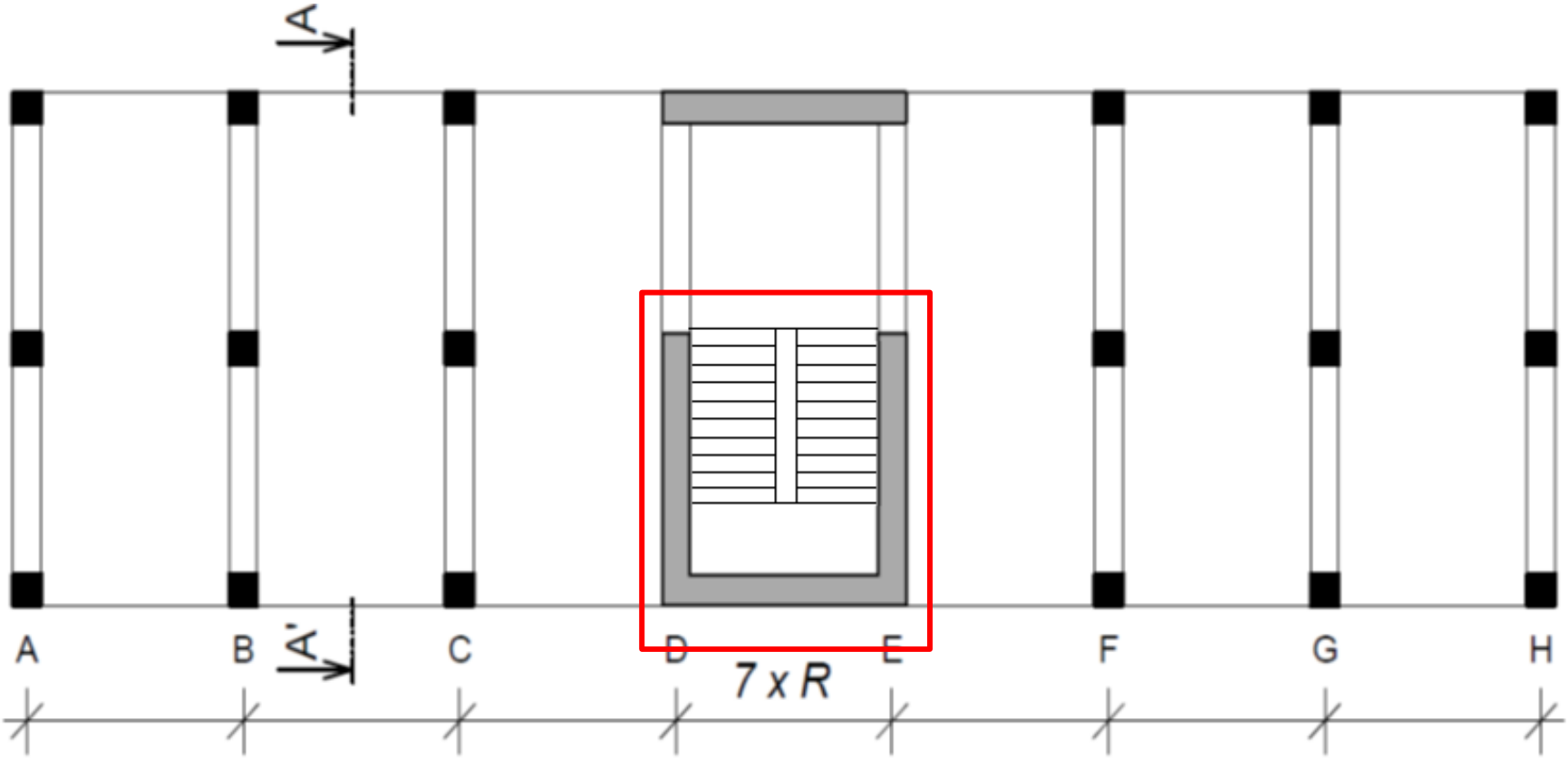
5th task: **RC staircase (for the structure from 1st task)**



Our goal will be to

- Design the geometry of the staircase
- Calculate loads, bending moments
- Design the reinforcement
- Sketch the reinforcement

- In general, there are usually **more possibilites** how to design the staircase. This presentation describes just **one possible approach** for **one particular structure**. Another possibilities will be explained during lectures.

