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BUILDING CONSTRUCTIONS 1

Floor structures 1: timber, steel and reinforced concrete floors

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groupings of floors (their load-bearing structures) by

- material
- technology
- structural design
- static scheme
- reinforcement
- position within the building

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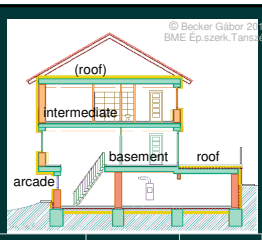


material	technology	structure
RC concrete	monolith, semi-monolith prefab.	slab, row of beams, beam
steel	mounted	beam
timber	mounted	row of beams, beam
brick, stone	masonry	vault

statical scheme	reinforcement	position
one-way load-bearing	mild steel bars	roof
two-way load-bearing	pre-stressed	basement
dual supported	post-stressed	intermediate
Multiple support		arcade

flat floors

traditional floors: timber floors, steel beam floors

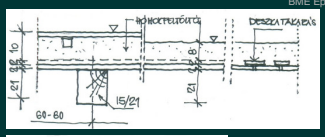
timber floors

today it is the structure of timber buildings, typically weekend houses and cottages, but also used in residential buildings (until 1920 the majority of the closing floors was timber)

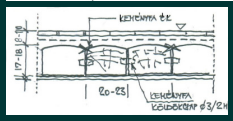
material: ● larch (resin content),
● oak (> bending strength), 600-800 kg/m³
strength: parallel to the fibers, the compressive and bending strength is greater, 130 kp/cm²
timber deformation: shrinkage (drying), swelling (moisture absorption)
design and reconstruction issues: support, rotting, fungus, worm/fire protection

cut from logs

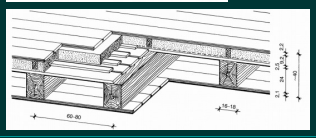
"cheap" floor



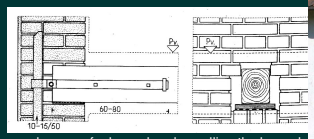
dowelled beam floor



covered beam floor



timber floor details



anchorage of a beam head to walled iron plate

walling the beam he (underlaying, ventil

evaluation

- holding the walls together is ensured by tie
- co-working of timber floors (except dowelle is difficult to be solved
- they are vibration-sensitive
- with a min. 8 cm thick filling of incombustible material they are moderately fire-resistant
- despite their small self-weight (due to the layered construction), their airborne sound insulation is favorable,
- hard floors of sanitary rooms (e.g. bathrooms) must be insulated!

historical timber floors

historical overview – timber floors – historical floor structures

steel beam floors

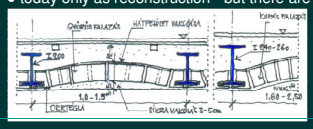
- rarely in residential buildings, more often in public, mostly in industrial buildings,
  typically used in steel-framed construction systems (halls)
- approx. until 1920, used as an intermediate floor of residential buildings (Chambered vault)
- material: hot rolled steel beams, I and U profile

design issues:

- fire and corrosion protection of the beams must be provided,
- joints - welded: rigid, moment-resistant, screwed: dismountable

Cambered arch floor - floor with steel beams and brick vaults

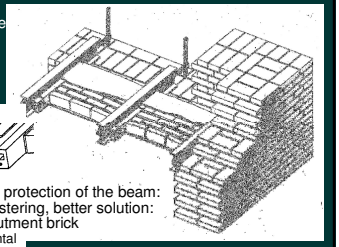
- historical floor, the sections between the beams are bricked as barrel vaults
- today only as reconstruction - but there are many of them



