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Dr. Becker Gábor

Introduction to Building Constructions

Building Physics
Structural Systems

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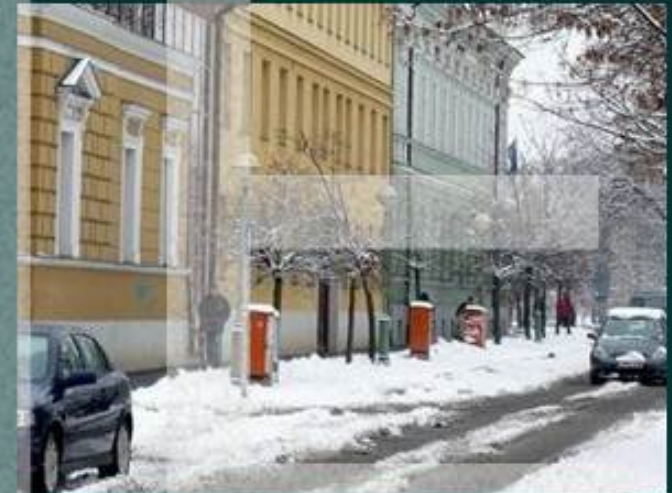


Budapest University of Technology and Economics
Faculty of Architecture  Department of Building Constructions

Energy efficiency and heat protection

Effects: winter-summer

winter heat protection: thermal insulation +
using the sun's energy



summer heat protection: to prevent overheating
+ shading (but assure an
adequate light influx!)



effects

general requirements – energy conservation and heat protection

the tasks of thermal insulation



why conserve energy?

- 40-50 % of european energy consumption is related to the use and/or construction of buildings
- our energy sources are limited
- heating related environmentally harmful emissions are to be reduced

the tasks of the architect

defensive

- the use of smaller openings,
- insulated border structures

cost effective

- large glass panels, big heat storage capacity, shading and ventilation in the summer, water surfaces
- the use of renewable energy sources



architectural tasks of energy conservation

general requirements – energy conservation and heat protection

with intensive thermal insulation



- to assure a warm interior
- to reduce heat-loss



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with the use of renewable energy sources



- solar: solar collectors, solar panel systems
- wind energy
- geothermal energy

these may be built into existing structures !



the reduction of building energy consumption general
requirements – energy conservation heat protection – **architectural tools**



selecting the right orientation



with the use of solar spaces



(traditional solution)

with the use of high mass boundary structures (walls, roofs)



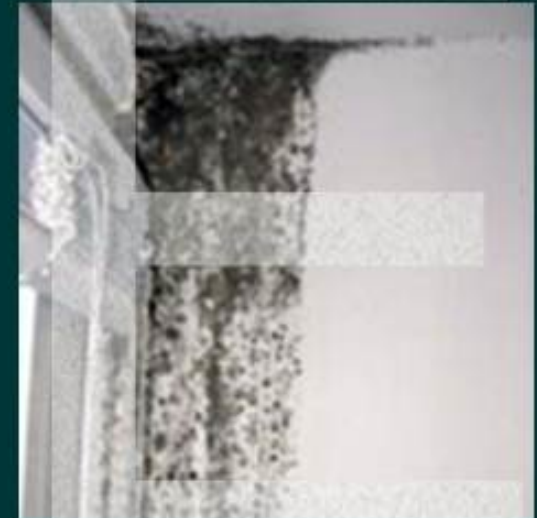
modern applications

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the reduction of building energy consumption general
requirements – energy conservation heat protection – **architectural tools**

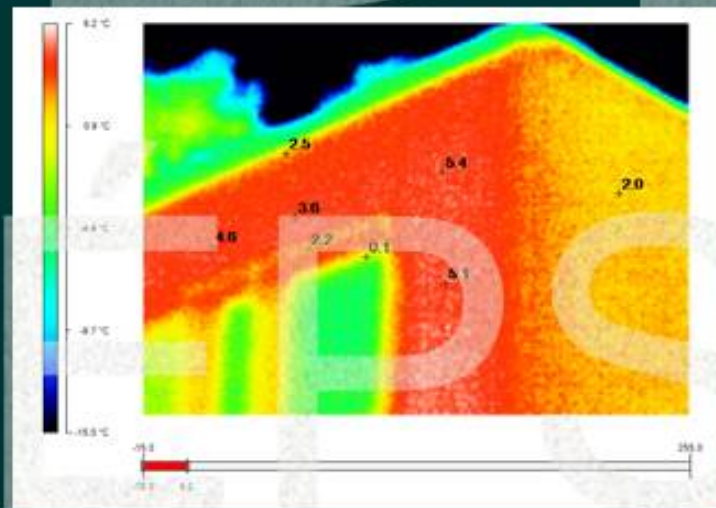
dew may condense on the cold surfaces of closed spaces



thermal insulation and condensation
requirements – energy conservation and heat protection – **relationships**



surface temperature



the results of condensation

- the reduction of thermal insulation cap.
- mildew

the prevention of condensation

- intensive, calculated thermal insulation
- adequate airspace and ventilation



thermal insulation and condensation
requirements – energy conservation and heat-loss protection – relations

Structural Systems

spot-type support



pillar frame structures

(pillar: condensed, spot-like
wall structure)



linear support



wall structures

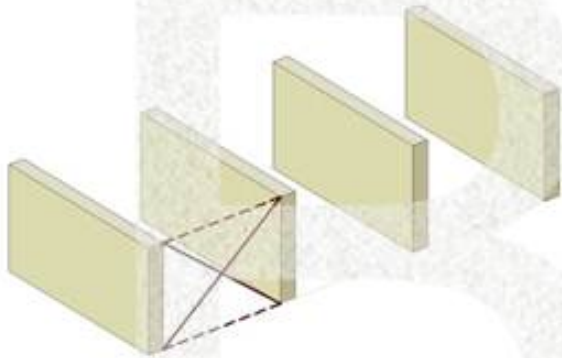
(wall: expanded, line-type
pillar structure)