Geometry

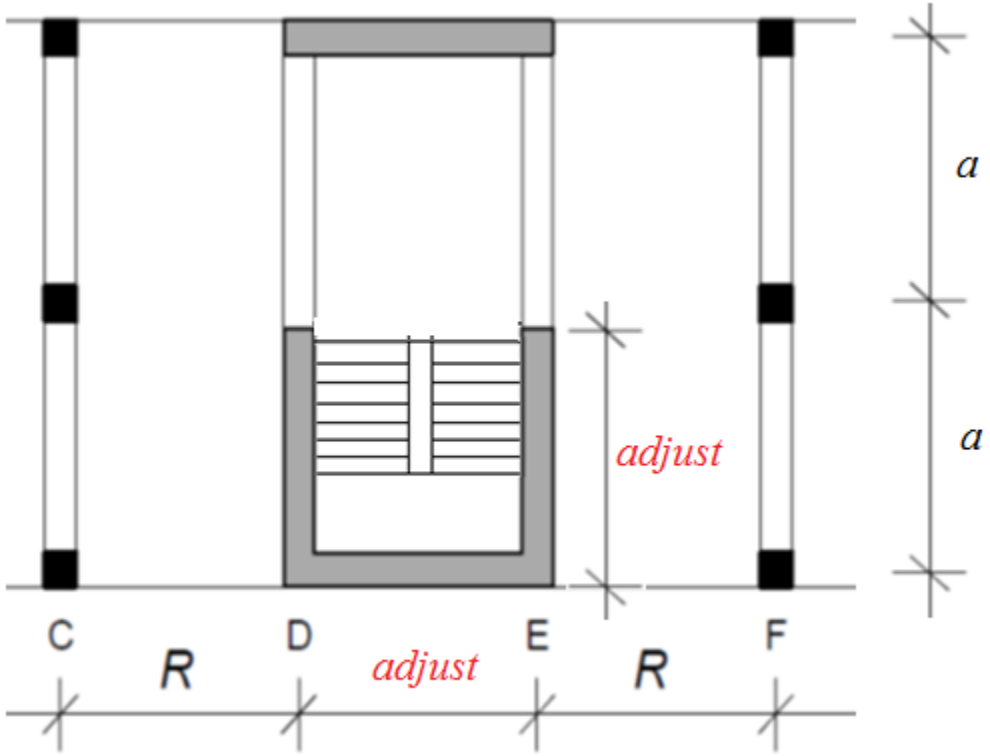
- Dimensions of one step

$$b = 630 - 2h$$

- Number of steps in one flight
- Width and length of the flight
- Width of the gap between the flights
- Width of the staircase
- Width of the landing
- Draw a scheme of the staircase and details
- Check the depth of the slab
- Check perpendicular and head clearance
- **Follow the example on my webpage**

Geometry

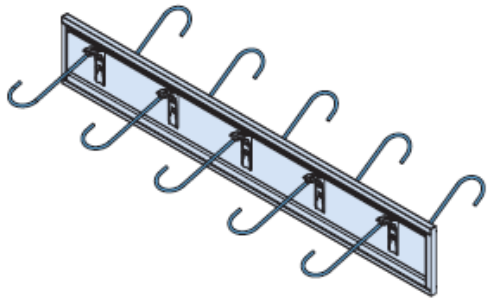
- Adjust the dimensions according to your staircase if necessary

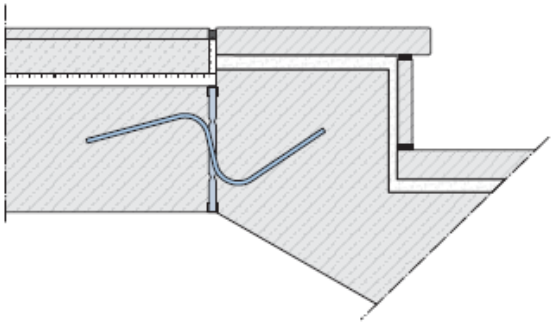


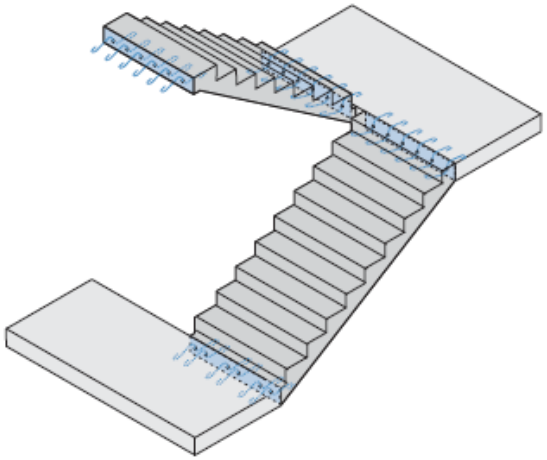
Supports

- The staircase will be supported by special elements to prevent transfer of impact sound to the rest of the building

