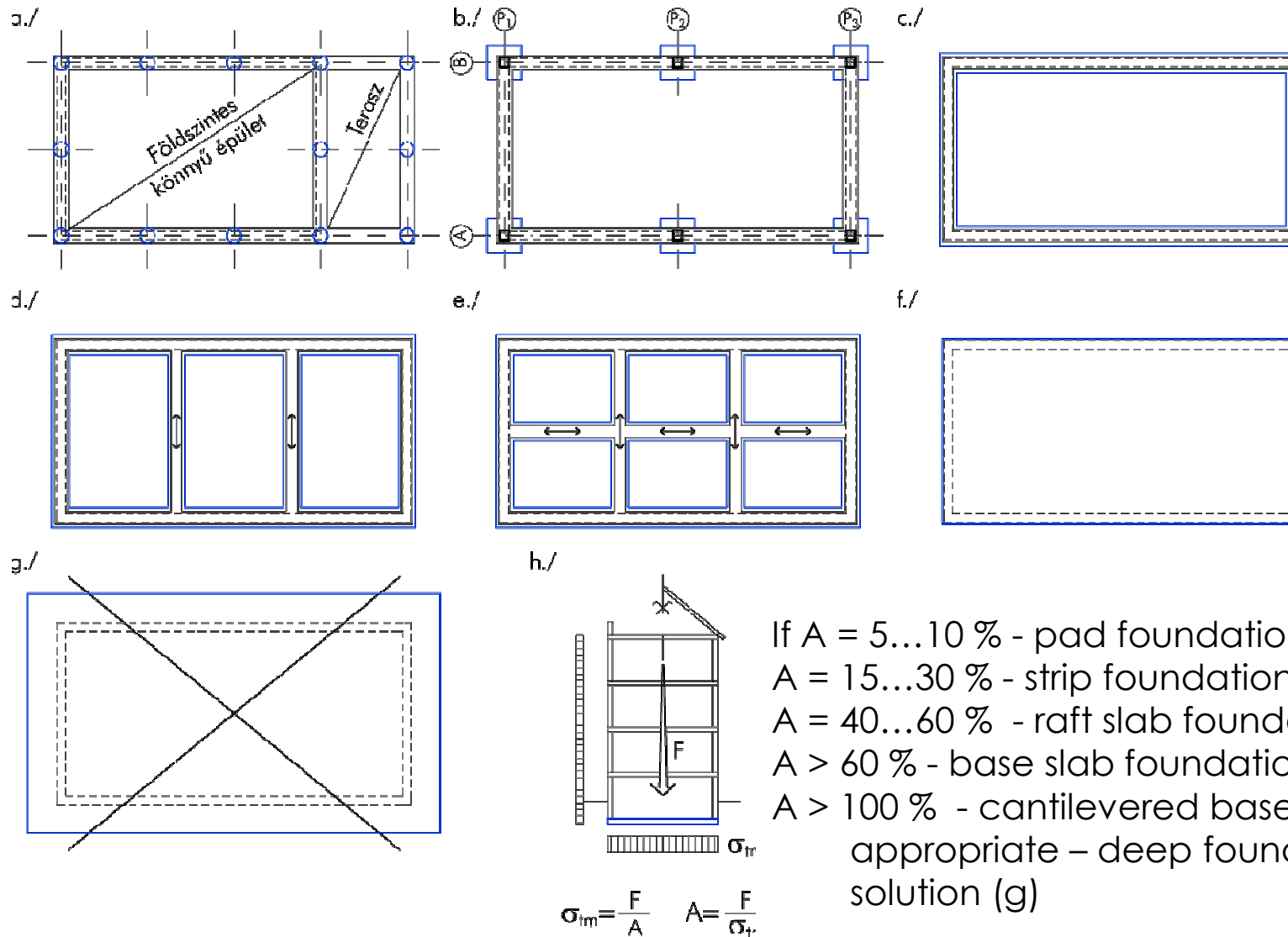


FOUNDATIONS II. SHALLOW FOUNDATIONS

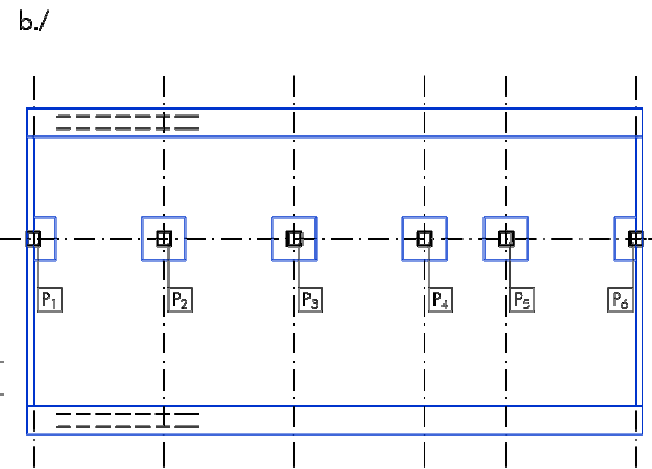
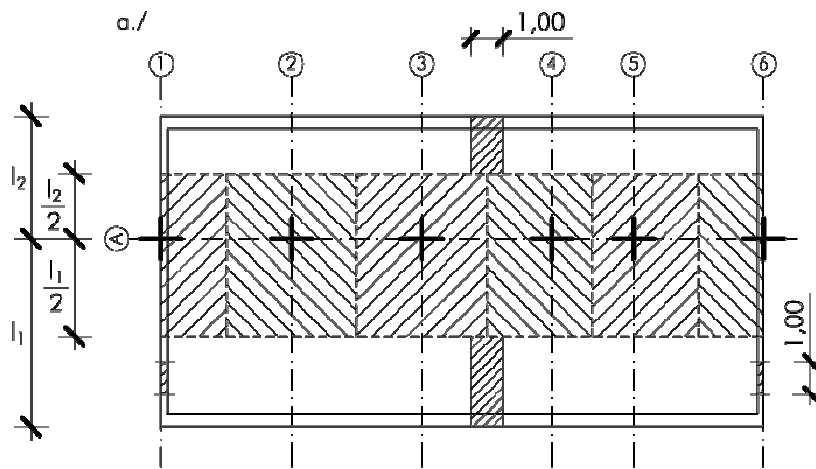
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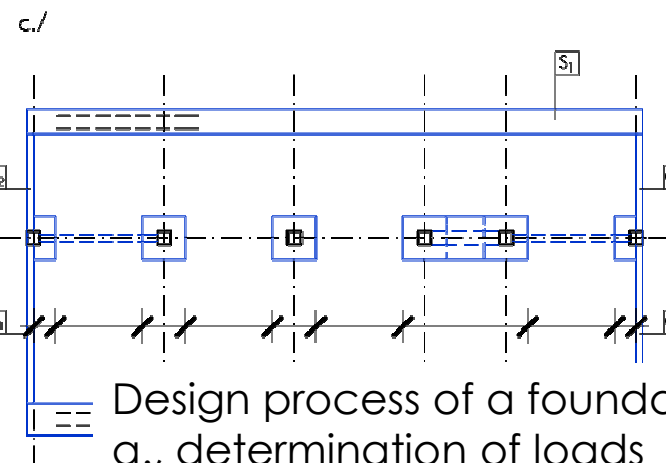
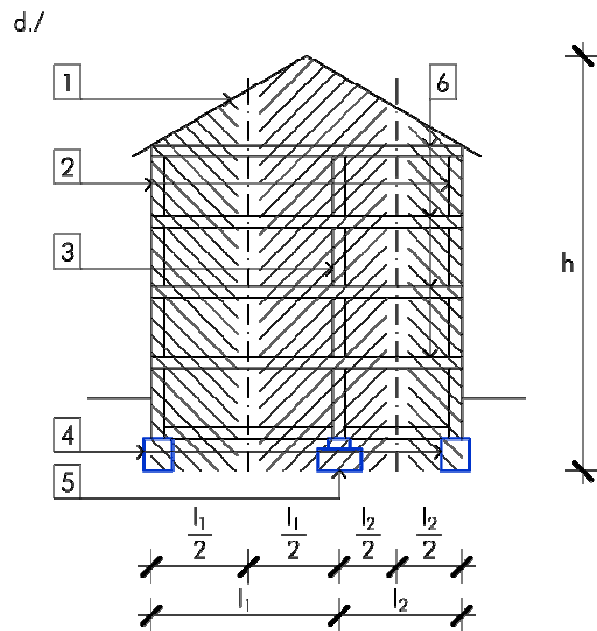
BASIC DESIGN PRINCIPLES OF SHALLOW FOUNDATION SYSTEM



BASIC DESIGN PRINCIPLES OF SHALLOW FOUNDATION SYSTEM



1. Roof construction
2. External wall
3. Internal wall
4. External foundation system
5. Internal foundation system
6. Slab construction