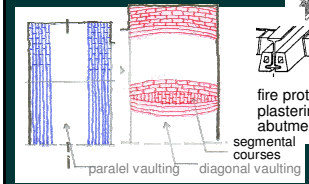
Cambered vaults

historical overview – steel beam floors

- 1,00-1,30 m axis distance → from below, the slab can be plastered to flat plane; larger span is plastered in curve
- vault between beams
- taking the lateral pressure of the side vaults: tie rod, RC slab;
- equalization of lateral pressure during construction: all fields are constructed at the same time
- co-working: thin cement mortar top-filling



fire protection of the beam: plastering, better solution: abutment brick



segmental courses

paralel vaulting

diagonal vaulting

anchorage of a beam head to walled iron plate, side fields with tie rod

Cambered vaults 2

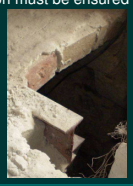
historical overview – steel beam floors

evaluation

steel beam floors:

- holding the walls together is ensured by tie rods
- are solid, medium durable, vibration-sensitive structures,
- co-working of structural elements should be ensured (e.g. with top-filling mortar),
- multiple support scheme → beams running over two tracts
- with a min. 8 cm thick filling of incombustible material they are moderately fire-resistant,
- moisture and corrosion-sensitive → their protection must be ensured





monolithic reinforced concrete floors

history: - with the introduction of concrete technology, since the early 1900s
- initially between steel beams, constructed as bottom or top ribbed slabs

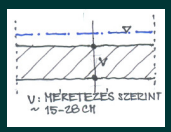
- constructed on site, concrete pouring after formwork preparation and reinforcement laying
- material: concrete (due to the curved structure with C16, C20….C30 class, where "C" means the 28-day strength of the concrete, 16, 20…30 N/mm2
- advantage: homogeneous material, robust co-working structure, good soundproofing, ensuring multiple-support, favourable cross-sectional ratios
- disadvantage: high self-weight, expensive formwork, relatively long


reinforcement during placement

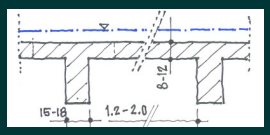

formwork during installation

type of monolithic reinforced concrete floors

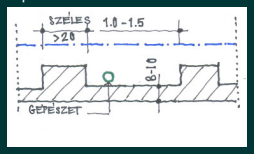
flat floor



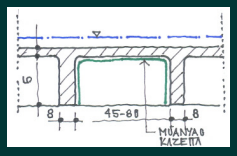
bottom-ribbed floor



top-ribbed floor



waffle slab

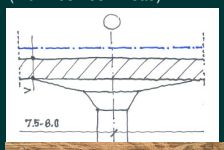


type of monolithic reinforced concrete floors

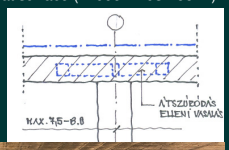
flat floor

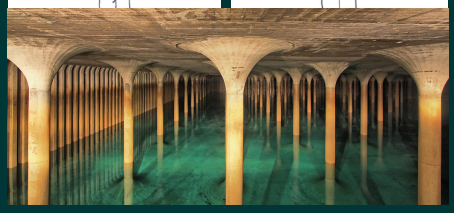
bottom-ribbed floor

mushroom slab
(with mushroom head)



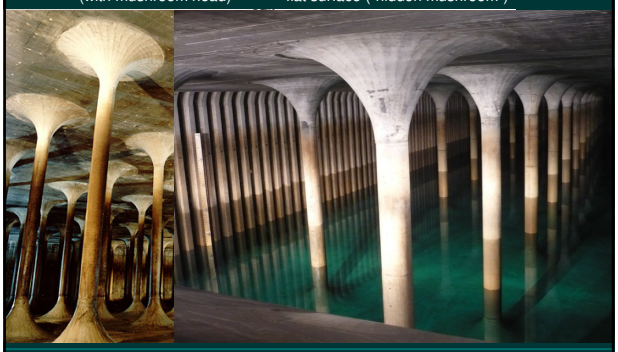
mushroom floor with top-to-bottom
flat surface ("hidden mushroom")