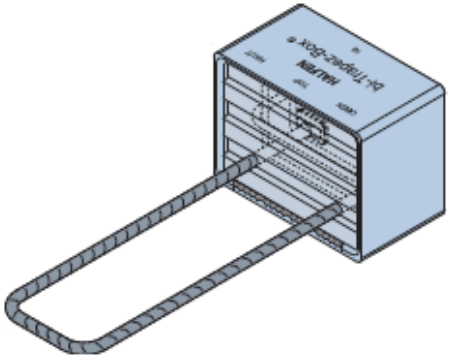
ISI units

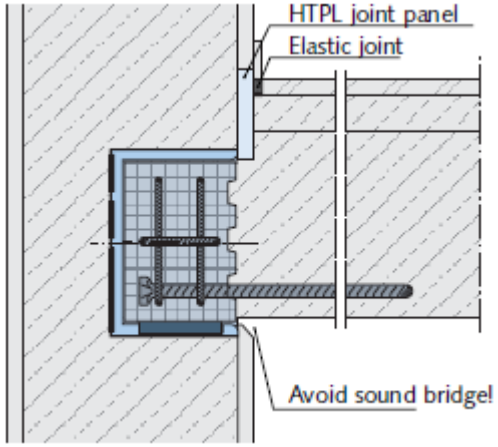


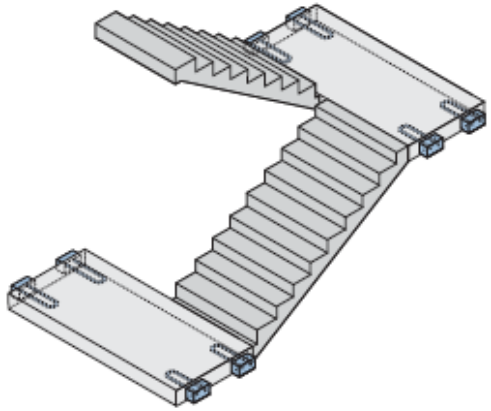




Trapez boxes + corbel elements

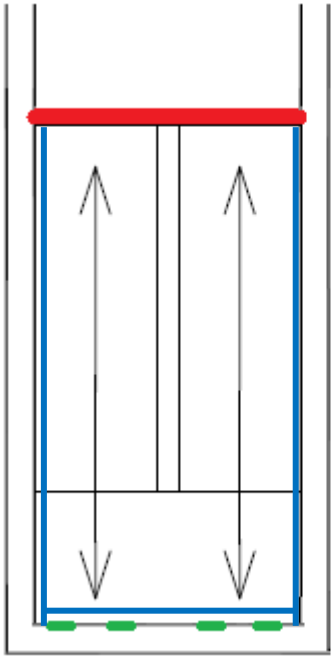






Supports

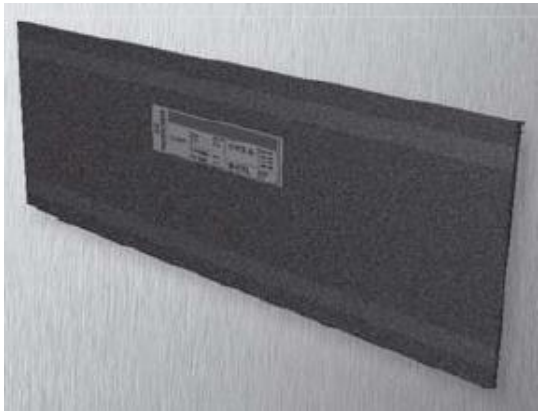
- In our staircase:

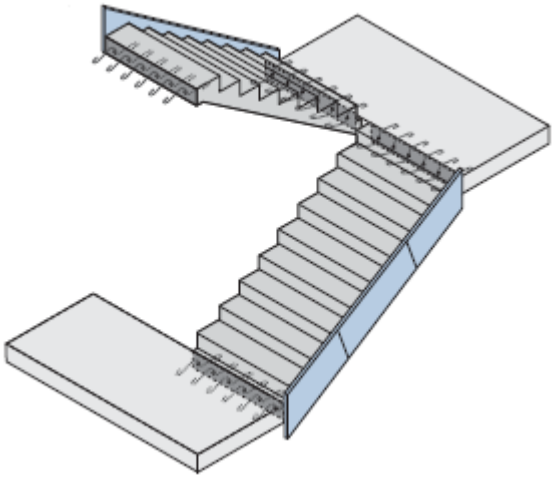


ISI units

Perimeter joint insulation

Trapez boxes





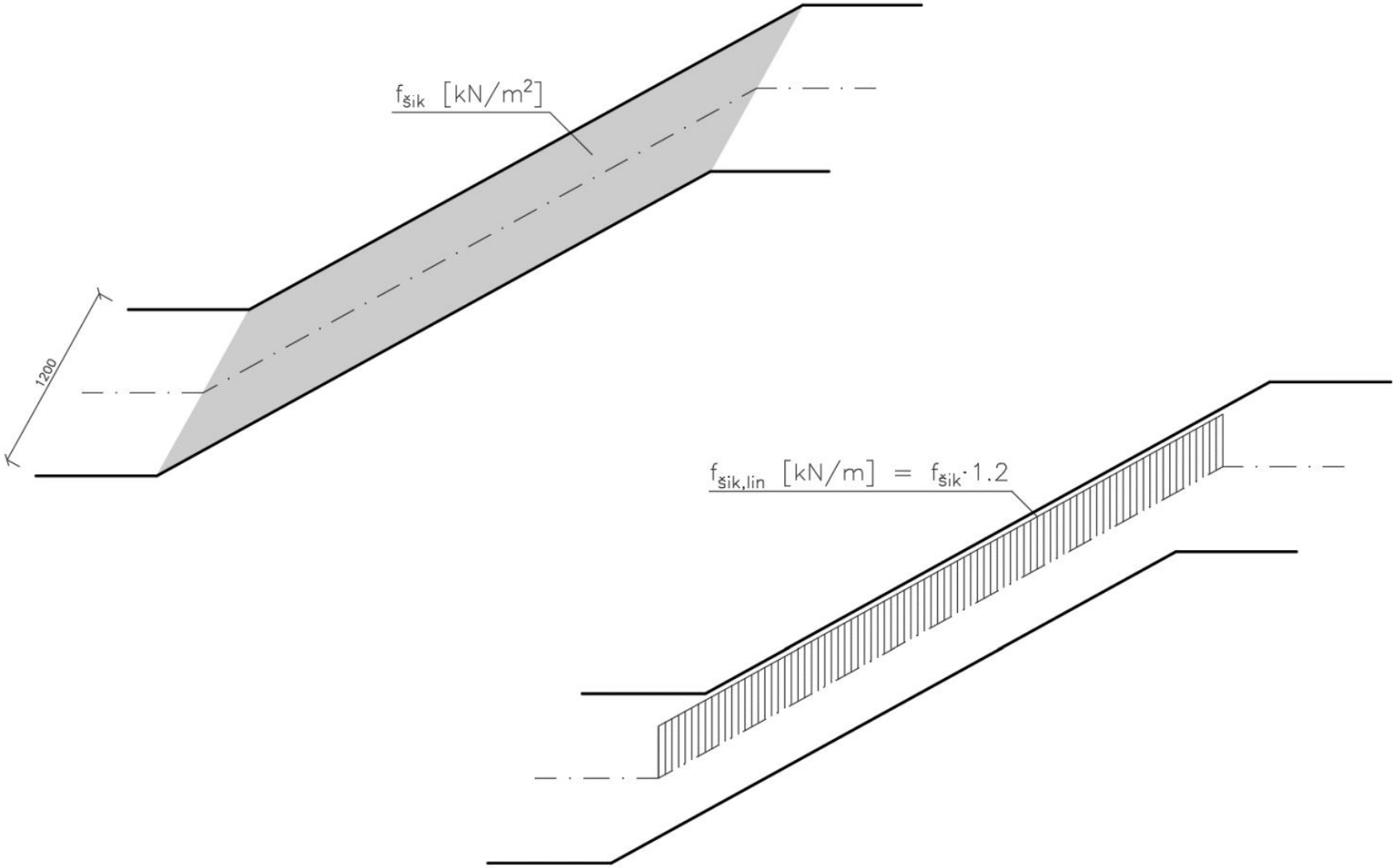
- The type and number of supporting elements should be specified in the structural analysis according to the values of reactions (not required in the homework)

Loads

- Following loads should be considered:
  - Self-weight of the slab – according to your design
  - Self-weight of floor structure – consider 1 kN/m^2
  - Self-weight of cladding of the steps – consider 0.5 kN/m^2
  - Self-weight of steps – according to your design
  - Live load – consider 3.5 kN/m^2
- *Be careful:* The landing has different loading than the flight
- **Follow the example on my webpage**