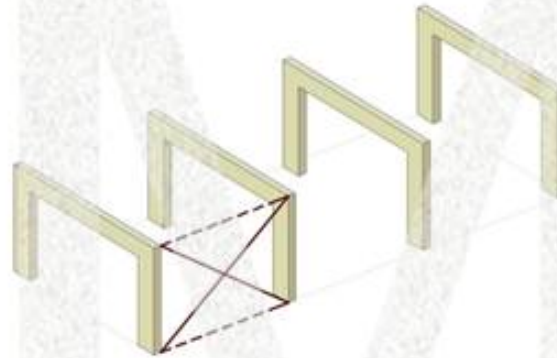
structural systems

structural systems - walls, pillar frames, slabs

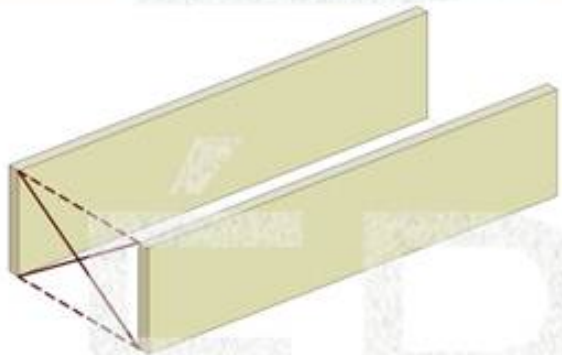
structural systems



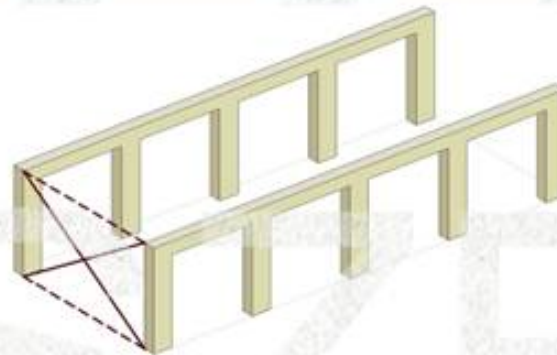
cross-wall



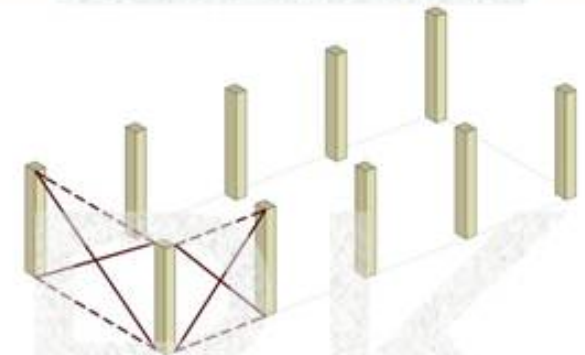
cross-frame



longitudinal wall



longitudinal frame



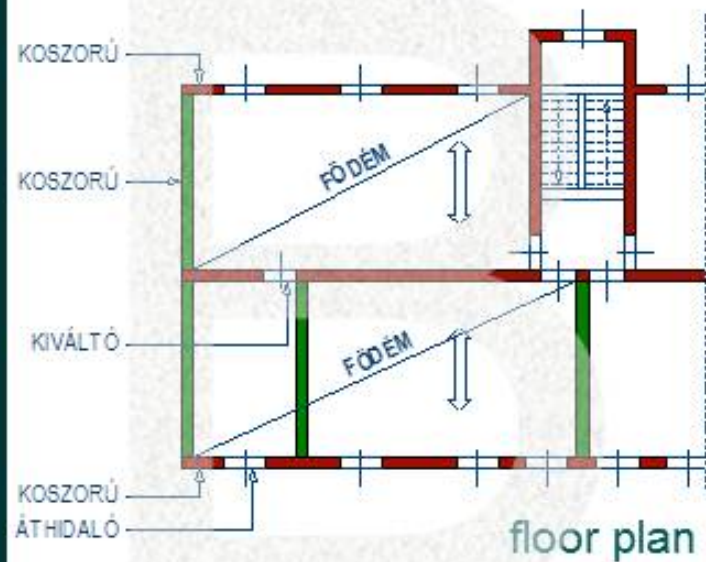
uniform



structural systems

structural systems - walls, pillar frames, slabs

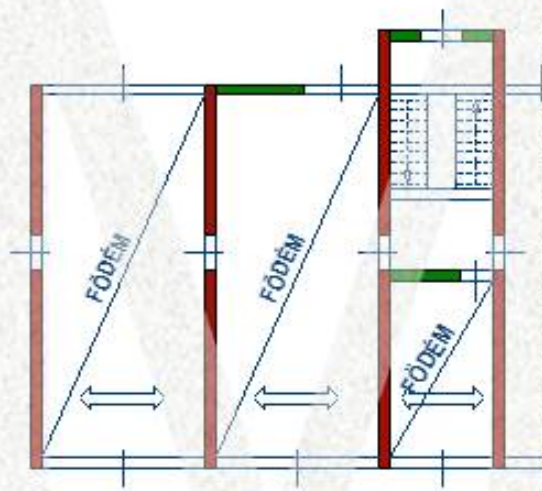
longitudinal wall



crosss-section

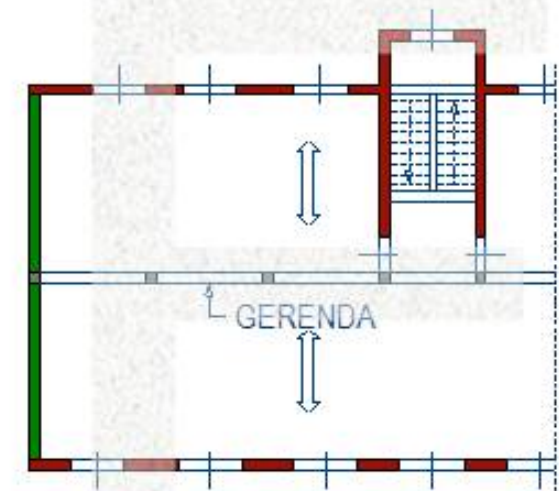
TEHERHORDÓ FAL
(MEREVÍTŐ FAL (ÖNHORDÓ

cross wall



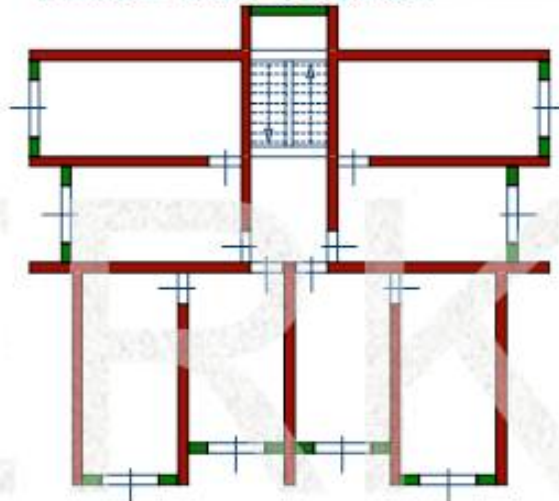
TEHERHORDÓ FAL
(MEREVÍTŐ FAL (ÖNHORDÓ

mixed



mixed wall-frame solution

mixed wall solution



wall systems

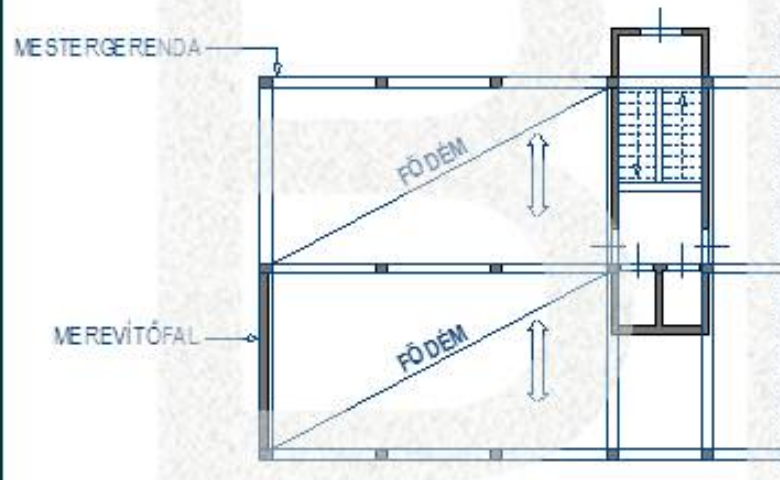
structural systems - walls, pillar frames, slabs



