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BUILDING CONSTRUCTIONS 1

Wall design, masonry structures

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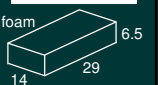
masonry structures, historical overview

- at the beginning thick, solid stone-mixed walls - strength is the primary consideration
- stone is expensive and cannot be found everywhere: rammed earth-dried, then fired brick - see in the Bible
- molded, fired: Mesopotamia, later Egypt
- fired bricks of various sizes: Rome →

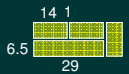
brick, masonry blocks

- fired clay elements: bricks, masonry blocks
- chemically produced elements: limestone, concrete, PS foam
- elements of natural materials: adobe bricks, wood chips



starting point is the old, large-size brick – its size is coordinated in three directions

masonry: structure made from bricks laid according to the walling rules and mortar



(wall - masonry: all masonry structures are walls but not all walls are masonry)

history, the brick
walls - wall design, masonry structures – overview

manufacture of bricks, clay building blocks

raw material: clay – group of sedimentary-eruptive rock

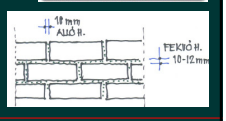
process:

- clay extraction, preparation (crushing + water), shaping – the purity of the clay is important: lime stains, efflorescence...
- adding additives for some walling blocks (increasing porosity and thermal insulation capacity, polystyrene beads, wood chips)
- sending through a press machine then a cutting machine
- drying and firing (950-1000 °C)

build up of bricks, the mortar

functions of mortar:

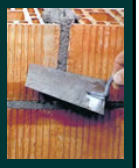
- connects construction elements
- levels the supporting planes
- fills the gaps (heat storage)
- even load transfer (horizontal or vertical joint)
- fixes, seals and bonds
- allows for dimension compensation



brick production and mortar
wall design, masonry structures – wall components

composition of the mortar:
binder + additive + mixing water
binder: slaked lime (CaOH2), for improved mortar + cement

additive: 0-3 mm rough and sharp mine sand (sieve-diagram)
function: when mixed with water and binder, the additive dilutes the mortar and provides needle-like crystals needed for binding



mixing water: sulphate-free pure soft water, function to ensure the workability of the mortar
way of binding can be: air-bind and water-bind

types of mortars: walling, rendering, coating mortar and mortar bed
walling mortar: denoted: H_i, can be H_3 – H_{100}
- lime mortar 0.3-1.0 N/mm² (4-10 kp/cm²)
- improved lime mortar 1.0-2.5 N/mm² (10-25 kp/cm²)
- cement mortar 2.5-10 N/mm² (25-100 kp/cm²)

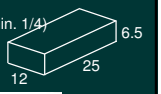
mortar composition (1m³): 1,05 m³ sand+ 0.2m³ slaked lime (+100-130 kg cement for improved lime mortar) + mixing water (~150-200 l)
material requirement for masonry: small-size brick 155 pcs/m², building block 8-20 pcs/m²
mortar needed for wall of 1 m² small-size brick: 0.094 m³, building block: 0.015 m³

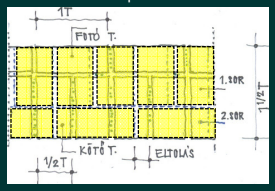
mortar
wall design, masonry structures – wall components

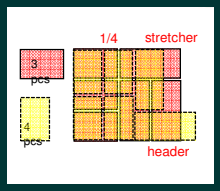
build up of building blocks – the rules of walling (brick bonds)