Design process of a foundation system

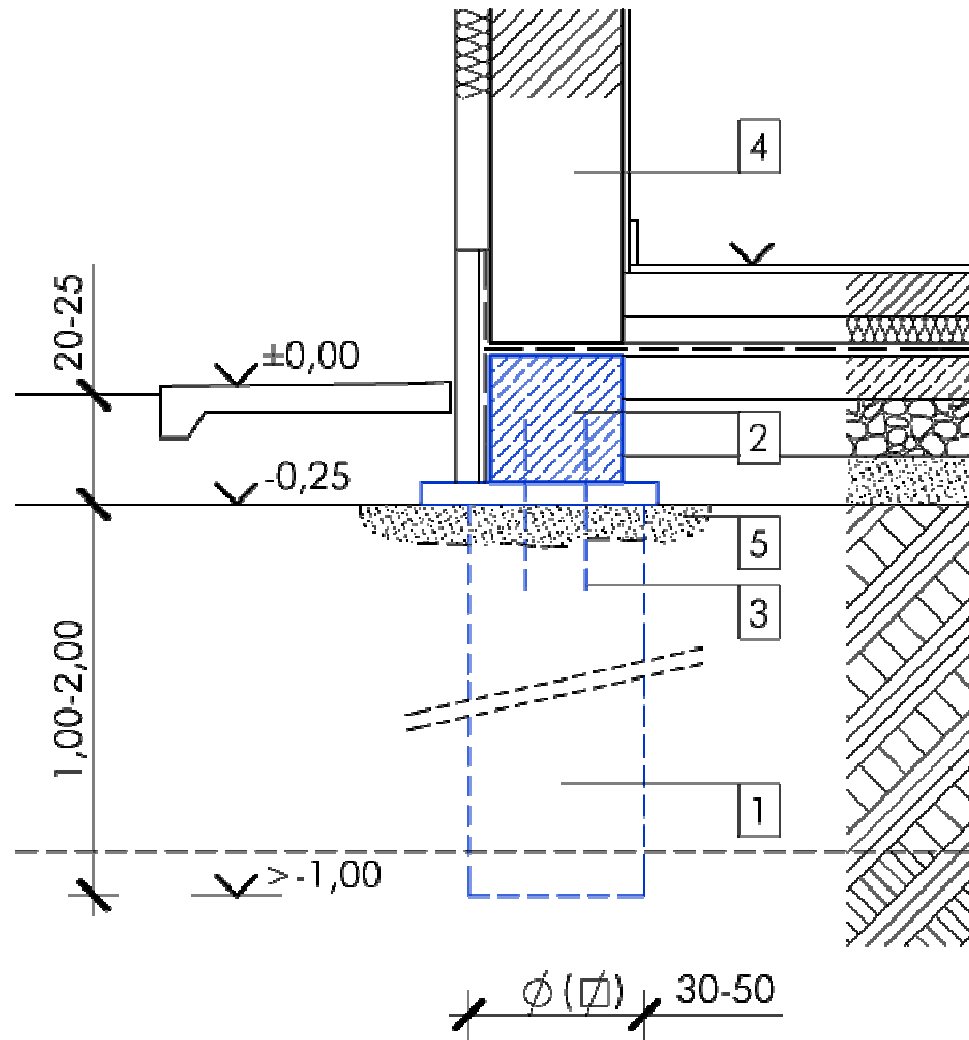
a., determination of loads

b., relationship between the loads and the foundation

c., equalization of stress and construction

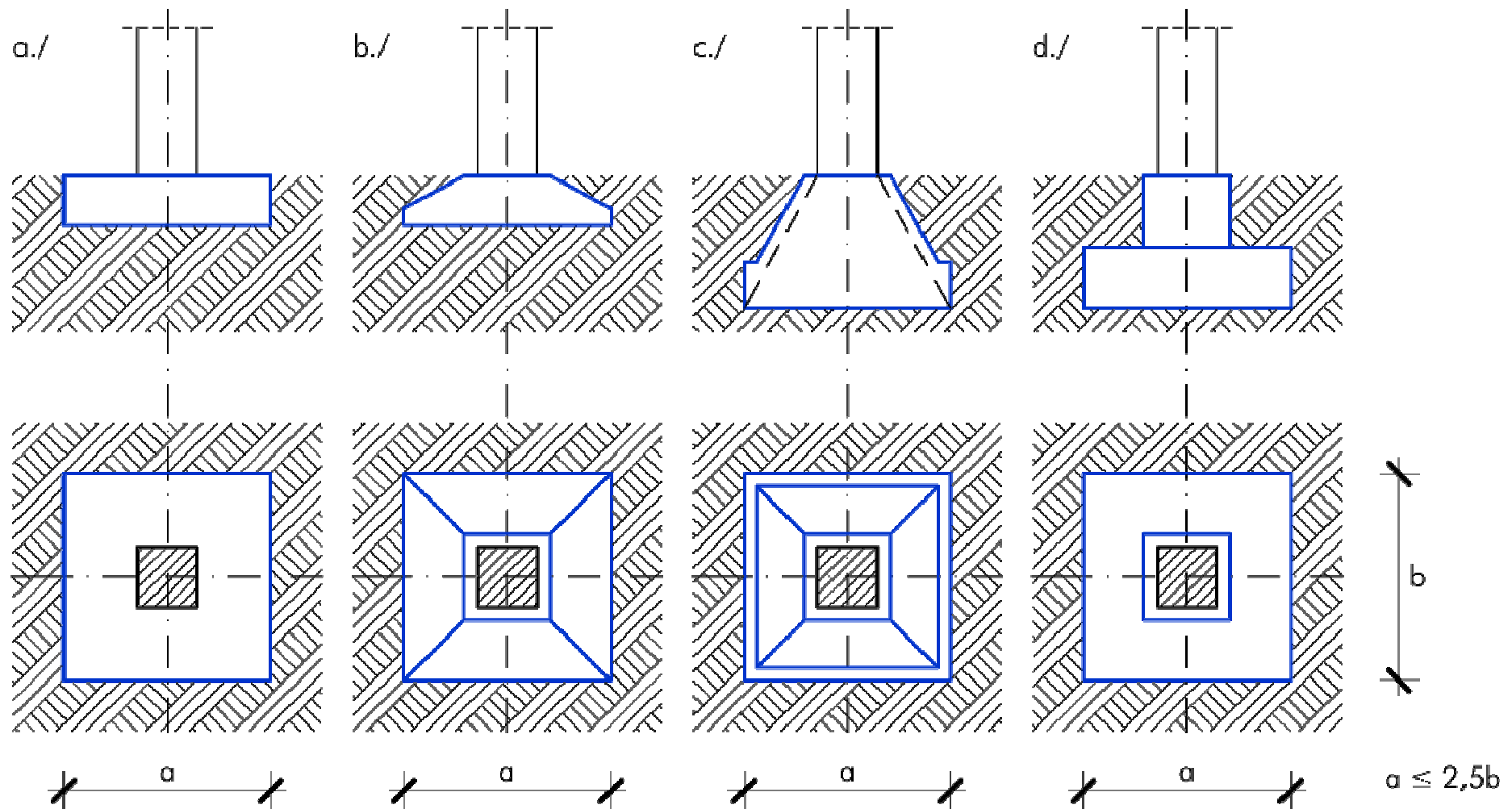
d., section

SHALLOW FOUNDATION ALTERNATIVES



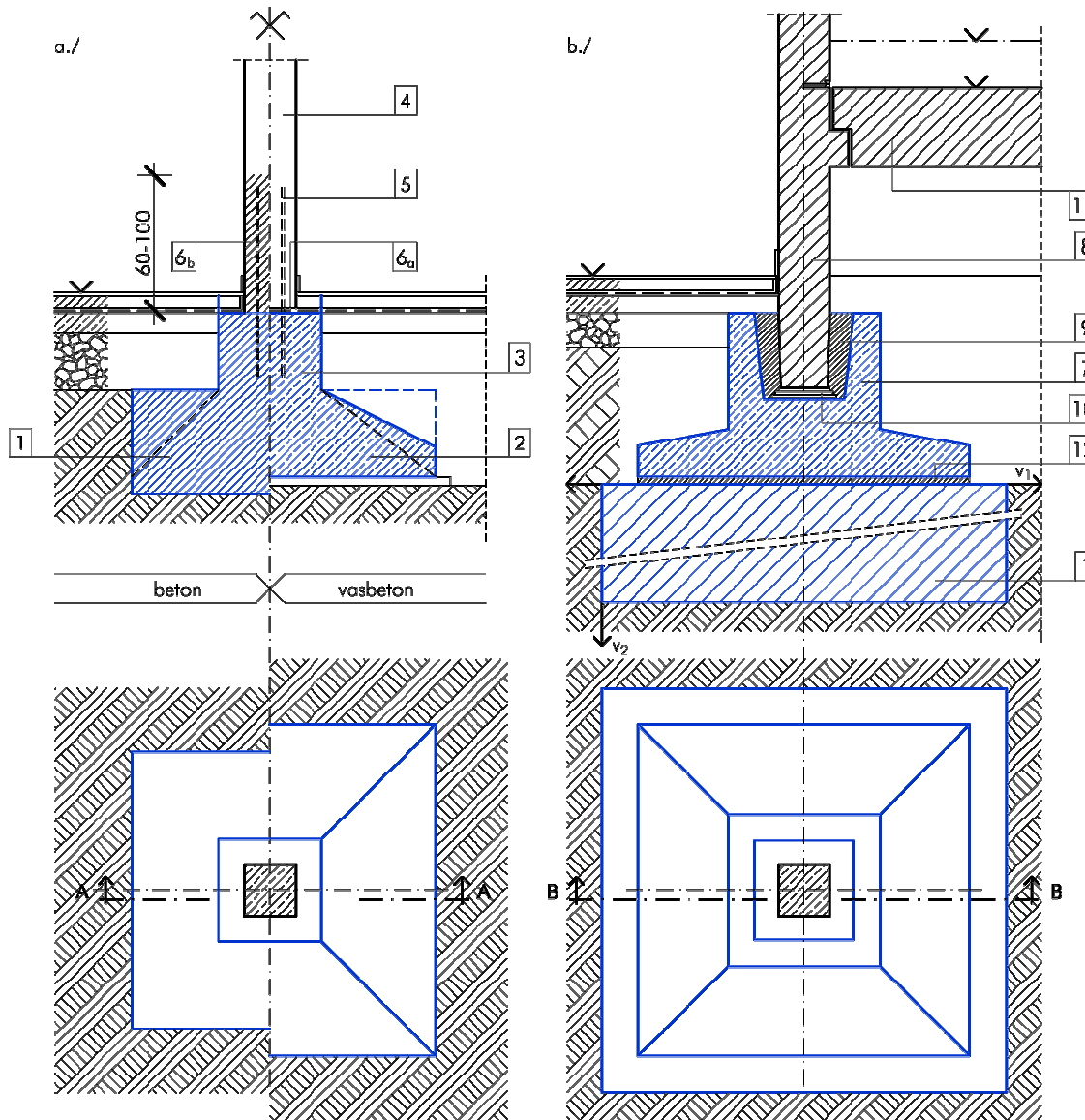
1. „Plug” foundation units at every 2-2,5 m
2. RC beam
3. Reinforcement
4. Superstructure
5. Hardcore

SHALLOW FOUNDATION ALTERNATIVES – PAD FOUNDATIONS



a, b: reinforced concrete, c: concrete, d: reinforced concrete

SHALLOW FOUNDATION ALTERNATIVES – PAD FOUNDATIONS



Monolithic

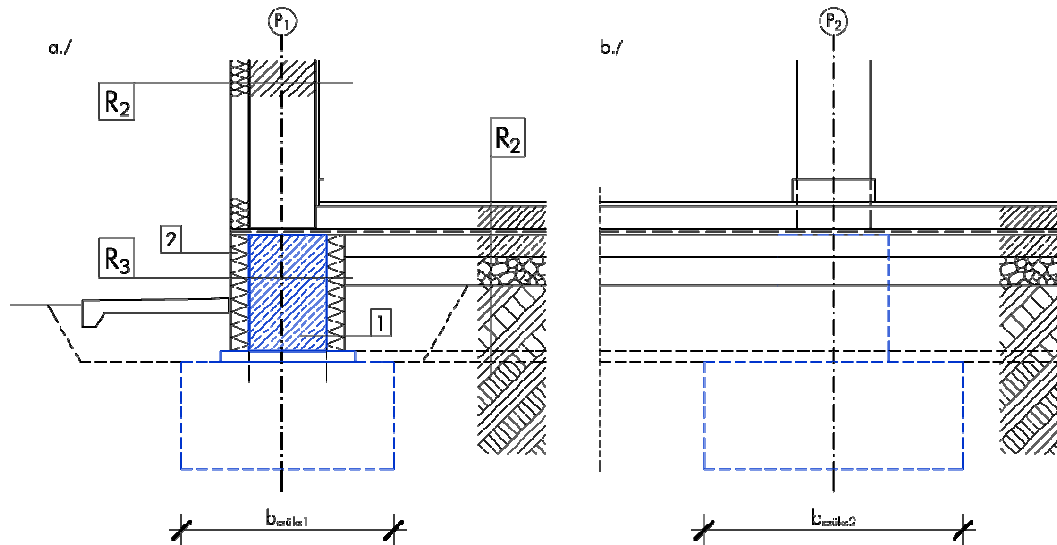
Prefabricated

1. Concrete pad
2. Reinforced concrete pad
3. Head of the foundation pad
4. Monolithic reinforced concrete pier
5. Reinforcement
6. Mass waterproofing
7. Prefabricated foundation
8. Prefabricated RC pier
9. Concrete infill
10. Level adjusting steel plates
11. RC beam
12. Bedding mortar