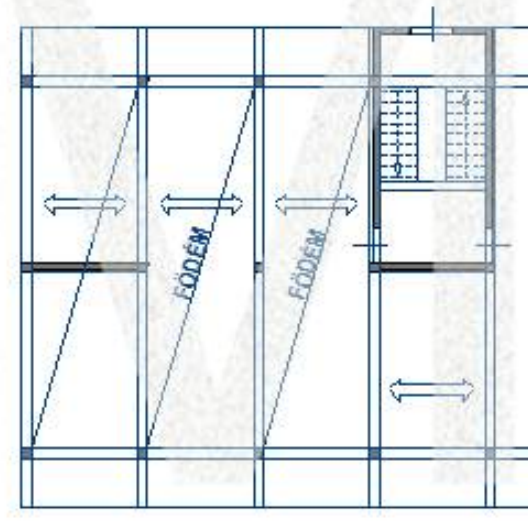
longitudinal-frame

cross-frame

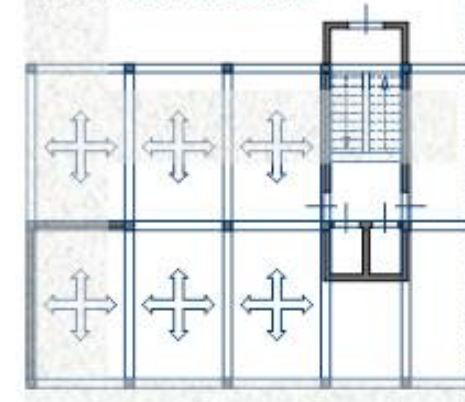
mixed



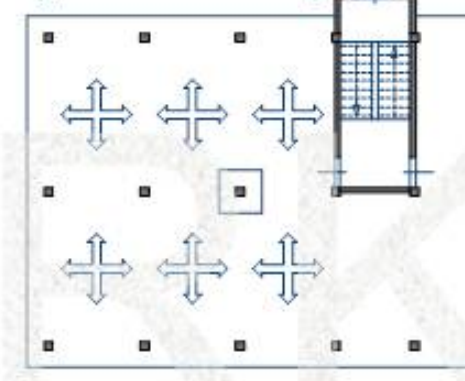
floor plan



uniform frame



level slab („mushroom” pillar heads)



cross-section



pillar frame systems

structural systems - walls, pillar frames, slabs

pillar frames

materials

- reinforced concrete
- steel
- wood

technology

on-site, pre-fabricated
assembled
assembled

walls

material

- stone
- brick, ceramic blocks
- concrete

monolit, előregyártott,



technology

laid
laid

on-site, pre-fabricated

semi-prefabricated

stone walls



pillar frames, walls

structural systems - walls, pillar frames, slabs



site manufactured r.c. frame
multi-story



pre-fabricated r.c. frames



concrete frames
structural systems - walls, pillar frames - frames



steel frames



site man. r.c.
+ steel



steel frames

structural systems - walls, pillar frames - frames

fa váz



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wood + site
manufactured
concrete frame



wood frames

structural systems - walls, pillar frames - frames

stone

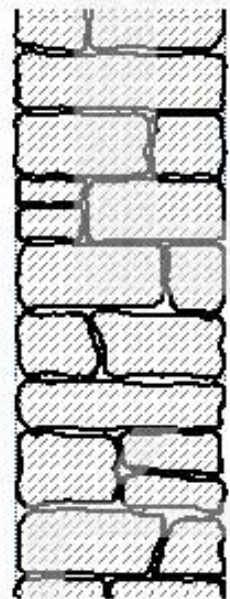
brick

blocks

light concrete

concrete

r.c.



typical thicknesses

50~

25-38-51-64

30-38-44

30~

20~

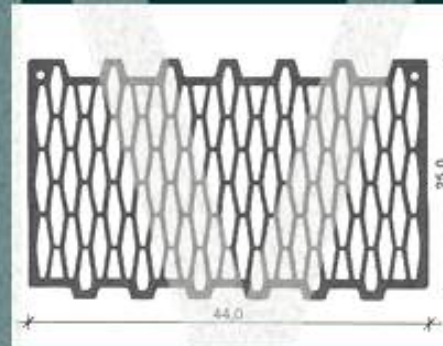
15~

wall materials and thicknesses relation
structural systems - walls, pillar frames - walls