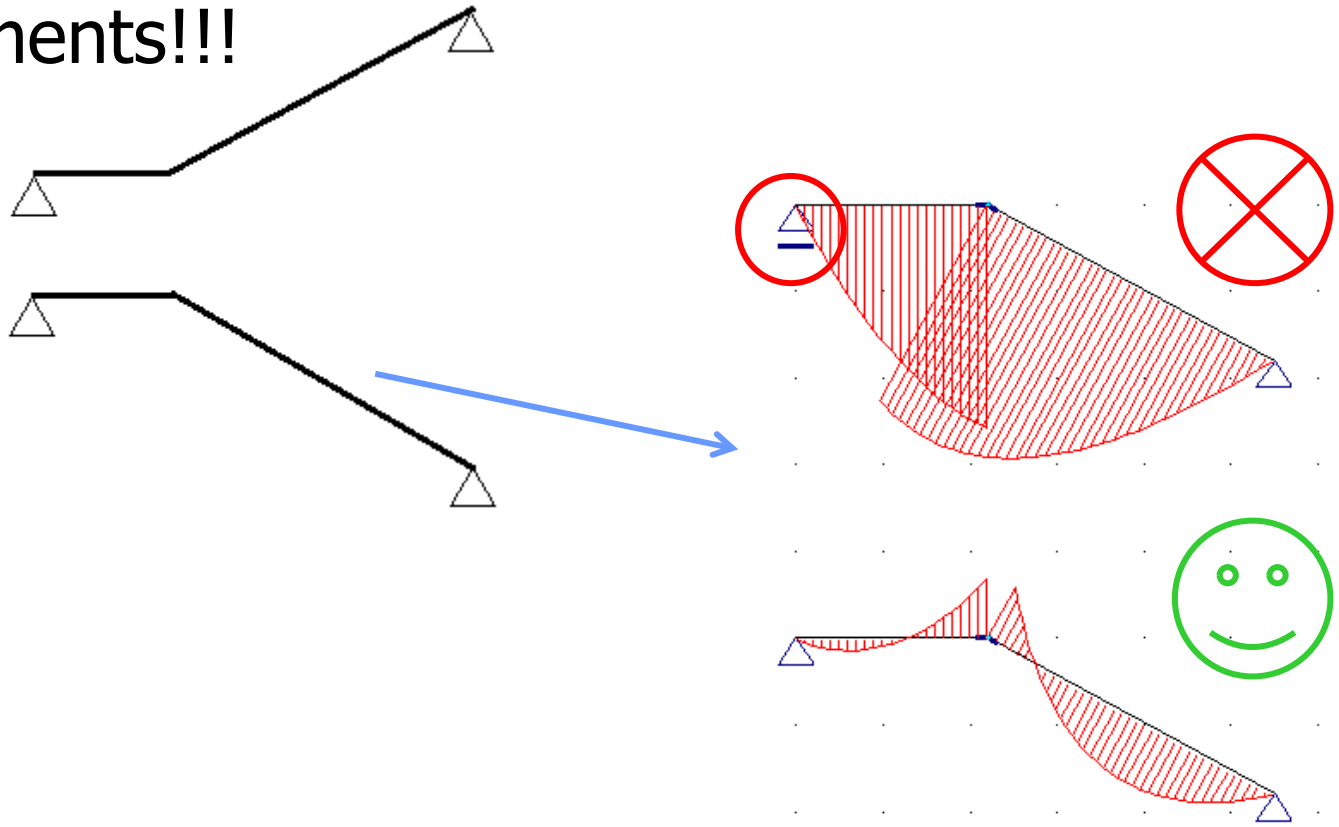
Loads

- Convert all area loads to **linear loads**!



Structural scheme

- The supporting elements that we selected do not transfer bending moments => pinned supports
- But they DO transfer horizontal forces – NOT simple beams => significantly different bending moments!!!



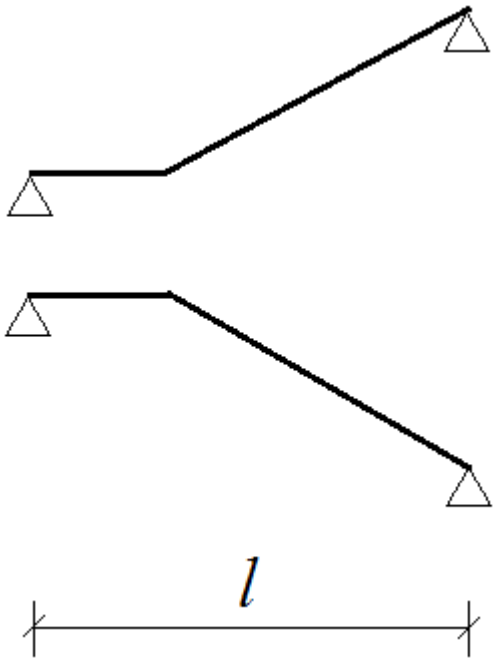
Design bending moment

- The structure is statically indeterminate => we should use e.g. FEM program or slope deflection method to calculate real bending moments
- **Estimation** (conservative, safe):

$$m_{Ed} = \frac{1}{12} f_{\mathrm{df}} l^2$$

Design load of stair flight [kN/m]