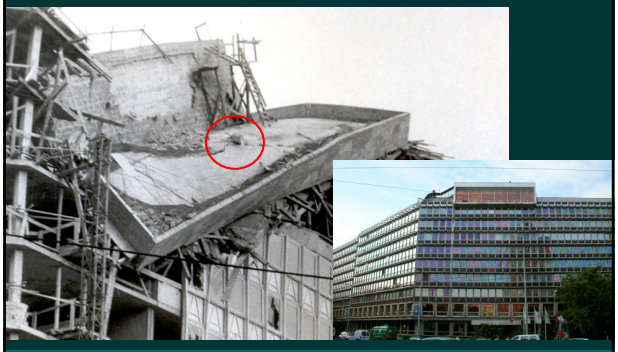




mushroom slab
(with mushroom head)

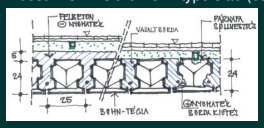
mushroom floor with top-to-bottom
flat surface ("hidden mushroom")

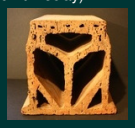


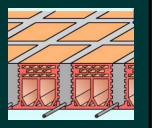


floors with closely placed ribs and ceramic elements

- dense, reinforced concrete ribs between the co-working loadable blocks (notched, ribbed side surface)
- increasing the compressed zone with concrete overlay
- increasing the positive moment with breaking out the rib of the block
- best known is the Bohn type slab (burnt fireclay)







lightened monolithic RC slabs

hollow block monolithic RC slab

recycled plastic

bubble deck slab

beam-fillerblock floors

- mass construction demand, development of the building industry and prefabrication
- introduction of size co-ordination and typization
- consisting of load-bearing beam and fillerblocks for transferring and distributing loads
- one-way, two-support beams (partially restrained)
- full load-bearing capacity is achieved after the concrete between the blocks and beams or the overlay concrete is hardened

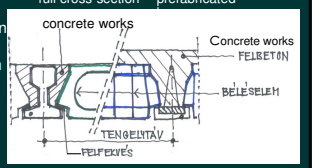
by the extent of prefabrication they can be:

- prefabricated in full cross-section (RC beam) and
- partially prefabricated

by their reinforcement

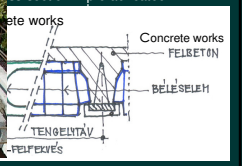
- mild and
- pre-stressed reinforcement

beam prefabricated in full cross-section | partially prefabricated



beam prefabricated in full cross-section

partially prefabricated



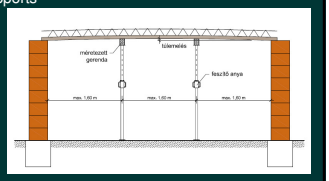
beam-block floors

RC concrete floors – prefabricated floors

design and installation (floors with beams and blocks)

supporting and over raising during construction

- during construction, the semi-prefabricated (ceramic profile) beams should be
  - supported – carrying a temporary load
  - over raised - reducing deflection (usually l /300)
- support
  - up to 2.50-3.20 m span one,
  - over 3.20 m two,
  - over 4.80-5.0 m three supports (product-specific, see application manuals!)

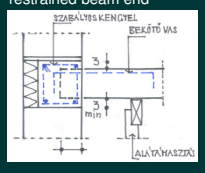


design and installation – temporary supporting

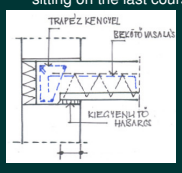
prefabricated floors - beams and filler blocks

ring beam - beam head joint

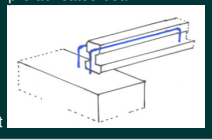
restrained beam end



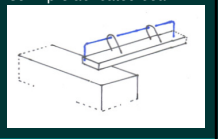
sitting on the last course of brick



prefabricated beam



semi-prefabricated beam



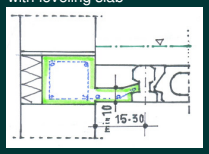
ring beam tie reinforcement

design and installation – ring beam

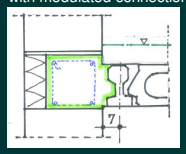
prefabricated floors - beams and filler blocks

beam position, ring beam connection parallel to the beams

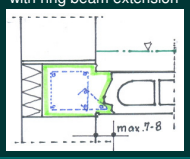
with leveling slab



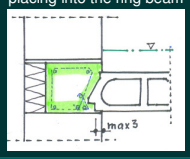
with modulated connection



with ring beam extension

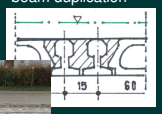


placing into the ring beam

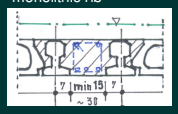


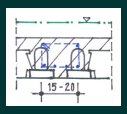
increasing options of load bearing capacity