brick



ceramic blocks



bricklaying



brick and other ceramic walls
structural systems - walls, pillar frames - walls

site manufactured (monolithic) r.c. wall

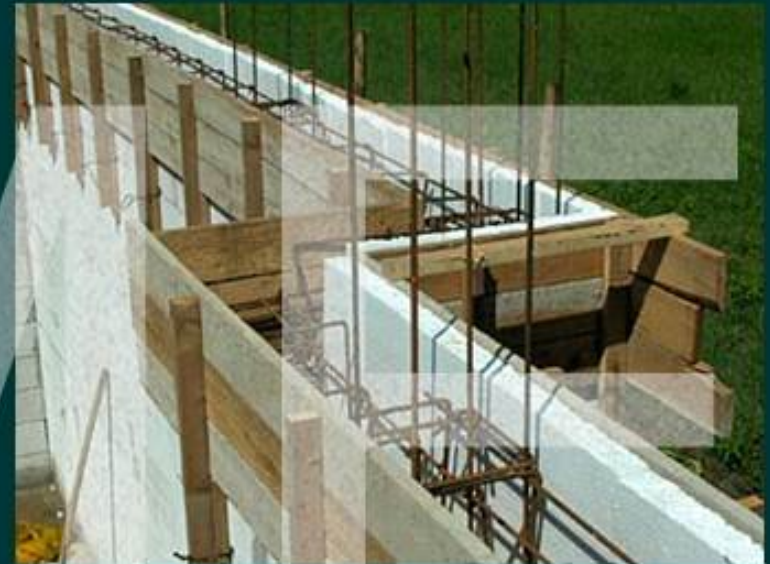


concrete casting element,
r.c. wall



r.c. walls and pillars
structural systems - walls, pillar frames - walls

ring beam steel inlays

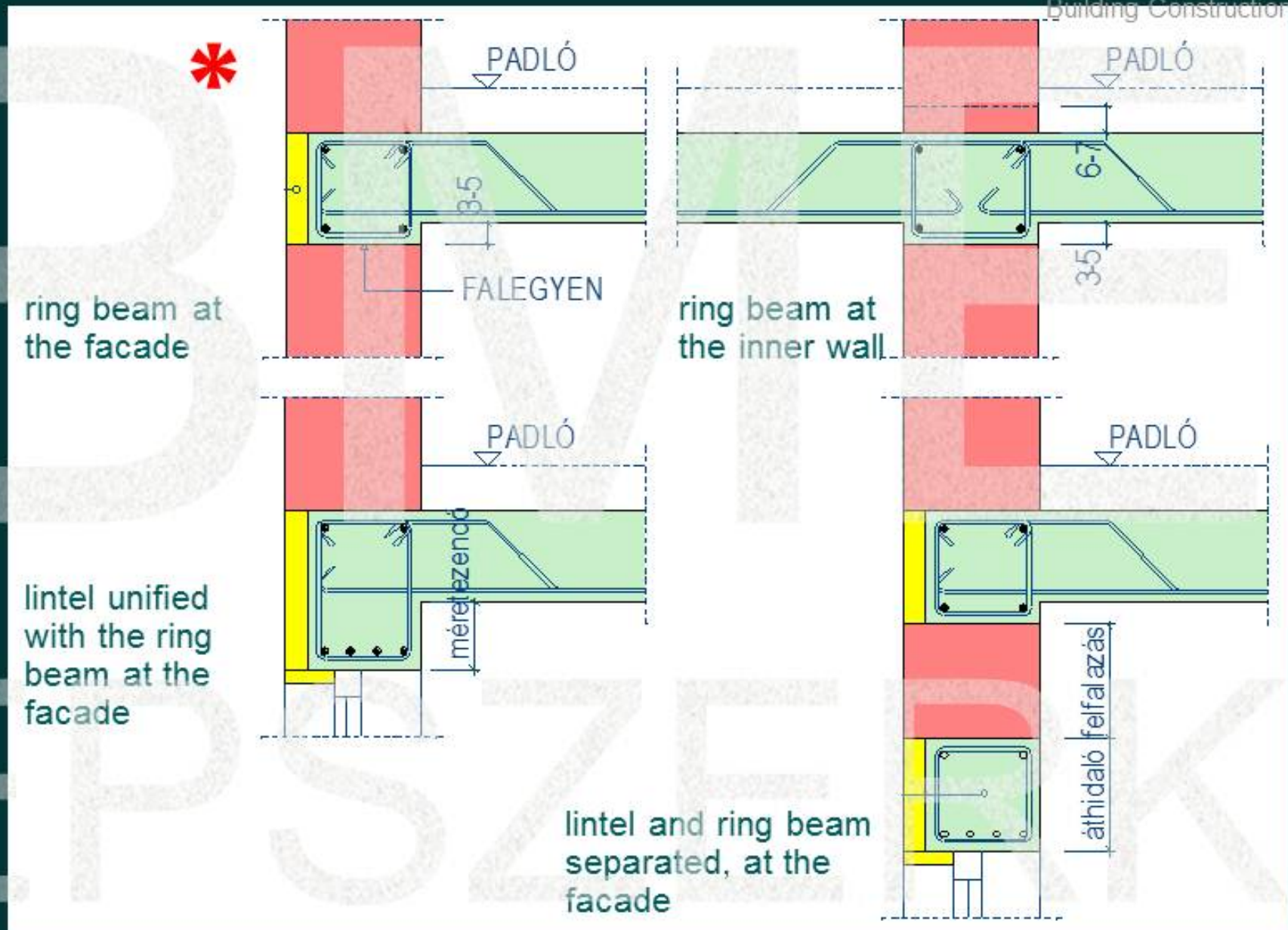


ring beams and lintels on the facade



lintels, ring beams

structural systems - walls, pillar frames – wall lintels and reinforcements




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Introduction to Building Constructions

Slabs, Stairs

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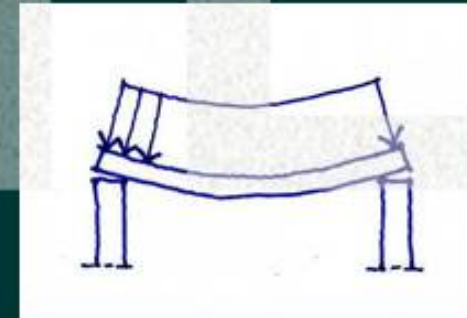
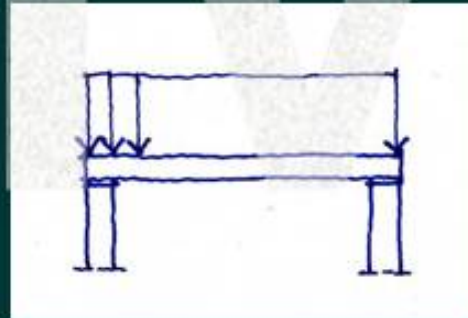
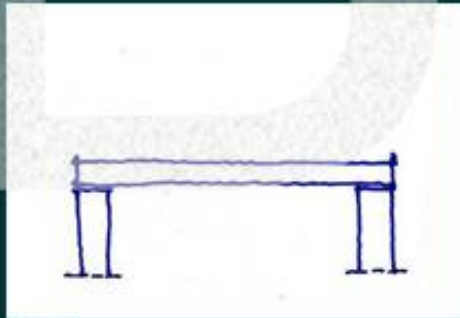
task (function): horizontal separation → load bearing

effect → resulting forces → requirement → **structure**
weight → bending → load bearing → bent, level **slabs**

space separation:
noise
temperature (cold, hot)

(rigidity against bending)

noise insulation → noise insulator (structure) construction
hőszigetelés → thermal insulation in the construction



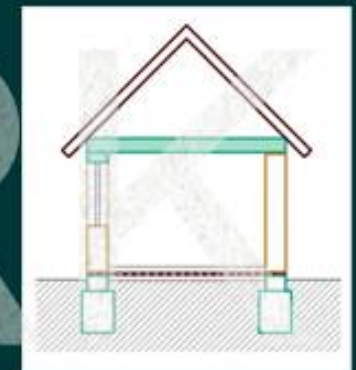
bending → **strength against tension** as material requirement

material

- r.c.
- steel
- wood

technology

site manufactured, semi-pre-fabricated,
assembled
assembled



slabs

slabs – function, operation, materials, technology



wood slab on loam wall



plank cover on the wood slab



wood slab on wall and r.c. beam singular wood slab



segmental masonry slab



trapezoid sheet slab



thin profile steel beam slab



trapezoid sheet slab



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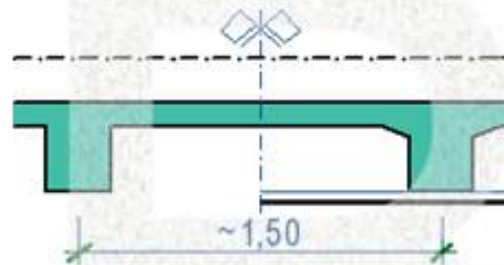


steel slab structures
slabs – assembled slabs

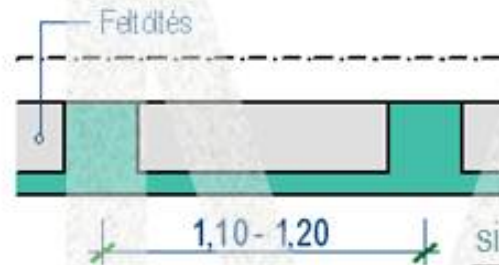
site manufactured r.c. (monolithic) slab