Horizontal length of the staircase

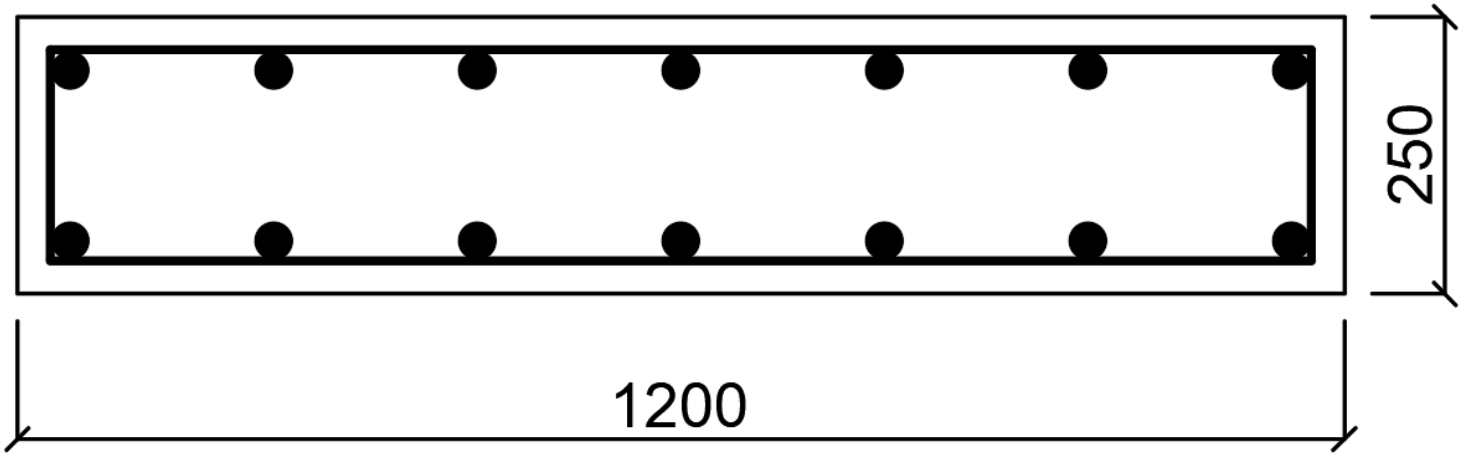


Design of reinforcement

- Use the estimated design bending moment for both upper and lower main reinforcement
- One way slab => design of reinforcement is the **same as for any other one-way RC structural member** (see HW3 and HW8).
- Don‘t forget to check the detailing rules!

Design of reinforcement

- For planar members (such as slabs), we usually calculate the moment and reinforcement per 1 m, but **in the case of staircase** (both landing and flight) we use the real width – i.e. **we design it like a beam** (M_{Ed} [kNm], n × ⌀, A_s [mm^2]).

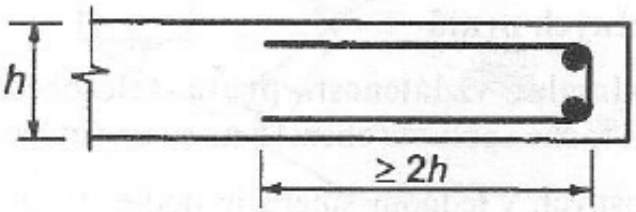


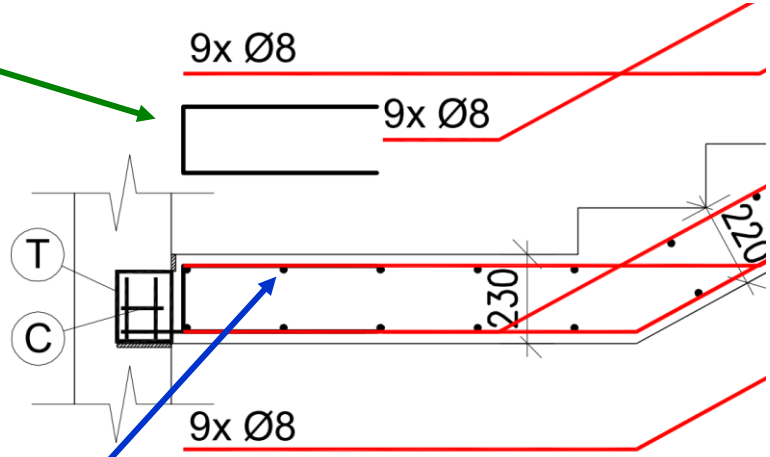
Sketch of reinforcement

- Sketch the reinforcement of **both flights**
- Main load bearing reinforcement – in red color, number of bars according to design
- Secondary reinforcement – just sketch the shapes and positions
  - Edge reinforcement
  - Transverse reinforcement
  - Secondary reinforcement of the upper surface
  - End stirrups