CONSTRUCTION OF A PAD FOUNDATION



SHALLOW FOUNDATION ALTERNATIVES – PAD FOUNDATIONS



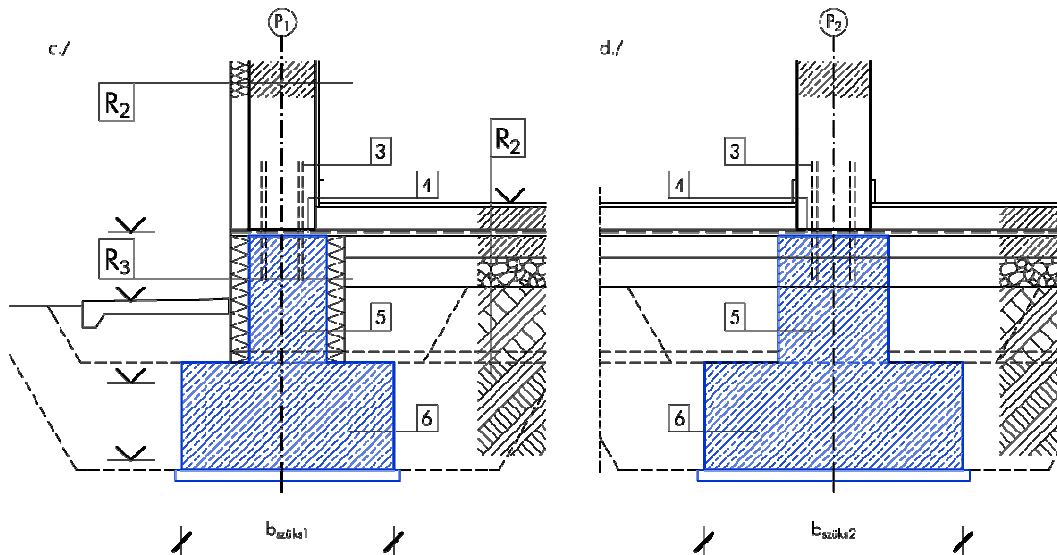
Building without basement, with skeleton frame loadbearing constructions

a., infill wall detail

b., floor construction detail

c., external loadbearing pier

d., internal loadbearing pier



1: RC beams below the infill walls

2: Thermal insulation (XPS)

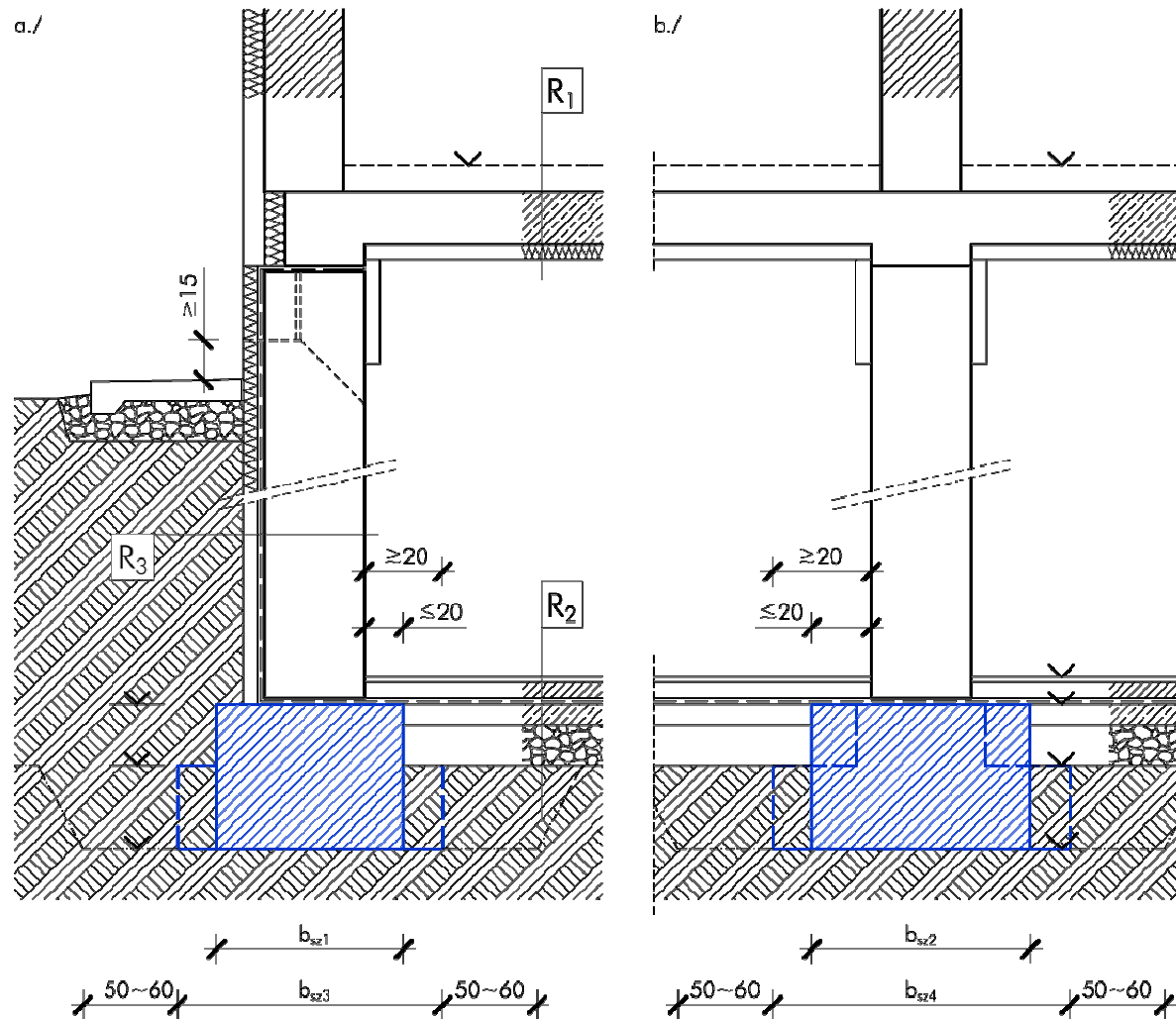
3: Mass waterproofing

4: Waterproofing coating

5: Head of the foundation pad

6: Foundation pad

SHALLOW FOUNDATION ALTERNATIVES – STRIP FOUNDATIONS

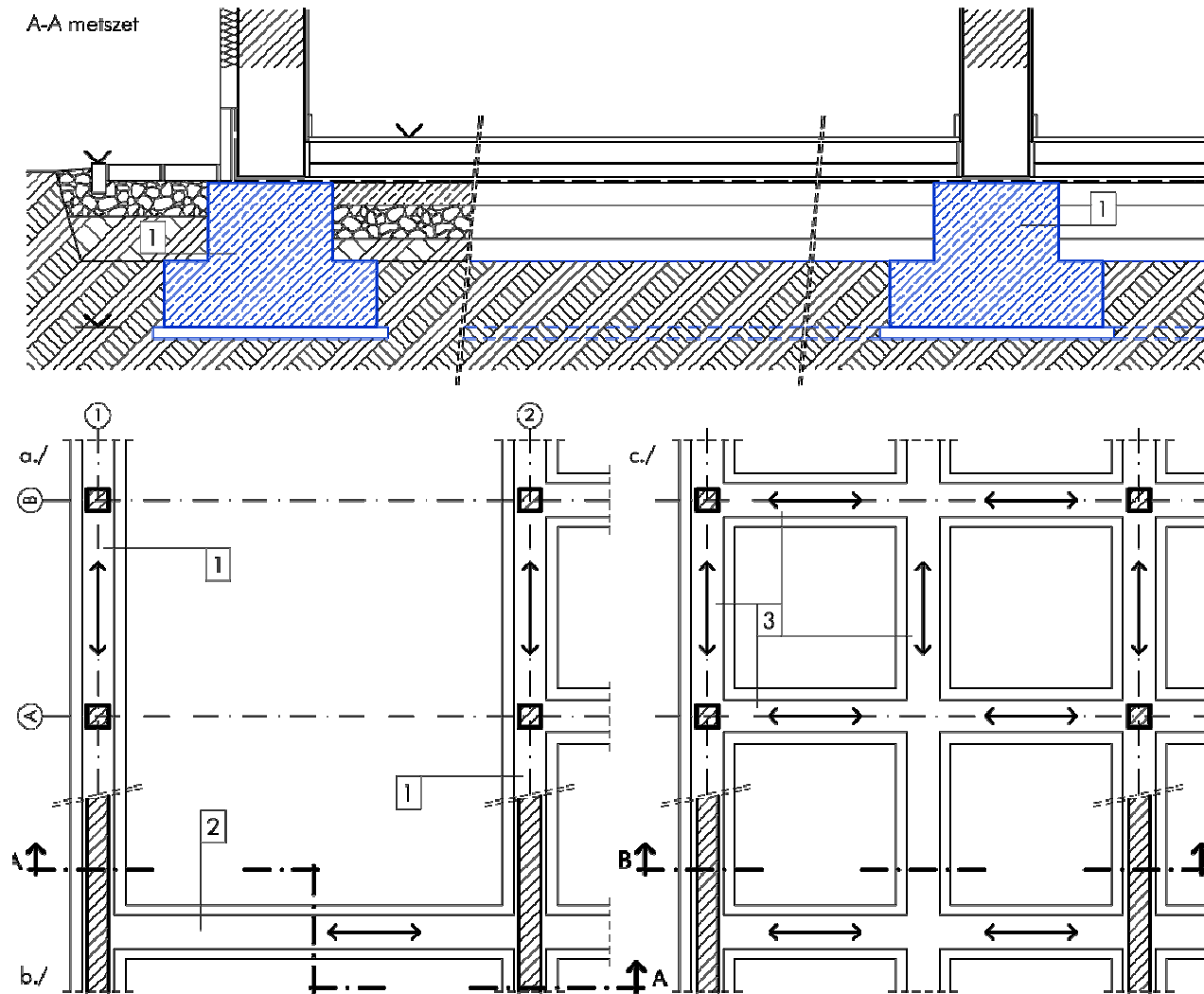


Building with basement, with loadbearing wall constructions
a., external loadbearing wall detail, b., internal loadbearing wall detail