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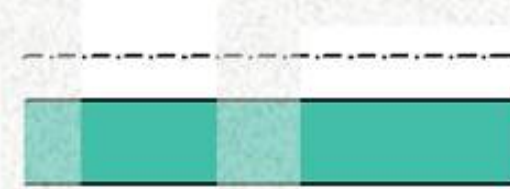
ALULBORDÁS FÖDÉM



FELÜLBORDÁS FÖDÉM



SÍK FÖDÉM



pre-fabricated r.c. slab

FÖDÉMPANEL



FÖDÉMPALLÓ



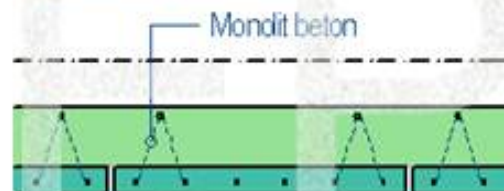
GERENDA-BÉLÉSTESTES FÖDÉM



sizes	slab	beam
r.c.	L/30, min. 8cm	L/15 - L/20
steel, pre-tension	L/40 - L/45	L/30 - L/40
r.c.		

semi-pre-fabricated (semi-monolithic) r.c. slab

ZSALLIZÓ KÉREGPANEL



GERENDA-BÉLÉSTESTES FÖDÉM



slab-plank



vasbeton födémek fajtái
födémek – vasbeton födémek

supporting structure



forming the pillar



steelwork (with integrated tubing)



pouring the concrete (with pumps)



top-bottom level, site manufactured r.c. slab
slabs – site manufactured slabs



r.c. beams + concrete inlays, doubled beams

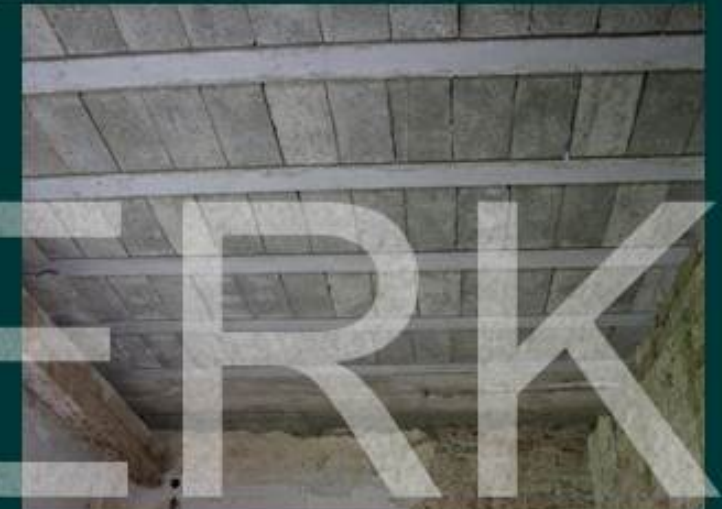
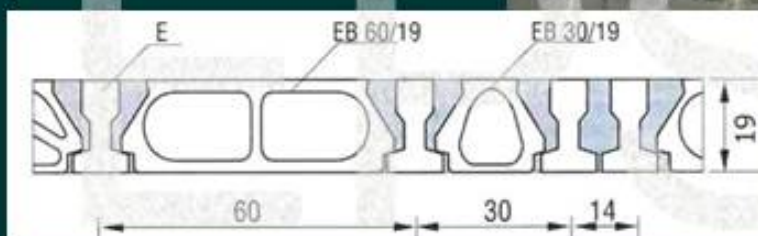