Sketch of reinforcement

- Edge reinforcement

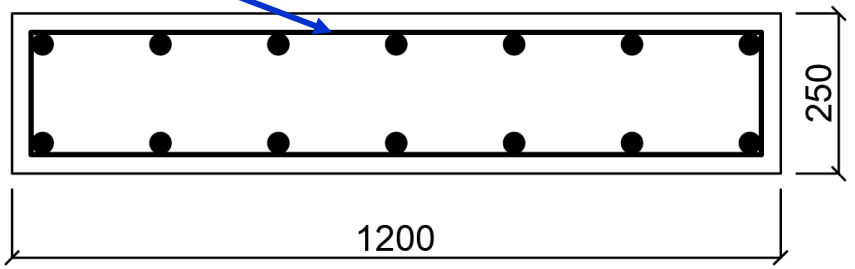




- Transverse reinforcement

$$a_{s,tr} \geq 0.25 a_{s,main}$$

$$s_{tr} \leq \min\left(3h; 400\ mm\right)$$

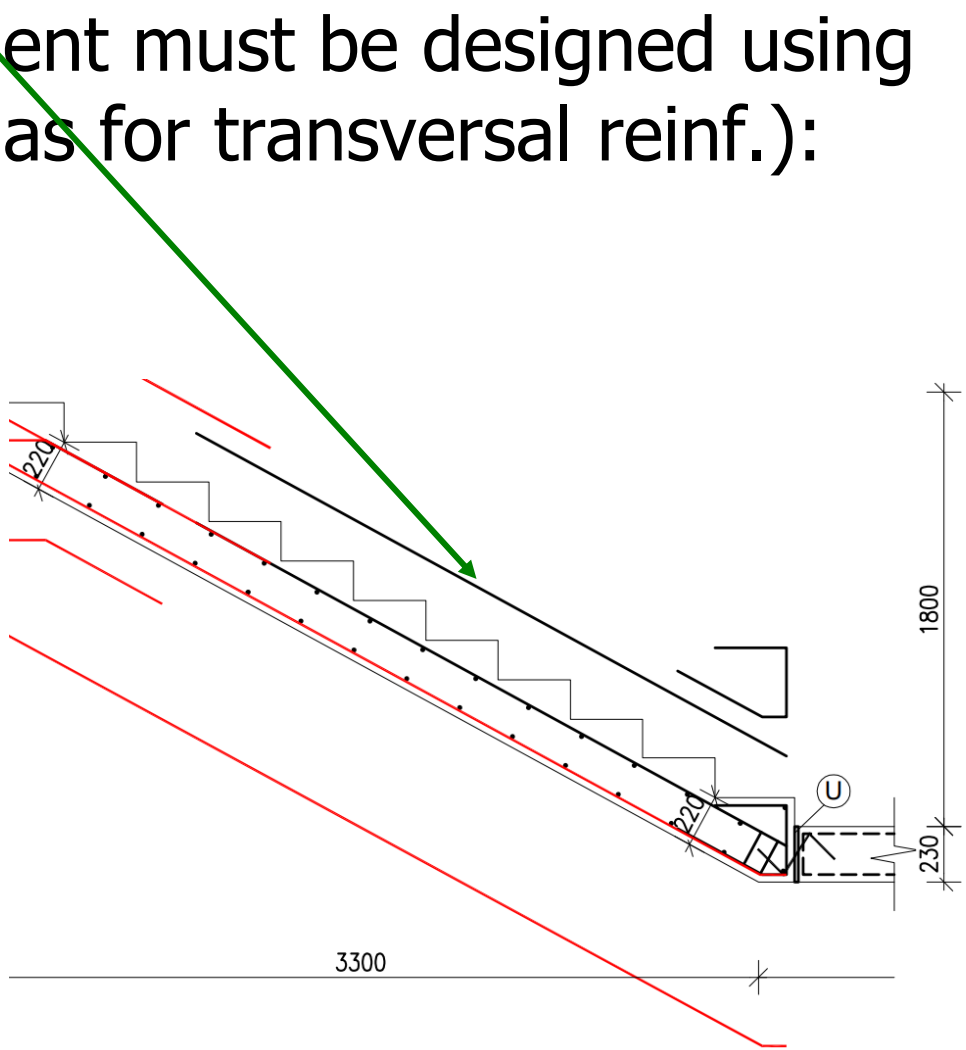


Sketch of reinforcement

- In the places where no main reinforcement was designed (e.g. upper reinforcement in the flight), secondary reinforcement must be designed using detailing rules (same as for transversal reinf.):