STRIP FOUNDATION

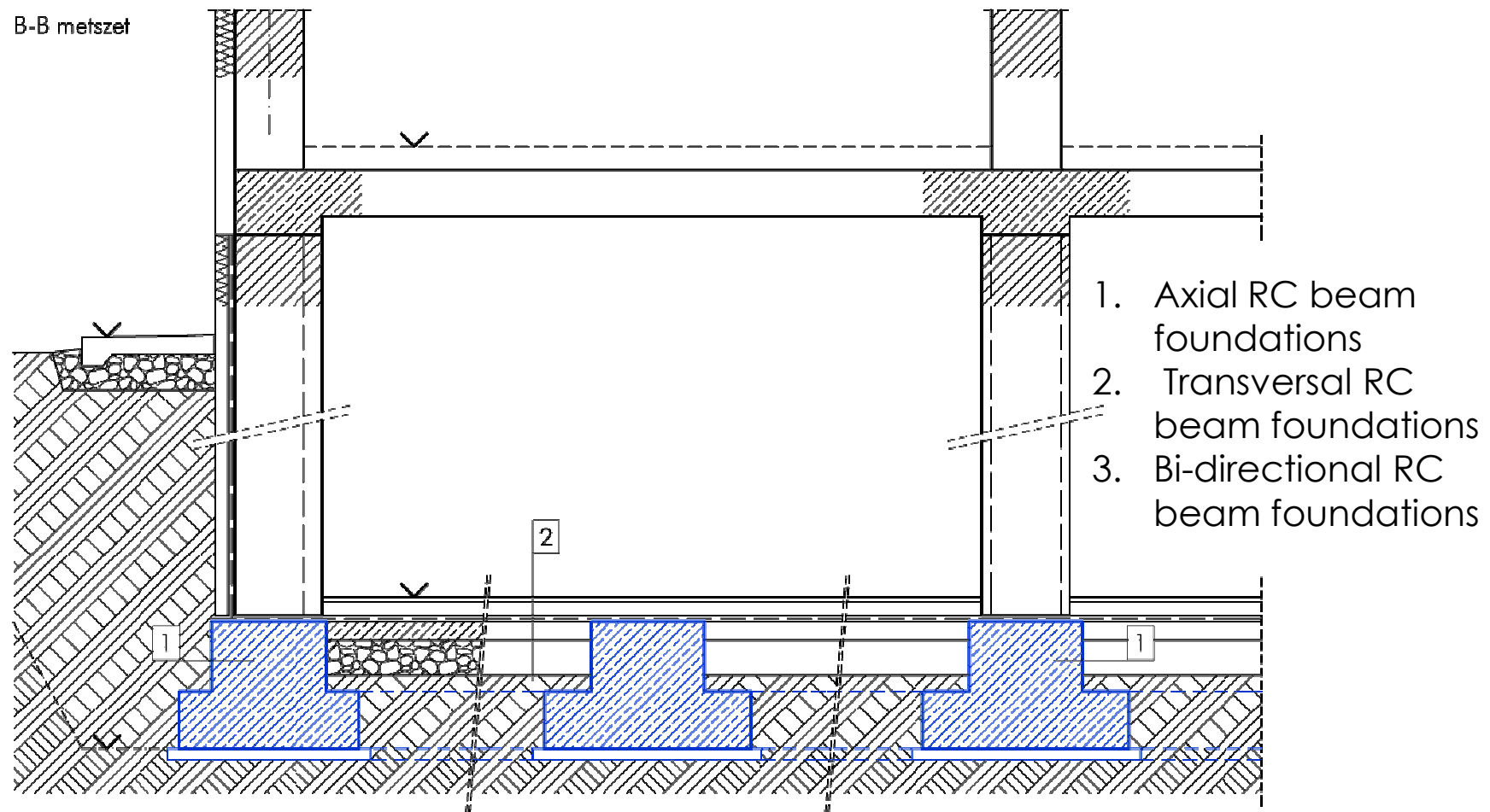


SHALLOW FOUNDATION ALTERNATIVES – STRIP FOUNDATIONS



RC beam strip foundation alternatives: a: layout , b, c: layout

SHALLOW FOUNDATION ALTERNATIVES – STRIP FOUNDATIONS



RC beam strip foundation alternatives with basement

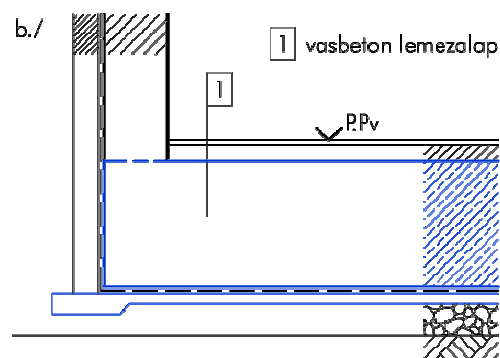
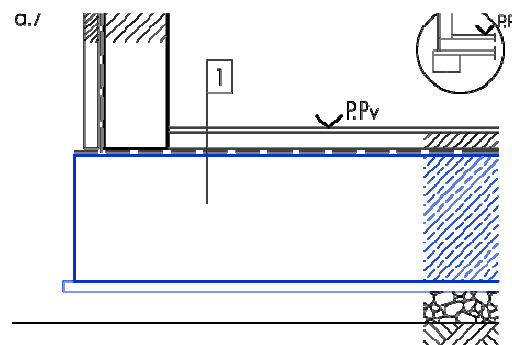
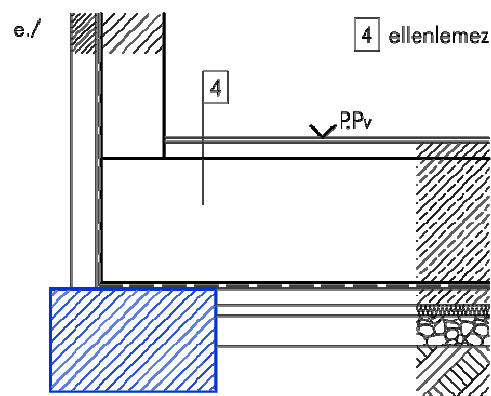
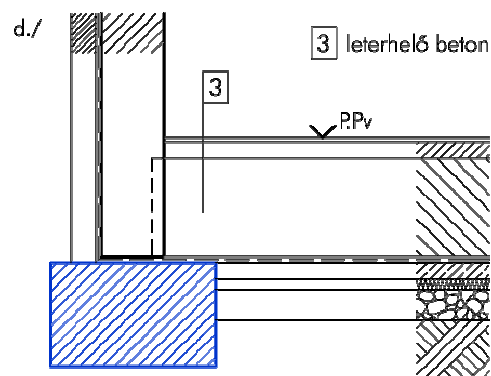
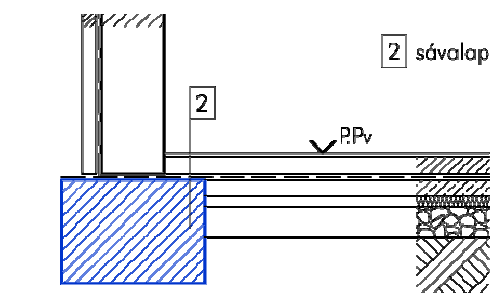
CONSTRUCTION OF A STRIP FOUNDATION