cross section



bottom view

bottom view, single beams

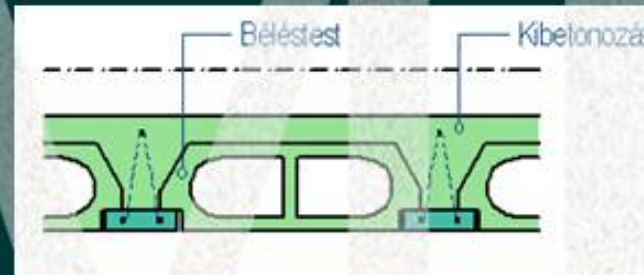


pre-fabricated, beam and inlay slabs
slabs – pre-fabricated slabs

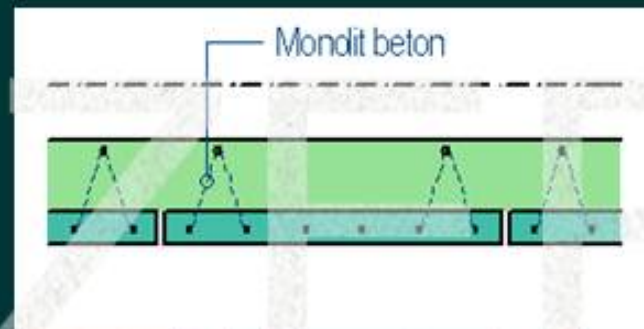




semi-monolithic beam and inlay slab



semi-monolithic crust panel slab

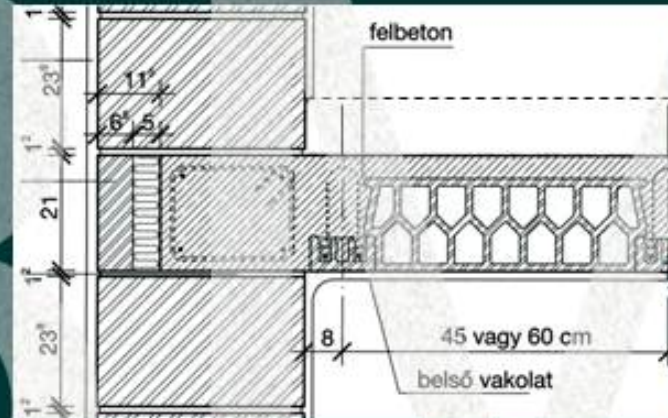


semi-site-manufactured (semi-monolithic) slabs

slabs – pre-fabricated slabs



ceramic inlay, semi-monolithic slabs

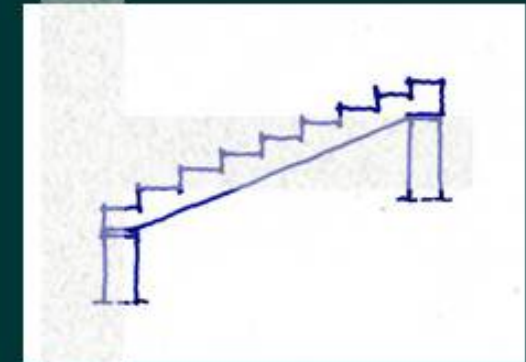
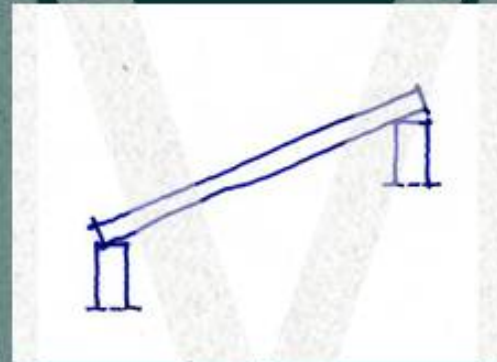
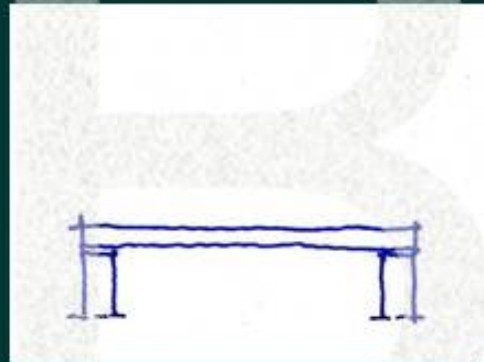


semi-pre-fabricated (semi-monolithic) beam and inlay slabs
slabs – pre-fabricated slabs

Stairs

task (function): vertical pedestrian traffic (between levels)

structure: tilted slab



drafting: from the geometry of steps

T = thread (depth)

R = riser (height)

R

T

$$2R + R = 60-63 \text{ cm} *$$

bending → materials with **tensile strength**

material

- r.c.
- steel, steel frame + steps
- wood

technology

site manufacturing, pre-fabrication, semi-pre-fabricated
assembled
assembled



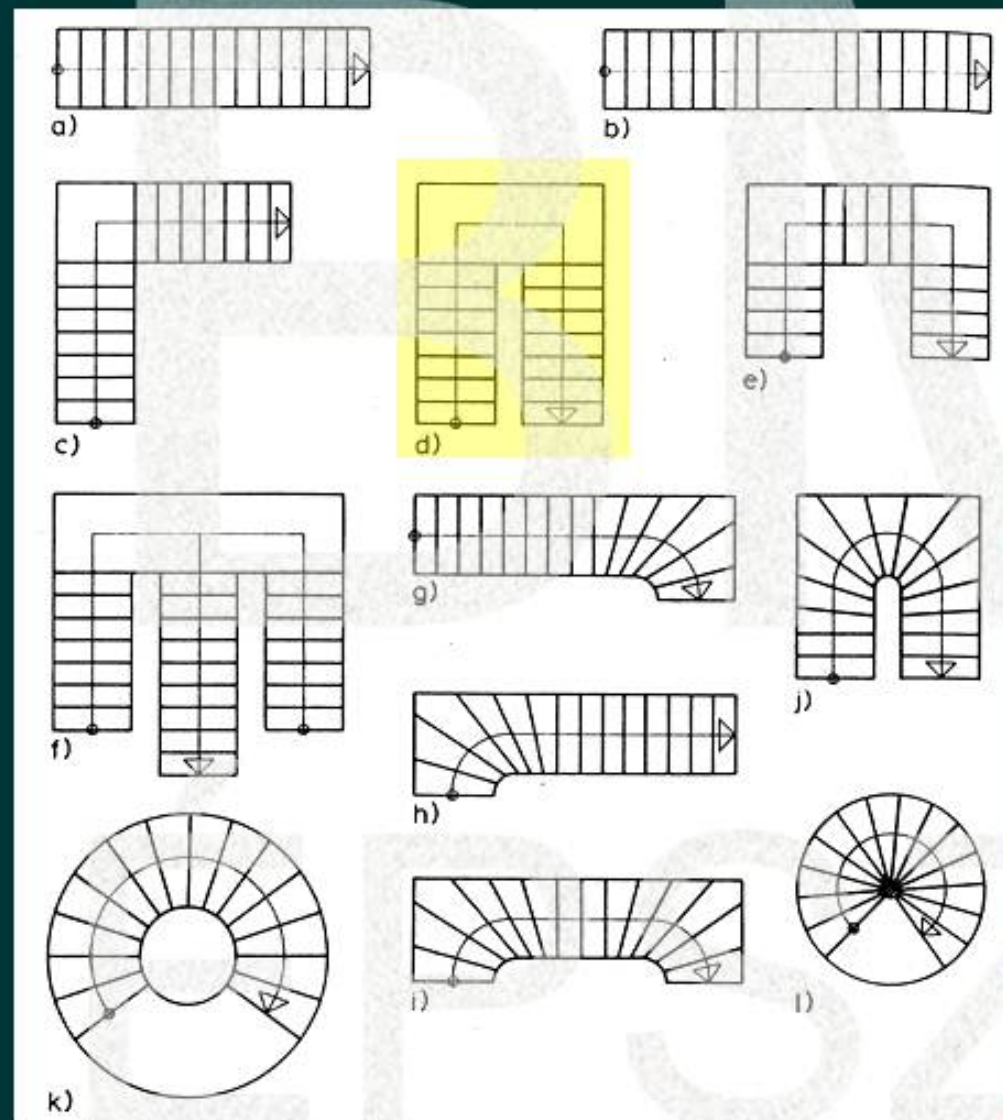
stairs

stairs – function, drafting, materials, technology

flight width: depends on the expression

- private: min. 80 cm
- apartment build.: min. 1,10 m

- a) straight, **single flight** stairs
- b) straight, **double flight** stairs with landing
- c) double flight, **L shaped** stairs with landing
- d) double flight, **U shaped** stairs with landing
- e) **triple flight** stairs with two landings
- f) **triple flight** stairs with one landing
- g-i) single flight, non-uniform step
- j) double flight, non-uniform step
- k) circular floorplan (spiral) stairs, with a central opening
- l) **spiral stairs**



stairs on the floorplan

stairs – drafting on the floorplan alaprajzi szerkesztés

where to use which?