1. alternating stretcher and header courses
2. vertical joints of the successive courses cannot lie in same vertical line
3. amount of lap should be 1/4-1/2 brick/block length (min. 1/4)
4. in each course as many headers as possible should be used
5. the least possible bricks should be carved

small-size brick



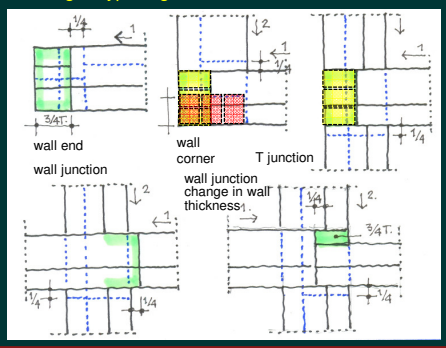




design of wall end

the rules of brick bonds
wall design, masonry structures – brick walls

bonding of typical geometries with brick

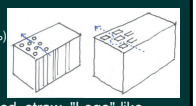


examples of brick bonds
wall design, masonry structures – brick walls

masonry blocks

development goals:

- reducing workforce demand
- increasing productivity
- reducing wall weight
- change in architectural demand and construction technology (frame construc
- increased thermal insulation requirements



Characteristics of the development of masonry blocks:

- increase of intergranular space volume (from12% to 60%)
- appearance of new raw materials (fine ceramics)
- shift of cavities
- increase of porosity (PS beads, wood chips)
- spread of bio-concrete and PS-shell elements (reed, straw, "Lego"-like construction)
- increase of size, reduce of quantity (small-size brick 153 pcs/m^2 masonry blocks 8-12-16 pcs/m^2)
- increase the weight of the element, reduce the weight of wall m^2 (small-size brick: 2.6-3 kg/pcs masonry block 8-16 kg/pcs)
- speed up of masonry works (change of shape, elimination of filling the vertical joints)

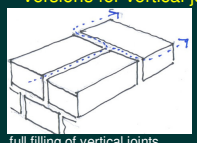
versions for horizontal joints (masonry mortars)

traditional layer of mortar
- thermal bridge, good airtightness
dimension compensation (leveling)

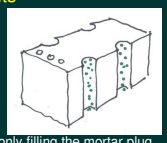
thin layer of mortar
- less thermal bridge, ~ airtightness, only with polished elements

adhesive bond
- no thermal bridge, ~ airtightness, only with polished elements

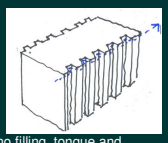
versions for vertical joints



full filling of vertical joints
- thermal bridge, good airtightness
opening is prevented

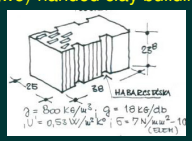


only filling the mortar plug
- prevention of thermal bridge and opening is to a lesser extent

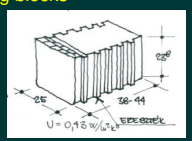


no filling, tongue and groove
- thermal bridge, risk of opening!

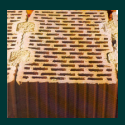
one(two)-handed clay building blocks

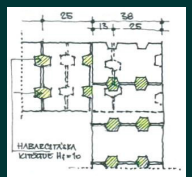


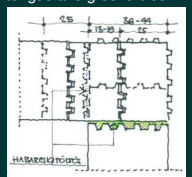
hollow block



tongue and groove block







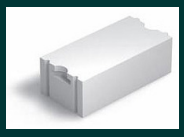
EUROCODE: overlap is min. 0.4 h (block height) or at least 40 mm

autoclaved aerated concrete (AAC) blocks

raw materials: quartz sand, lime, cement and water + pore forming aggregate

manufacturing: grinding, mixing, maturation in forms, cutting, autoclaving

- lightweight, good thermal insulation, several strength (density) classes
- exact geometry – 0.25-0.5 cm with (adhesive) mortar – thin joints
- block height: 20 cm, length: 50 and 60 cm
- wall thickness: 30, 37,5 50 cm
- U-value: 0.27-0.45 0.22-37 0.17 W/mK°
- easy to work with, can be cut with handsaw


PS foam formwork element system

(ISOTEQ, Hungarian innovation)

construction system with formwork element, sandwich panel, poured wall structure
(wall, ring beam, lintel, slab)

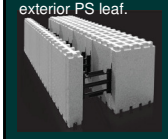
block dimensions 25-40/25/100 cm

raw materials: polystyrene hard foam (E additive)

assembly: building toy system (click-fittin

advantages: fast construction, thermal-b diffusion?