CONSTRUCTION OF A STRIP FOUNDATION



SHALLOW FOUNDATION ALTERNATIVES WHEN THE SUBSOIL WATER LEVEL IS HIGHER THAN THE BASEMENT FLOOR LEVEL



1. Base slab foundation
2. Strip foundation
3. Loading concrete layer
4. Counter slab

CONSTRUCTION OF A SLAB FOUNDATION

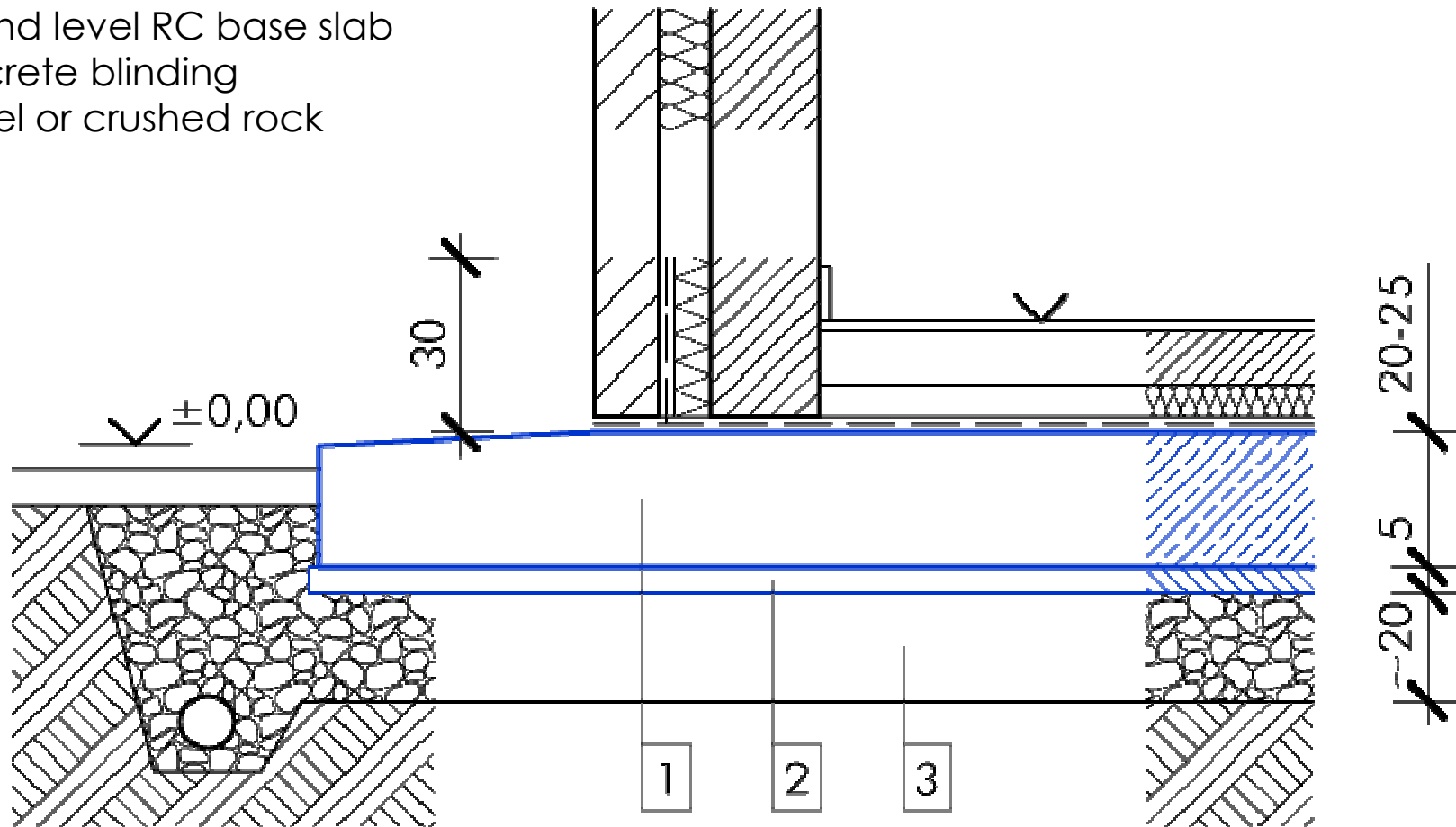


DETAIL OF A BASE SLAB BEFORE CASTING

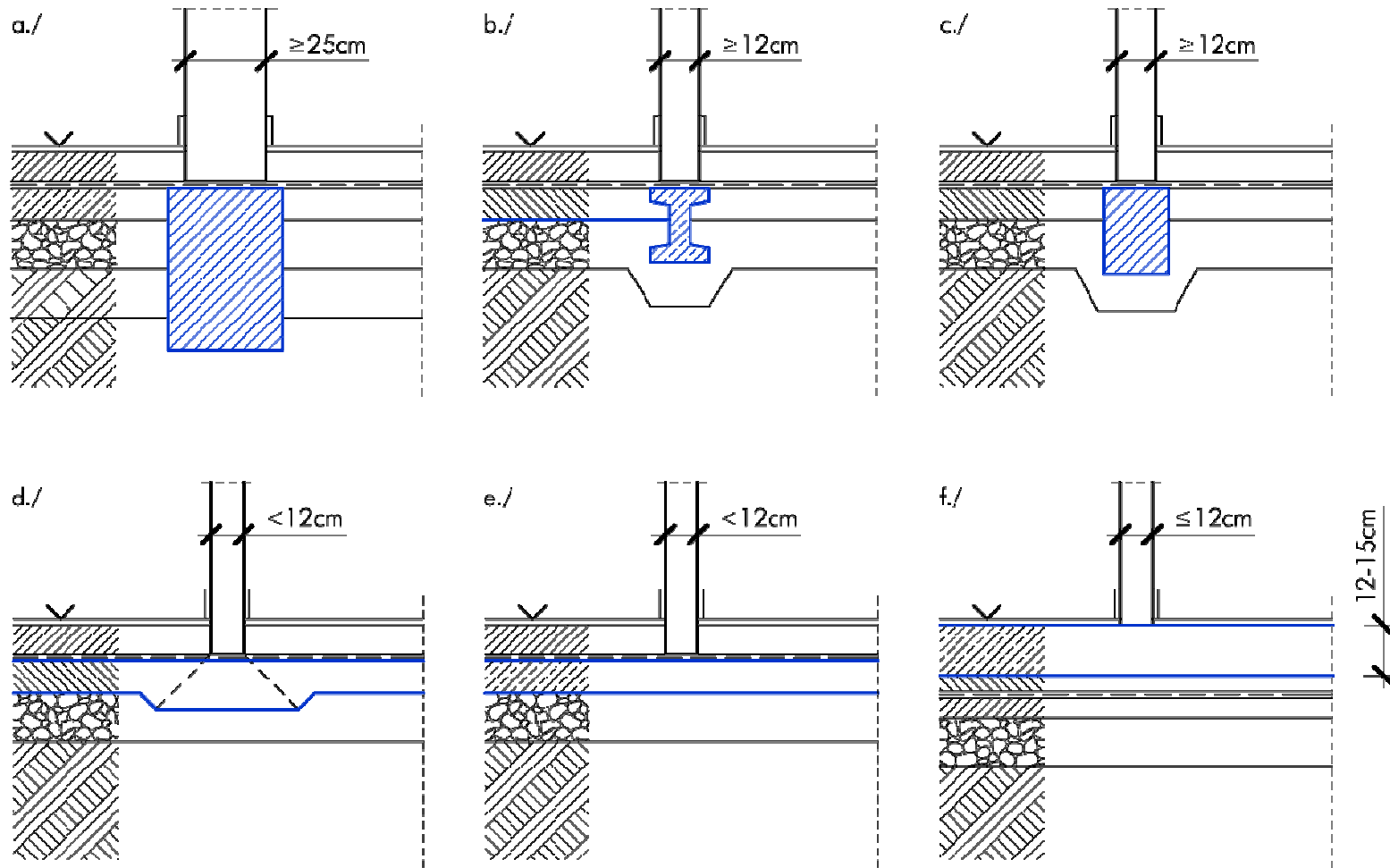


GROUND LEVEL BASE SLAB

- 1: ground level RC base slab
- 2: concrete blinding
- 3: gravel or crushed rock



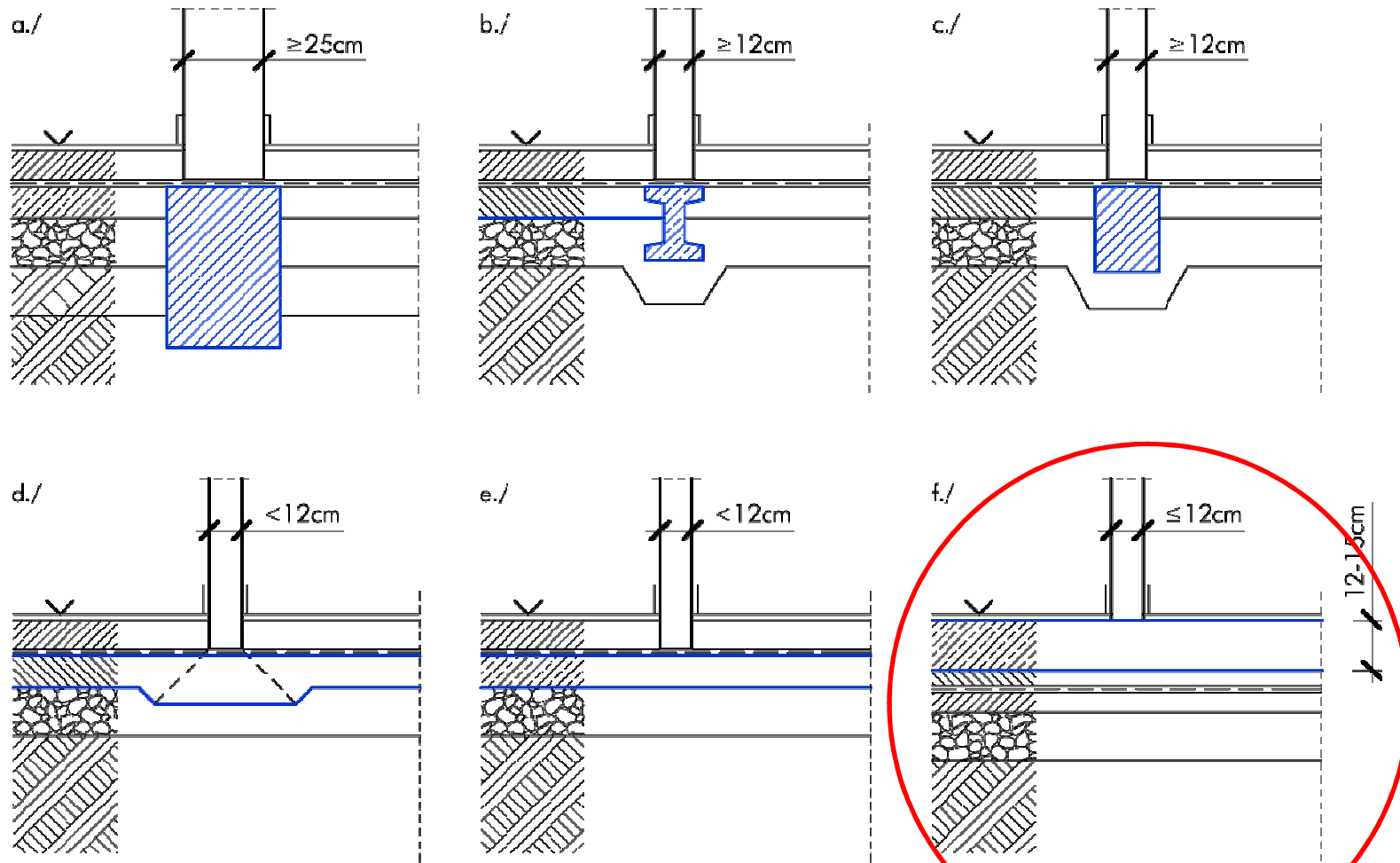
FOUNDATION ALTERNATIVES OF PARTITION WALLS



Foundations of heavyweight partitions
a., on a with foundation strip
b., on a prefabricated RC beam
c., partition on a RC beam

Foundations of lightweight partitions
d., on a screed
e., on RC screed
c., on RC slab

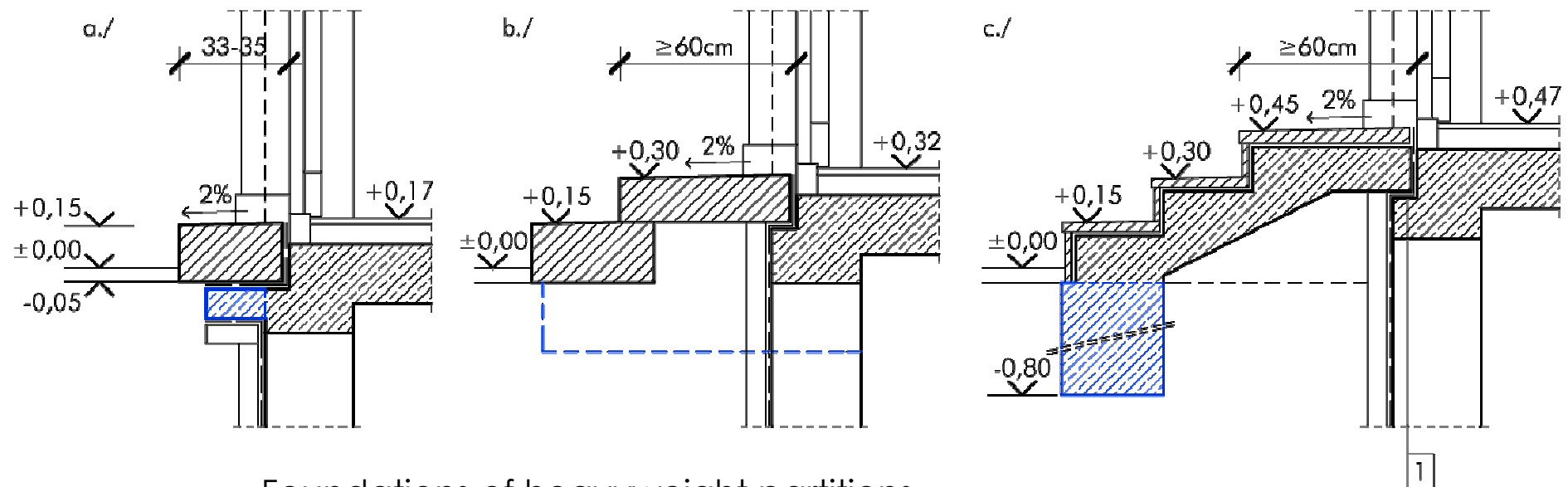
FOUNDATION ALTERNATIVES OF PARTITION WALLS



Foundations of heavyweight partitions
a., on a with foundation strip
b., on a prefabricated RC beam
c., partition on a RC beam

Foundations of lightweight partitions
d., on a screed
e., on RC screed
c., on RC slab

