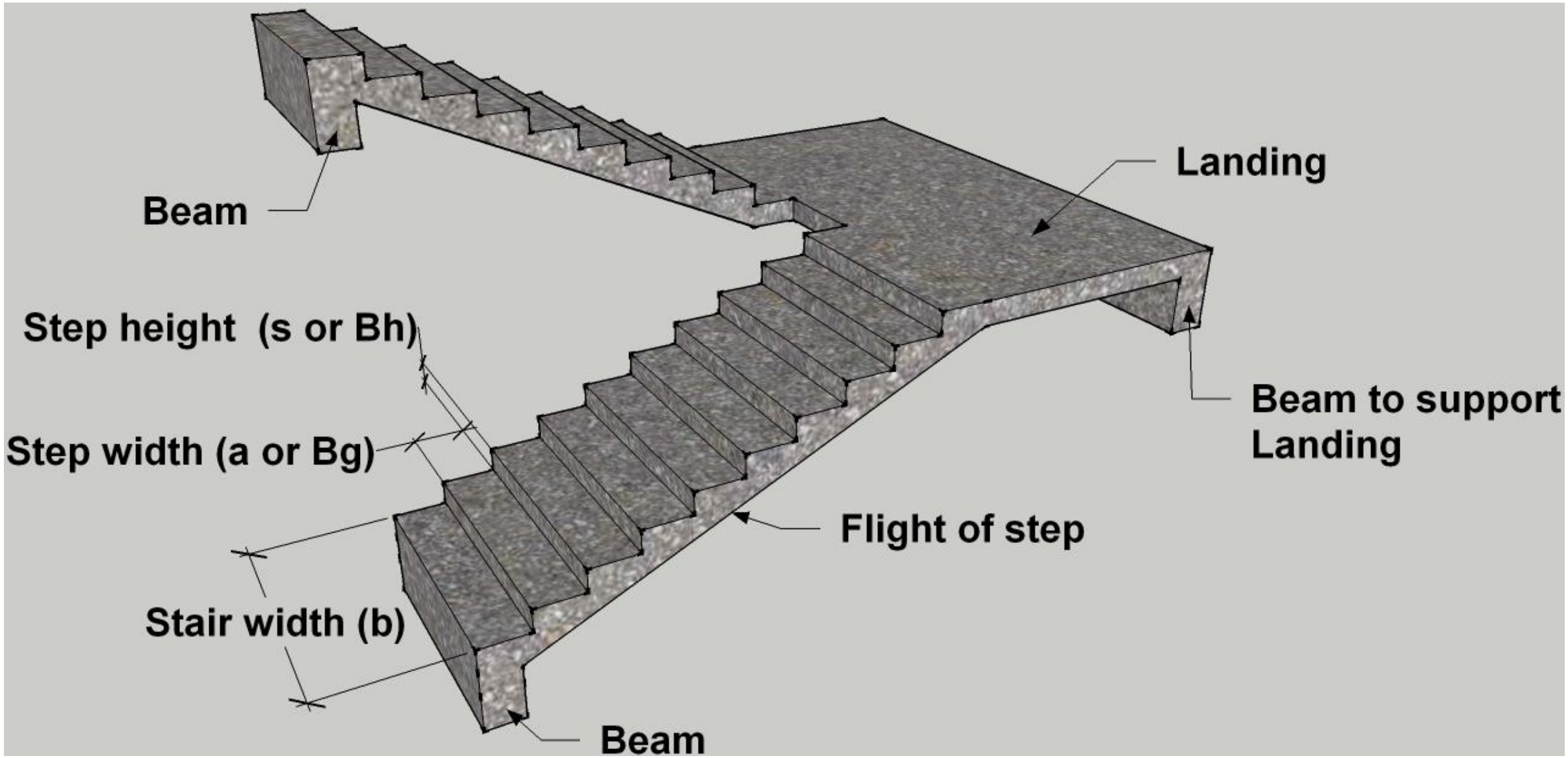
CE421
REINFORCED CONCRETE STRUCTURE DESIGN

STAIRCASE DESIGN

STAIRCASE

- The structural members which provide vertical movement (circulation) between floors of the building at different vertical levels.
- The stairs of RC buildings may be designed by using various materials (wood, steel, RC, etc.).
- The idealization of support conditions of the stairs may not be straigthforward as in other parts of the building. Therefore, a careful assumption should be made. Different assumptions may lead to different design solutions for the same staircase.
- Basic Definitions: flight of step, landing, step width, step height, stair width.