- wood – in the interior, mostly in apartments (fire protection!)
- steel – interior, industrial, light weight (fire protection!)
- r.c. – public function: residential - community, outside, general use



interior stairs

stairs – relationship between function and materials' selection



steel stairs

stairs – relationship between function and materials' selection



r.c. stairs: **surface materials**



- stone, art. stone, ceramics
- pvc, rubber, carpet, wood

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monolithic outer stairs



pre-fabricated and site-manufactured stairs
stairs – r.c. stairs





artificial stone with rubber thread

steel structured stair in a public use



monolithic r.c. stairs



stairs in public use

stairs – relationship between function and materials' selection

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Introduction to Building Constructions

Foundation, waterproofings

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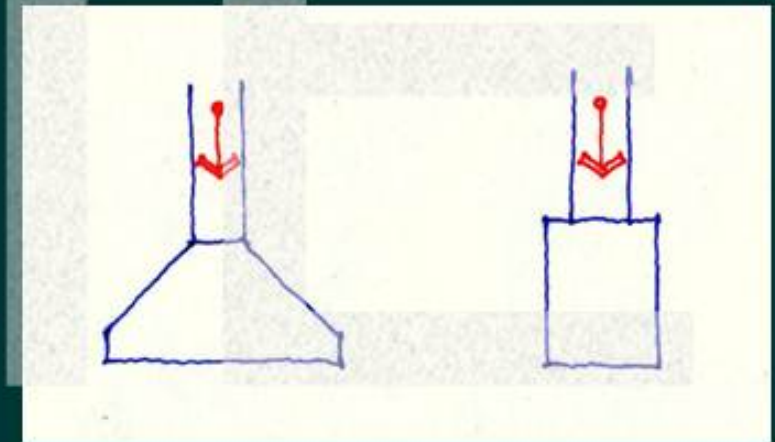
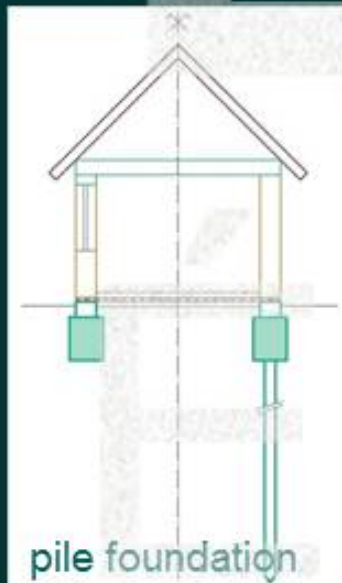
task (function): to transfer loads to the soil

effect → resulting forces → requirements → **structure**
loads → pressure → load bearing → **foundation**
(compression strength)

loss of stability
(wall, pillar → soil)

↓
increased surfaces

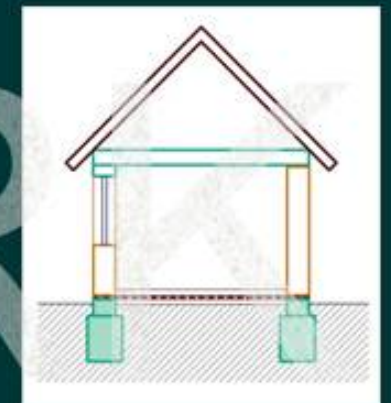
surface/depth foundation



if the load bearing soil is near the
building: **surface foundation**

if the load bearing soil is far: **deep f.**
deep foundations:

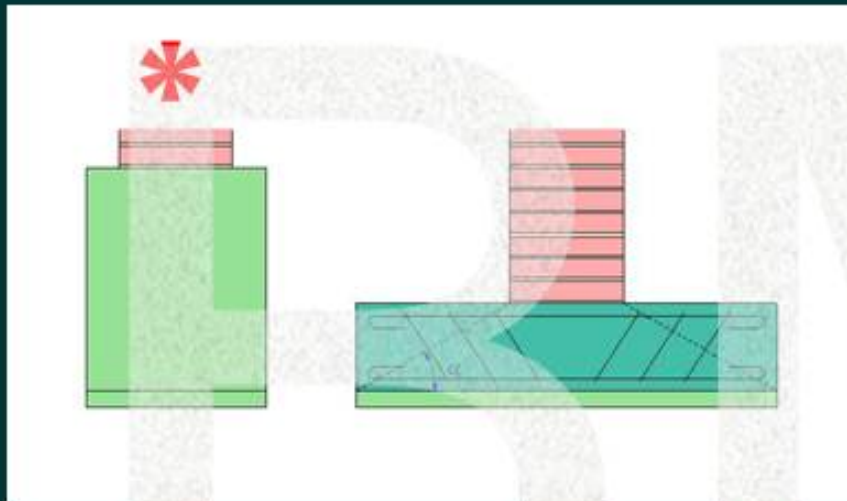
- piles
- slurry wall
- well foundation




foundations – terminology

foundations, insulations– terminology – **surface and depth foundations**



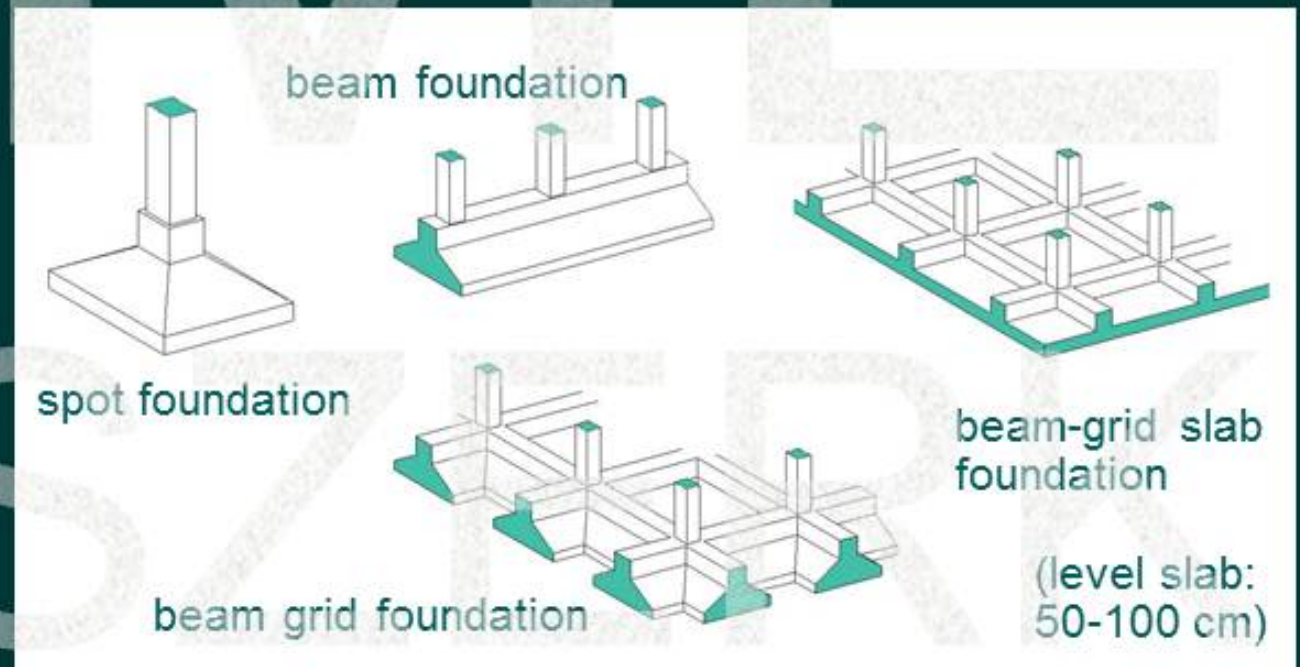
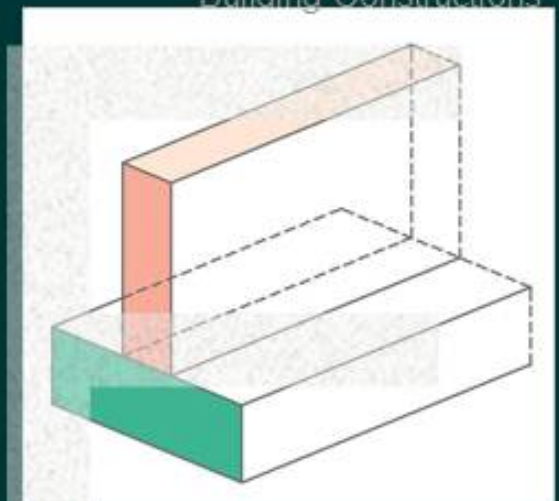
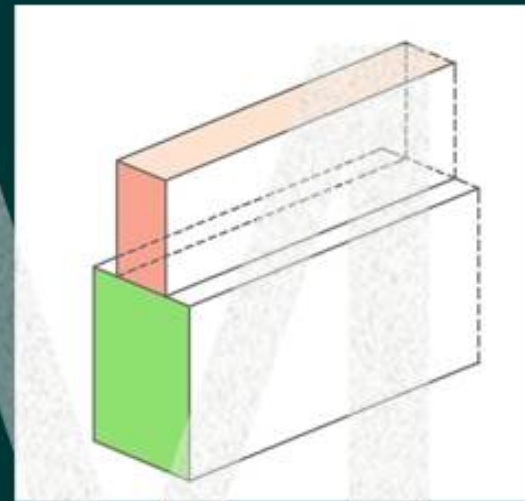