FOUNDATION ALTERNATIVES OF DOORSTEPS



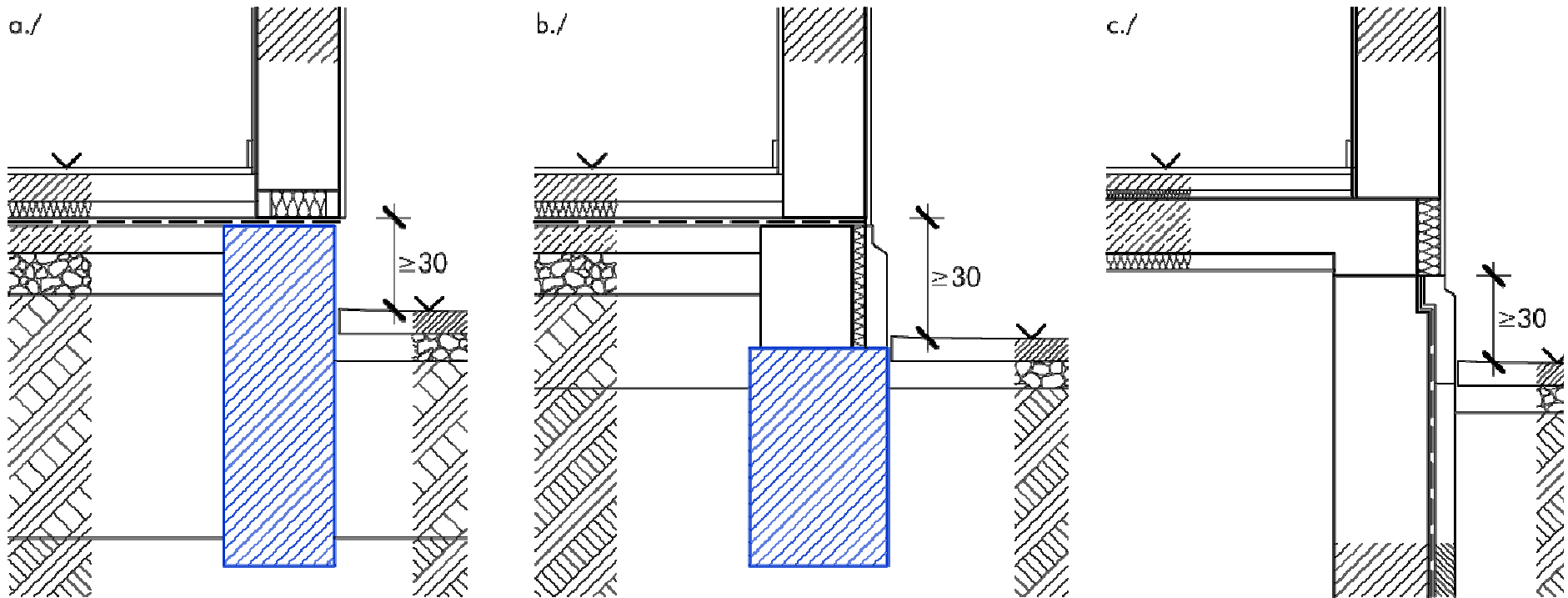
Foundations of heavyweight partitions

a., foundation of one step with cantilevered slab

b., foundation of two steps with cantilever beams

c., foundation of more than two steps with foundation strip

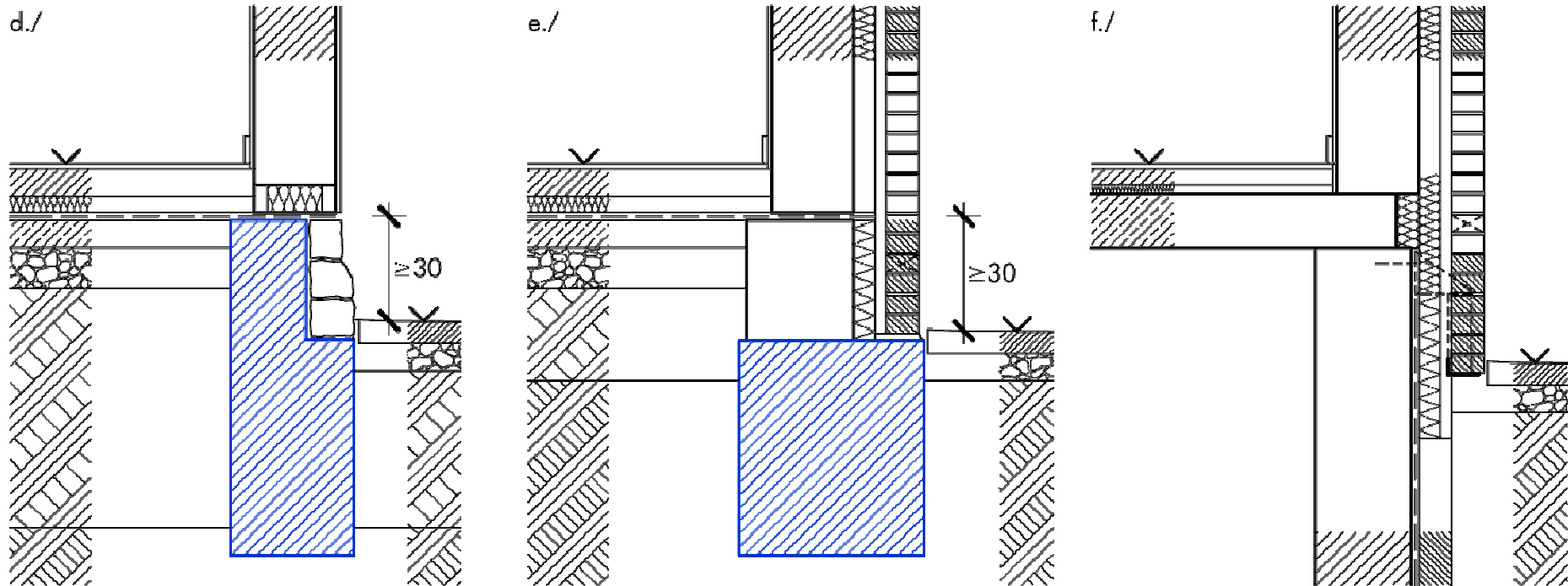
FOOTING ALTERNATIVES (WITHOUT BASEMENT)



Without basement:
a., concrete
b., artificial stone

With basement:
c., artificial stone

FOOTING ALTERNATIVES (WITHOUT BASEMENT)



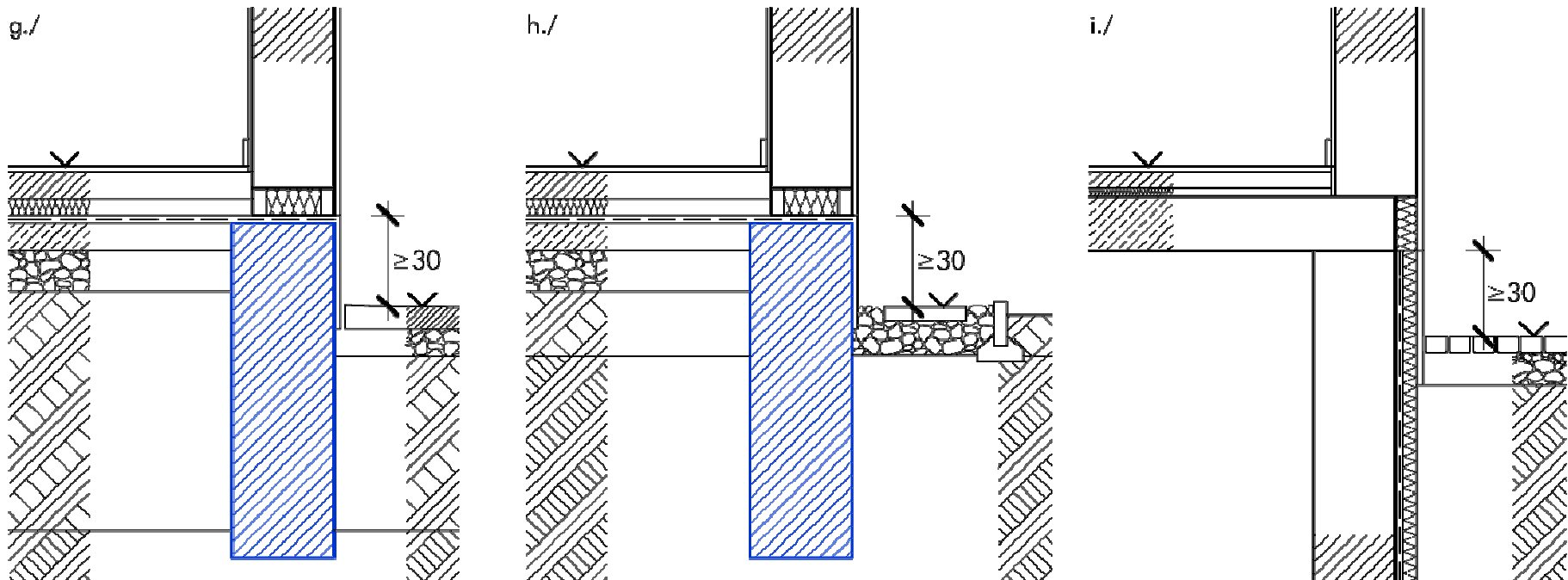
Without basement:
d., natural stone
e., brick

With basement:
f., brick

FOOTING ALTERNATIVES (STONE, BRICK)



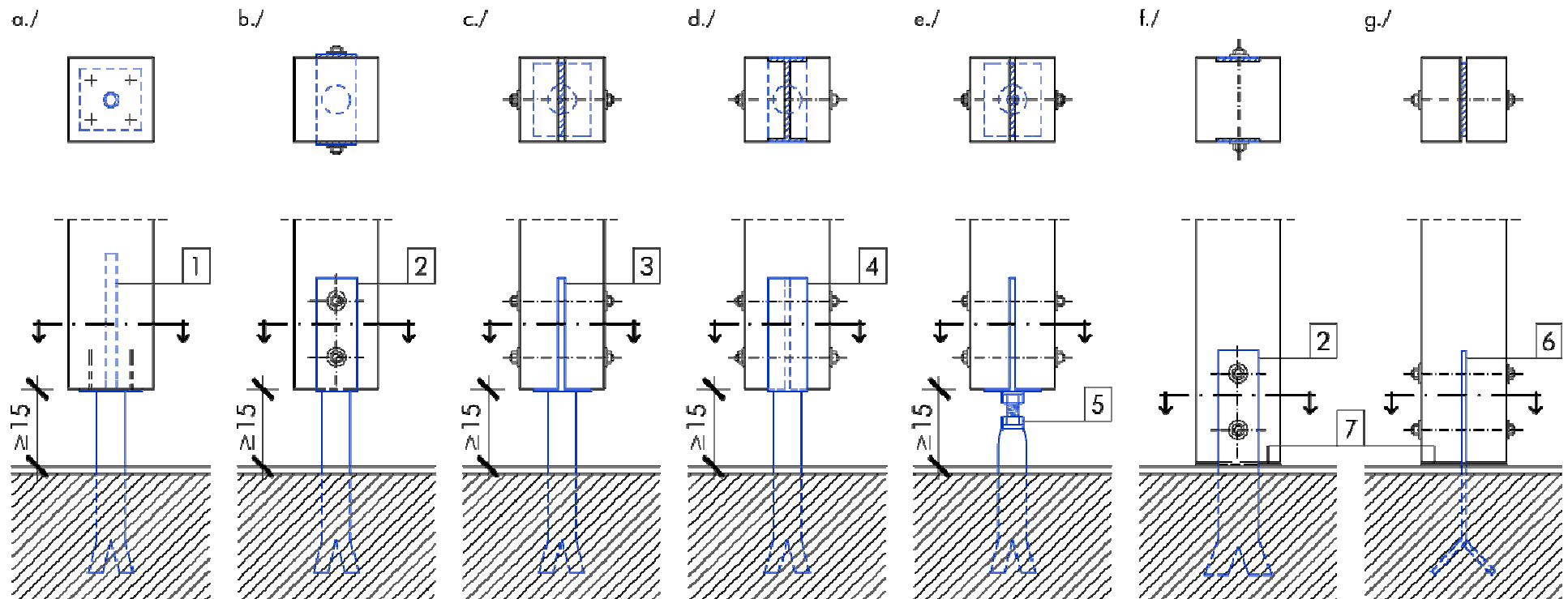
FOOTING ALTERNATIVES (WITHOUT BASEMENT)