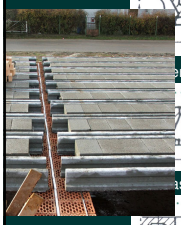
beam duplication



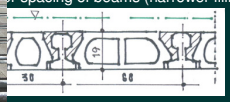
monolithic rib

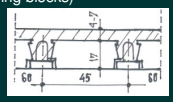






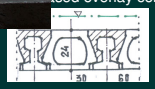
er spacing of beams (narrower filling blocks)

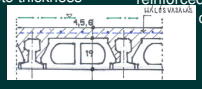




ased overlay concrete thickness

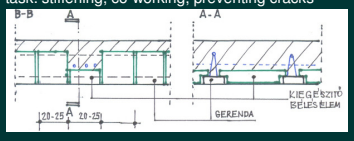
reinforced overlay concrete



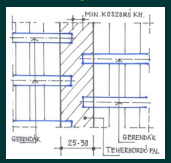


cross rib - stiffening rib

task: stiffening, co-working, preventing cracks



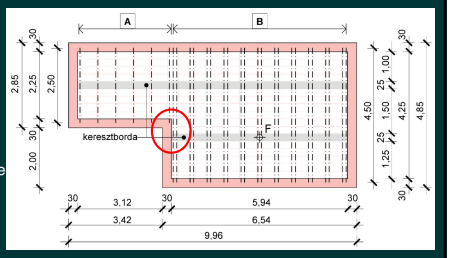
minimal ring beam on internal load bearing wall !!



number of stiffening ribs:
2.00-3.75 m span - 1
3.75-5.75 m span - 2
5.75-7.00 m span - 3
(product-specific, see application manuals!)

floor design

- load-bearing walls
- stiffening walls
- load-bearing direction
- span
- choice of structure
- (span check)
- loadb. capacity check determining the structure
- critical places: openings, shafts, partitions
- balcony, loggia
- beam arrangement
- detail plans



2.50 m span: single beam, 60 cm spacing

4.25 m span: double beam, 45 cm filler block

the plan serves only as an illustration, the right-hand floor is actually over-calculated by approx. double than needed

floors – flat floors – timber floors

today timbered small buildings, building parts; historical floor structures
material: larch, pine, oak – shrinkage, swelling
"cheap" floor, dowelled beam floor, covered beam floor
timber floor details: sitting, ventilation, anchoring
anchor irons, moisture-sensitive

steel beam floors

steel-framed buildings – high-rise public buildings, halls – historical structures
fire protection, corrosion protection, screwed (or riveted) connections

Cambered vault floor - floor with steel beams and brick vaults

- parallel or diagonal vaulting, cement mortar top filling

tie rods, corrosion sensitivity

monolithic reinforced concrete floors

flat slab floor, bottom-ribbed, top-ribbed, waffle and mushroom floor

floors with closely placed ribs and ceramic blocks – e.g. Bohn-type floor

lightened monolithic RC slabs: hollow section, bubble deck (with "balls")

beam-block floors

floors prefabricated in full cross section or partially

design and installation

ring beam - beam head joint: restrained, sitting on the last course of brick
ring beam tie reinforcement
beam spacing, connection to crown parallel to the beams
reinforcing options of floors: beam duplication, closer spacing of beams, monolithic rib, overlay concrete on top of beam, thicker and reinforced overlay concrete
stiffening rib: stiffening, co-working, preventing cracks

floor design dimensioning (from table), beam spacing, joints