concrete and r.c.
strip foundation
(width: 45-100 cm)

the foundation **level** is  defined by:

- the location of the load bearing soil
- the level of the frost barrier

r.c. foundations



surface foundations
foundations, insulation – main foundation types

Insulation against ground water

task (function): to keep dampness away from the building
to assure comfort levels, to prevent deterioration

effect → resulting force → requirement → **structure**
dampness → water deterioration → impregnation → **waterproofing**
(humidity, dampness, water) (waterproofing)

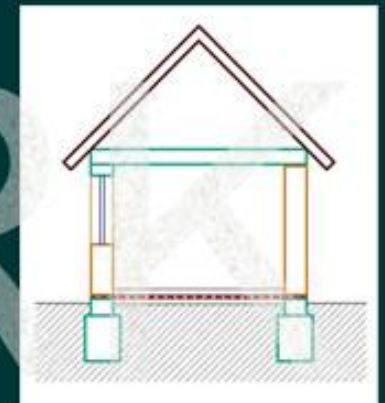
water **effects**:



- ground water (coherent water in the ground)
- dampness (water droplets inbetween soil particles)
- water vapour (evaporation from ground wetness)

performance **categories**:

- **waterproof** (heightened water resistance)
- **water resistant**



waterproofing terminology

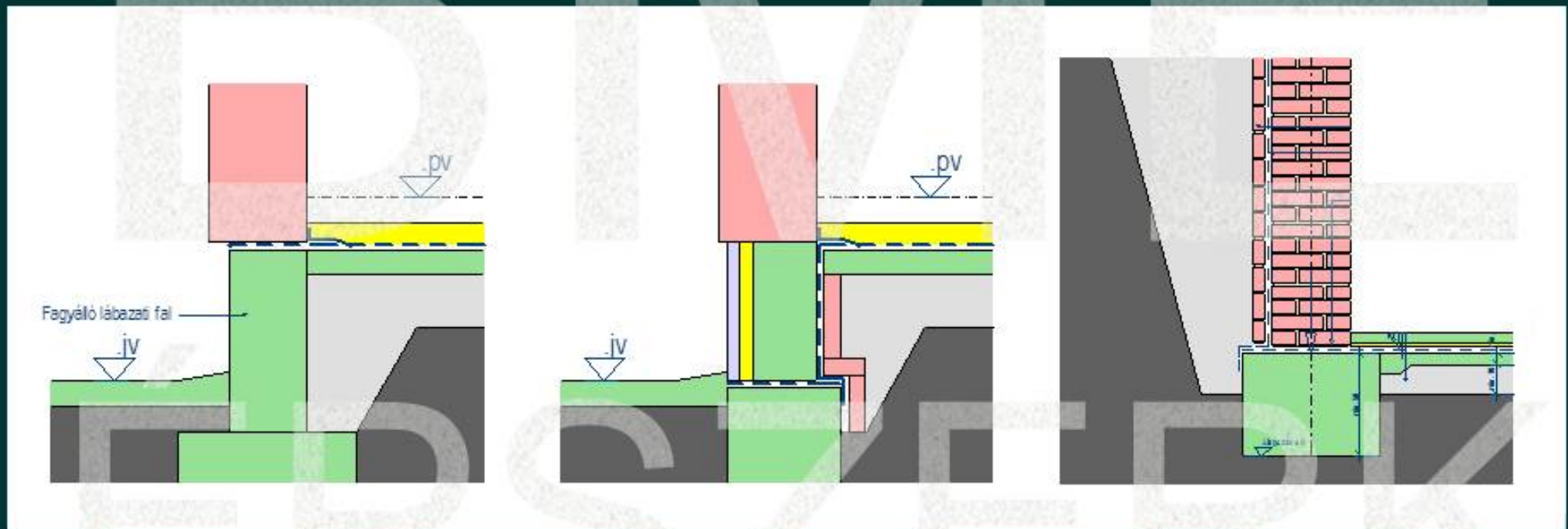
foundations, insulation – **insulation** against wetness from the ground

the waterproofing line must be **continuous** on the whole surface concerned
and it must be **protected**!



insulation of the footing

insulation of the basement



footing wall is frostproof

footing wall is insulated

the connection of the wall



waterproofing footings and basements

foundations, insulation – the geometry and protection of water insulations



horizontal, wall insulation against dampness from the ground

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soilwork, foundations, wall waterproofing

foundations, insulation – fabrication stages





vertical wall waterproofing (basement)
foundations, insulation – fabrication stages

slabs

bent structures → materials must possess tensile strength

- steel, wood, r.c. **materials** in slabs
- **monolithic (site manufactured)** r.c. slab sizes
- **pre-fabricated** and **semi-pre-fabricated** r.c. slabs

stairs

tilted slabs intended for vertical traffic

- stair step **geometry rules**
- **floor plan** variations
- wood, steel, r.c. stairs – relationship between function and material
- the surface material of the stairs

foundations – waterproofings

- **surface** (strip, beam, slab) and depth **foundations**
- effects of ground wetness: ground**water**, ground**dampness**, ground**vapour**
- performance levels: **waterproof**, water resistant
- insulation **geometry** and **protection**



Summary

slabs – stairs – foundations, insulation



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