Without basement:
g., h frostproof plastering

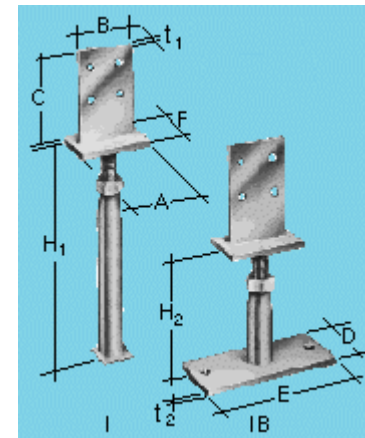
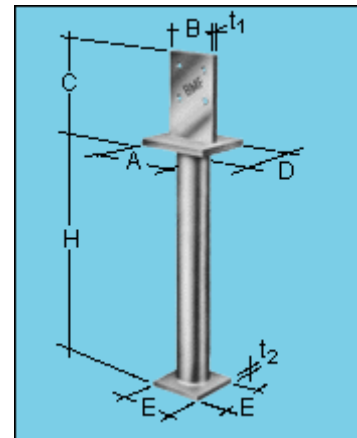
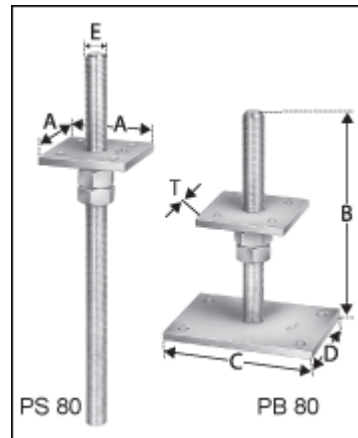
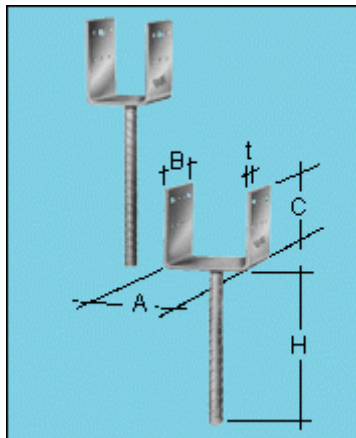
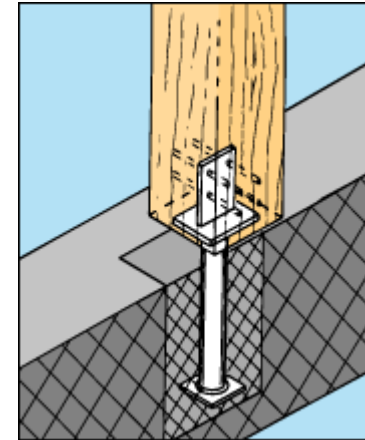
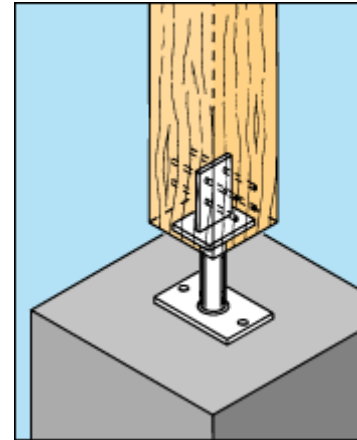
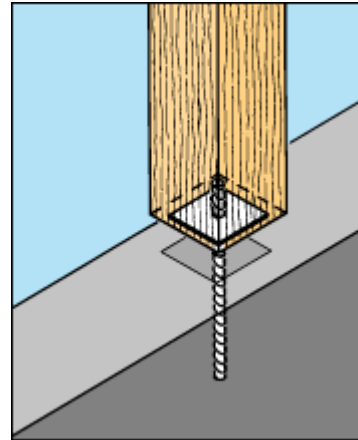
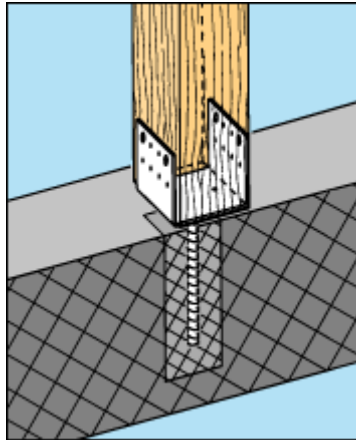
With basement:
i., frostproof plastering