5 cm interior leaf + 15cm concrete + 10-25cr exterior PS leaf.



Durisol formwork element system

(Hungarian innovation)

construction system with formwork element, sandwich panel, poured wall structure
(wall, ring beam, lintel, slab)

block dimensions 25-40/25/100 cm

material: cement-based chipboard elements

Build-up:

- building as from walling block – 2 layers
- putting in reinforcement
- pouring concrete
- vibrate (driving out bubbles – compaction)

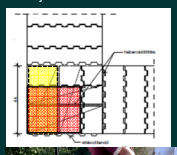

Durisol formwork element system

(Hungarian innovation)

construction system with formwork element, sandwich pa
structure (wall, ring beam, lintel)
block dimensions 25-40/25/100 cm
material: cement-based chipboard elements

Build-up:

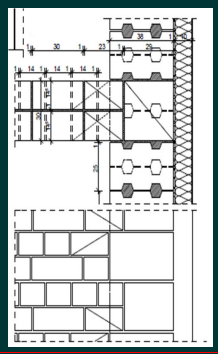
corner junction bond from fireclay building blocks



separating wall bond from fireclay building blocks

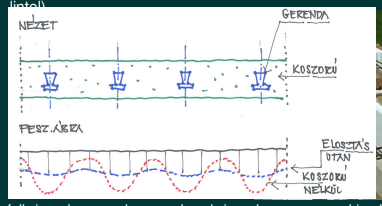
separating wall bond from limestone brick

flemish bond



role and function of ring beam

- holding the walls together
- bearing horizontal forces (e.g. roof)
- distributing concentrated loads (pillar, beam)
- distributing concentrated torque (balcony)
- bridging openings (in case of combined ring-beam and lintel)



full size – beam end is fixed

reduced size – beam resting on the wall

combined with lintel – working together

design of walls

dimensions: to be designed preferably with the integer multiple of the building block size (width, height) + joint

1. horizontal (floor plan) size coordination

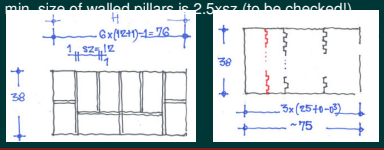
small-size brick: overlap 1/4 B, width unit is 1/2 B = sz

H (Length) = n x (sz+1) -1

no carved brick is allowed for load-bearing wall pillars and for exposed brick cladding

building blocks: the unit is the width size of one block (sz=20-25 cm)
to be designed on basis of the minimum overlap (usually sz/2) - half block and wall end elements

min. size of walled pillars is 2.5xsz (to be checked!)



2. height (vertical) size coordination

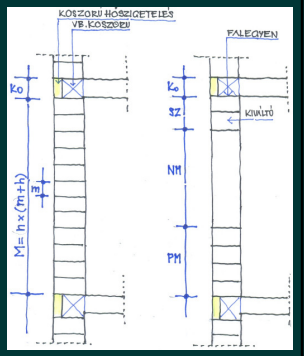
unit: height of a block (m)
+ horizontal joint (h)

good, if:
- the parapet (PM)
- opening's size (NM)
- lintel (SZ)

can be divided by the height of a block (m)

M = n x (m+h) = PM + NM + SZ

no cut block is allowed under the prefabricated lintel!



masonry structures, historical overview

brick, masonry blocks
- build up of bricks, the mortar
- build up of building blocks – the rules of walling (brick bonds)
- bonding of typical geometries with brick

masonry blocks
- options for horizontal and vertical joints
- one(two)-handed clay building blocks
- autoclaved aerated concrete (AAC) blocks
- PS foam formwork element system
  - building blockbonds

role and function of ring beam

design of walls: horizontal (floor plan) and vertical size coordination