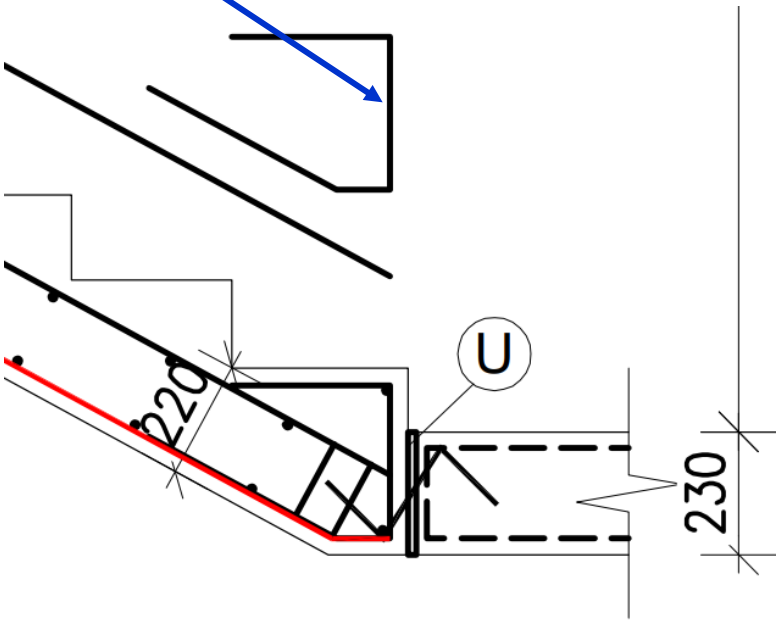
$$a_{s,tr} \geq 0.25 a_{s,main}$$

$$s_{tr} \leq \min\left(3h; 400\ mm\right)$$

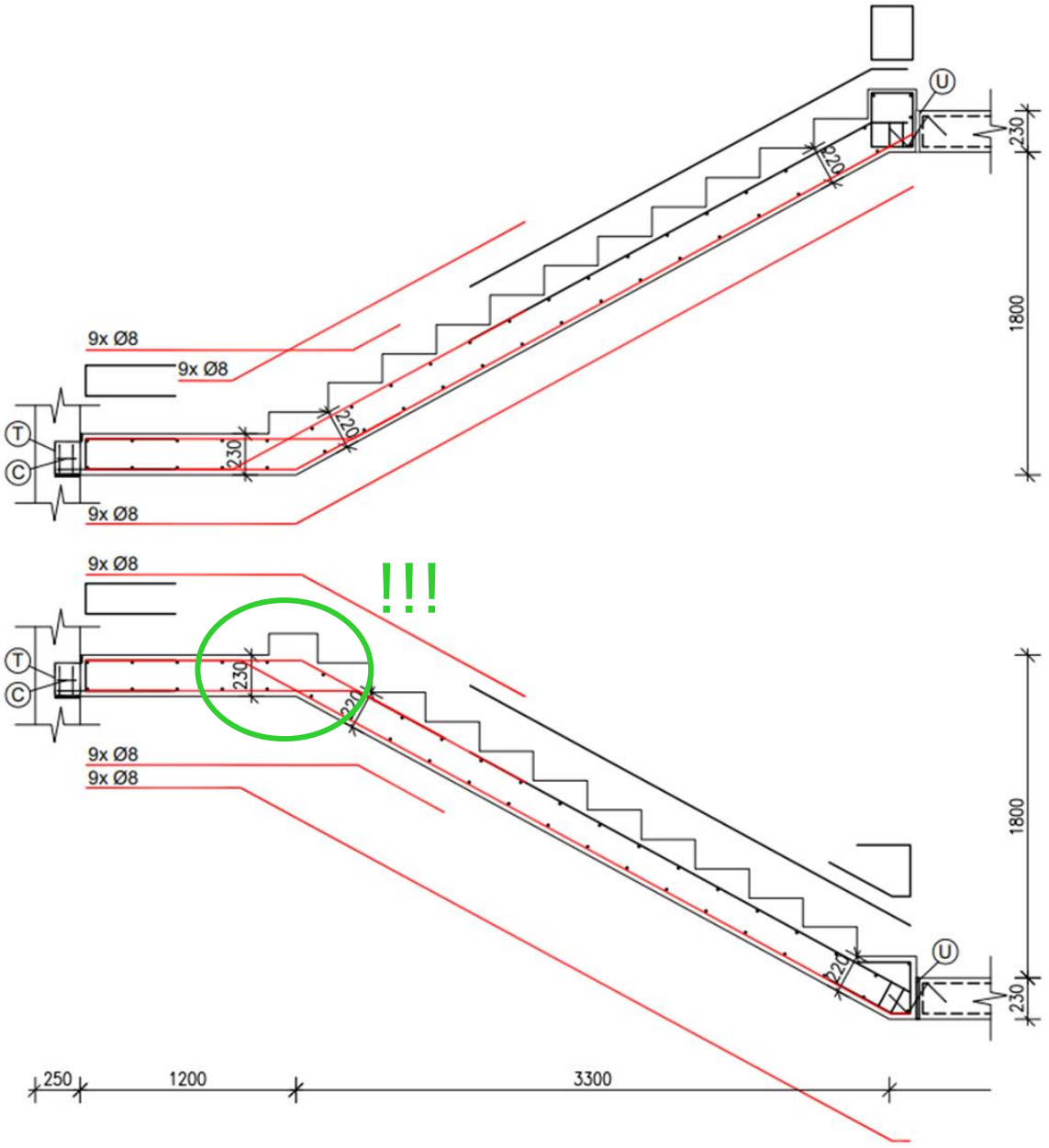


Sketch of reinforcement

- End stirrups:
  - according to the manufacturer of sound insulation elements (e.g. 2x Ø8)



Sketch of reinforcement



Corresponding bending moments