FOUNDATION ALTERNATIVES OF TIMBER PIERS

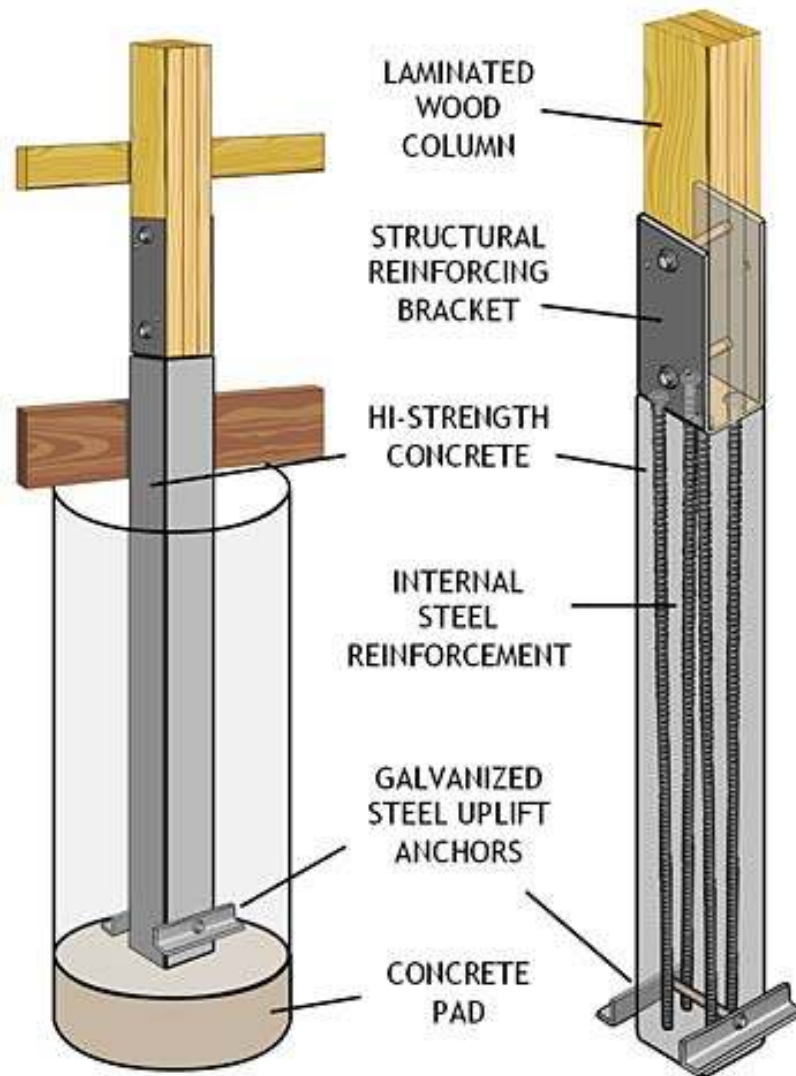


a, b, c, d, e: outdoor; f, g : indoor

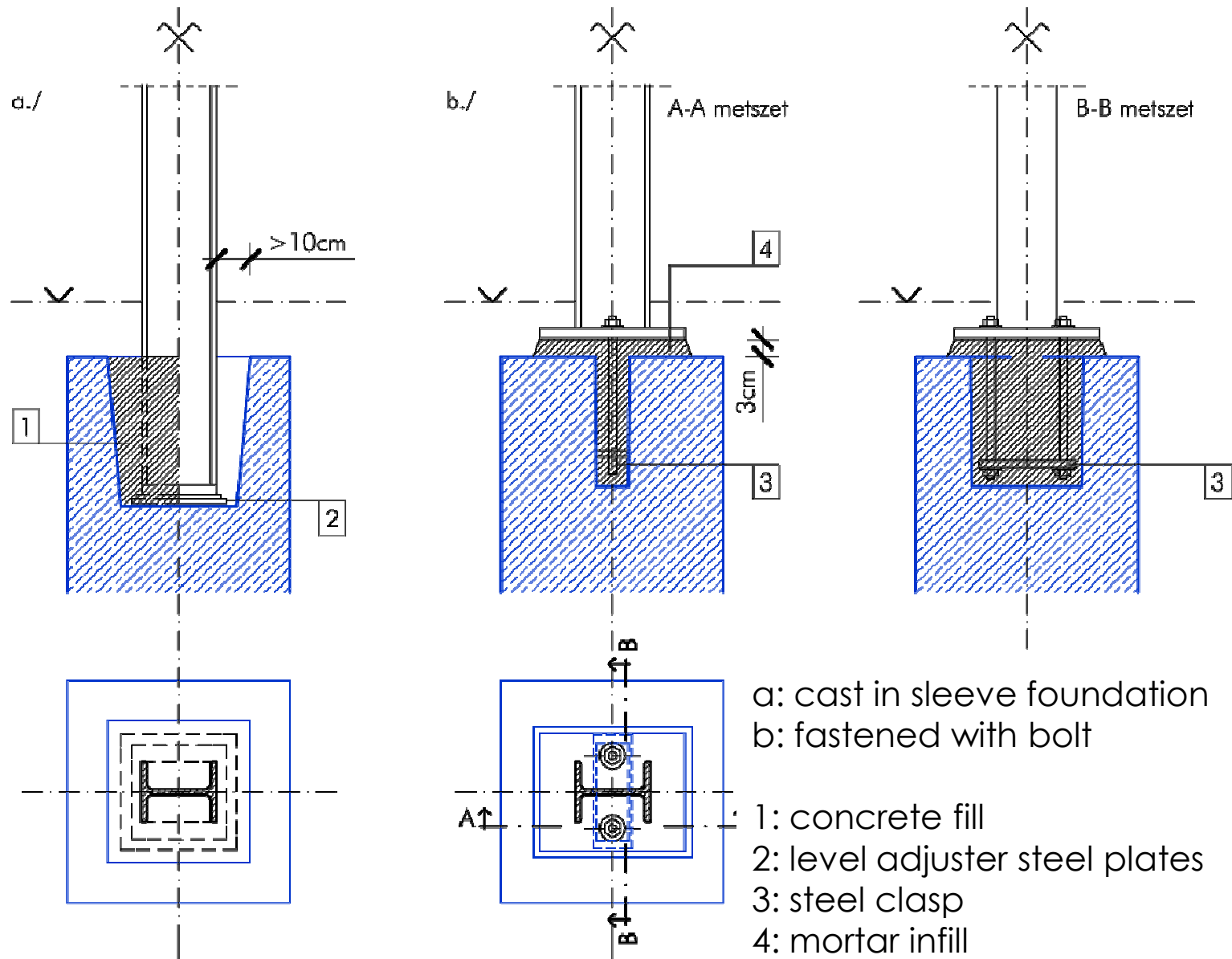
FOUNDATION ALTERNATIVES OF TIMBER PIERS



SPECIAL HI-STRENGHT CONCRETE FOUNDATION FOR TIMBER PIERS



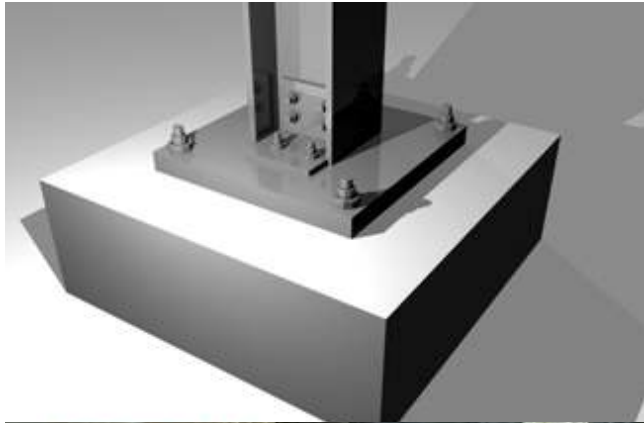
FOUNDATION ALTERNATIVES OF STEEL PIERS



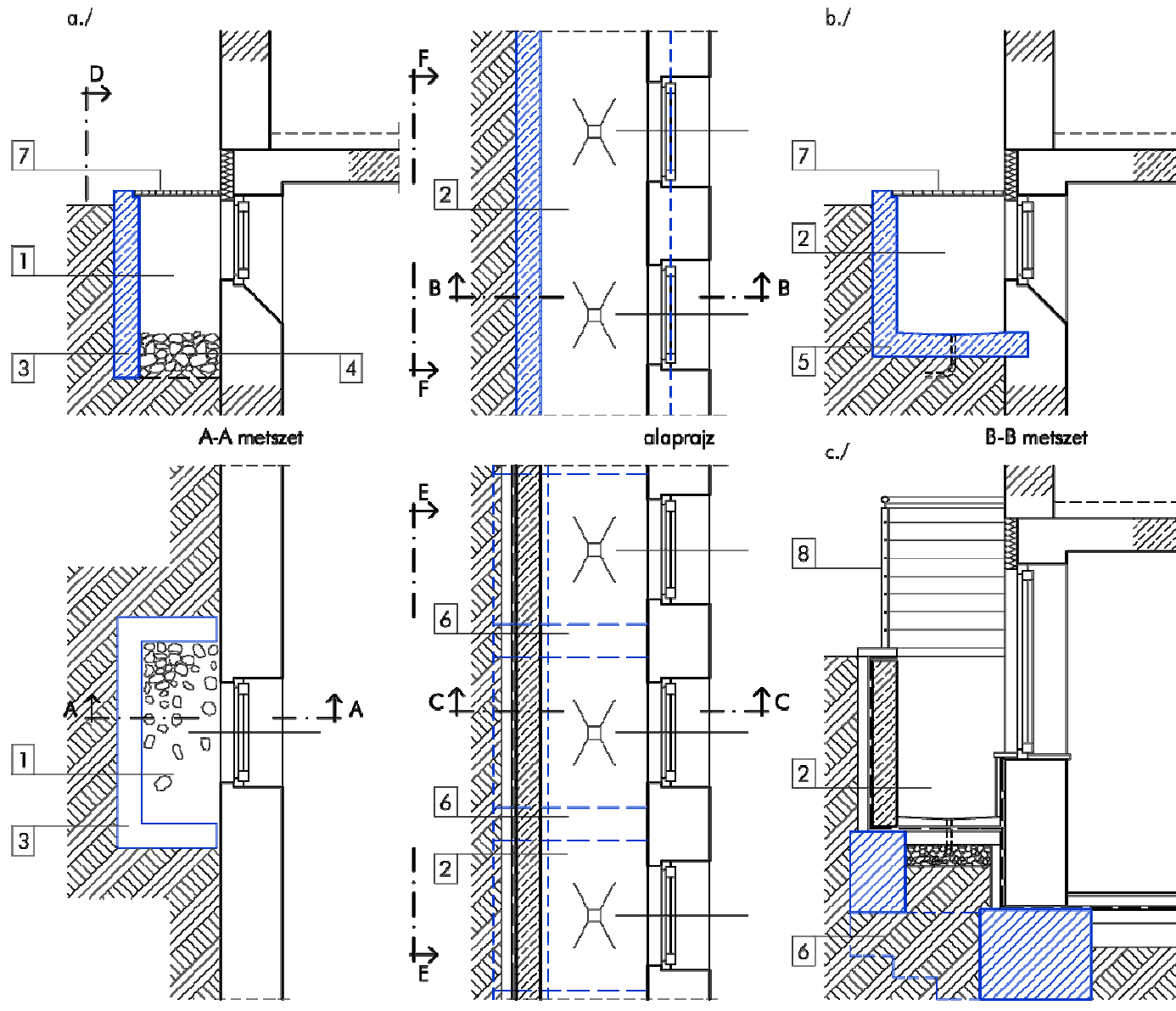
FOUNDATION OF STEEL PIERS



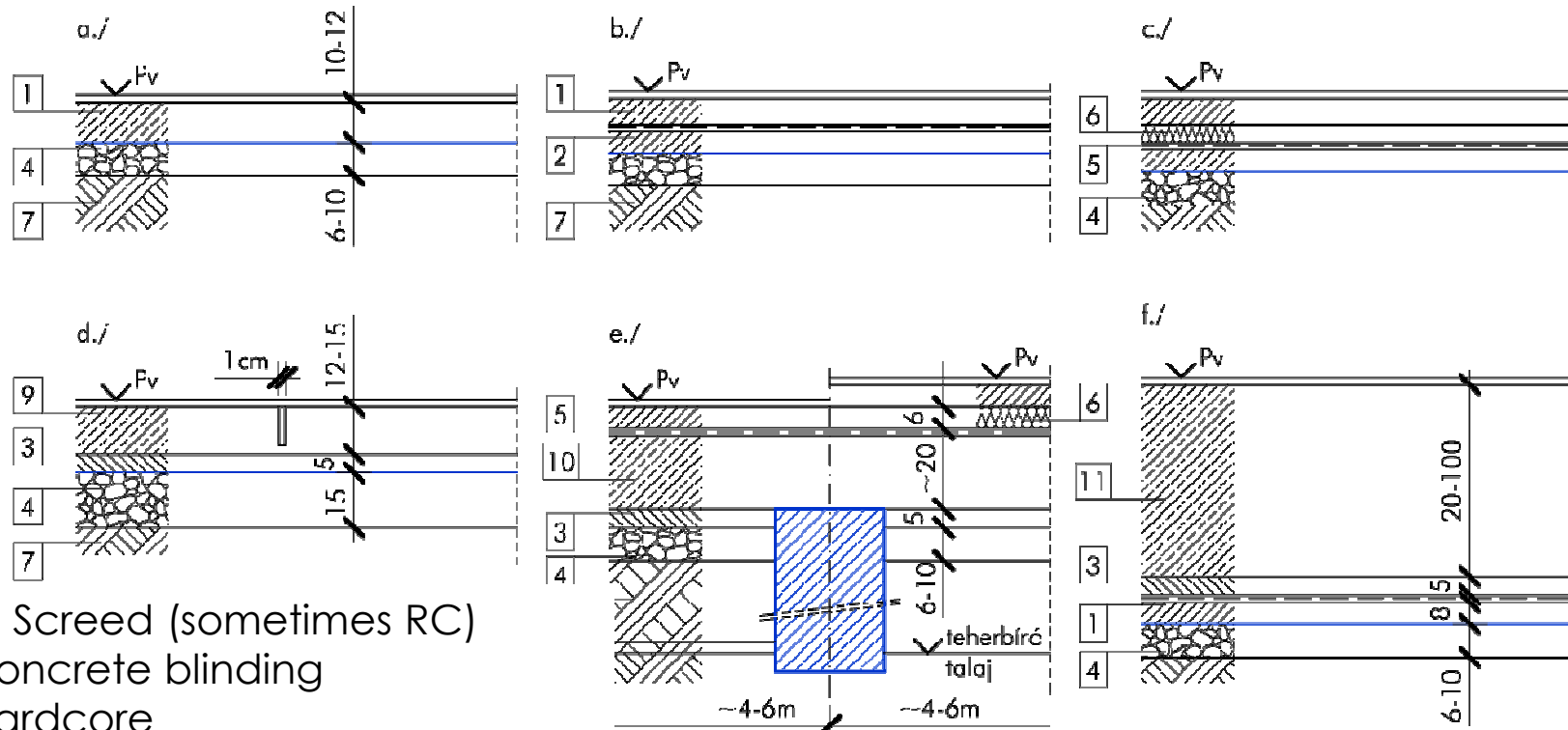
FOUNDATION OF STEEL PIERS



AIR/LIGHTING SHAFTS



FLOOR CONSTRUCTIONS ON THE SOIL



1, 2: Screed (sometimes RC)

3: concrete blinding

4: hardcore

5: waterproofing

6: thermal insulation

7: loadbearing soil

8: soil backfill

9: RC slab on subsoil

10: RC slab on RC foundation beam

11: RC slab or loading concrete

12: foundation strip

Floor constructions on the ground

a., floor covering is not sensitive against water

b., floor construction with waterproofing

c., like b., but with thermal insulation

d., outdoor floor construction (terrace)

e., floor construction of a hall for high loads

f., floor construction in case of high subsoil water pressure

CONSTRUCTION OF A STRIP FOUNDATION