STAIRCASE


Beam
Landing
Step height (s or Bh)
Step width (a or Bg)
Beam to support Landing
Flight of step
Stair width (b)
Beam

STAIRCASE

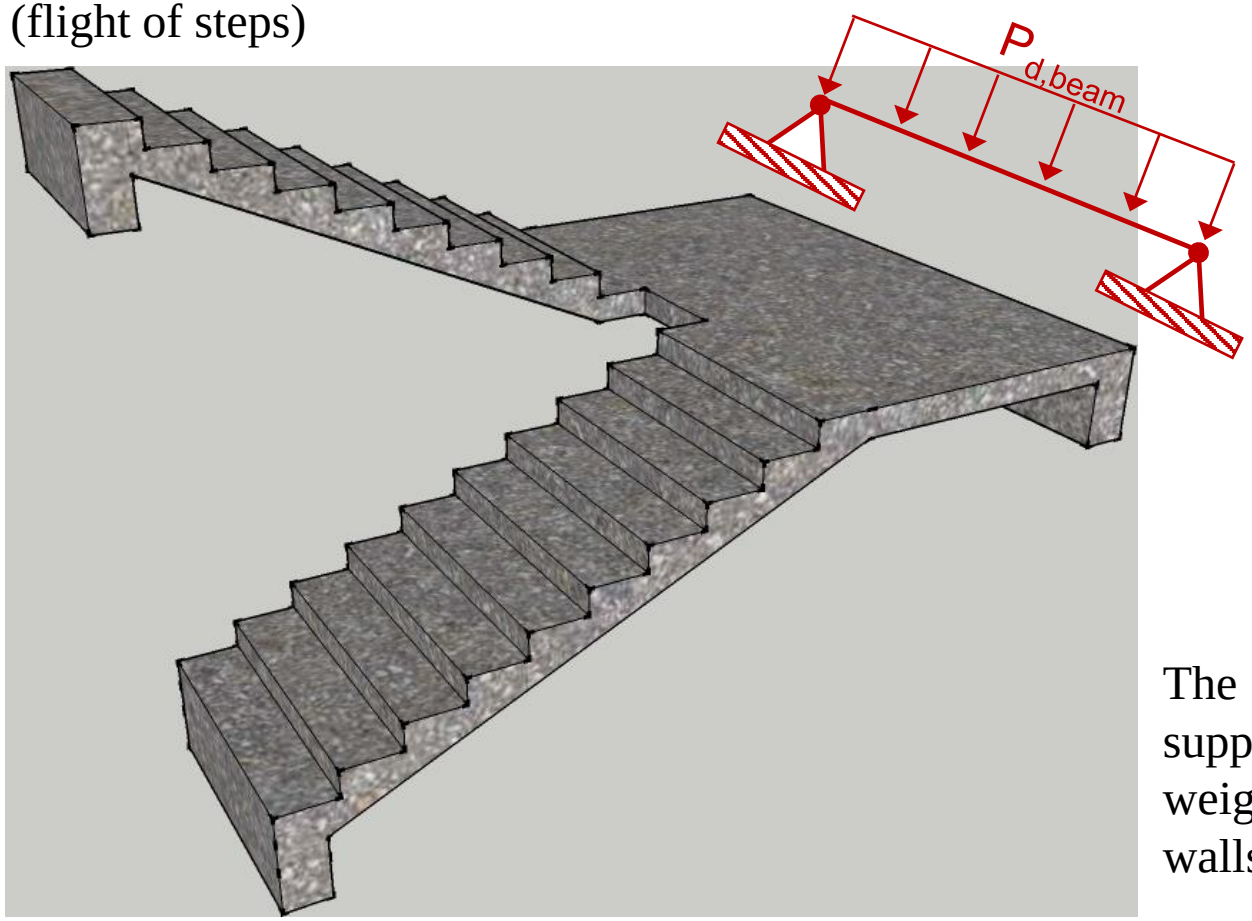
- Inclination (slope) of the steps, α: $\tan \alpha = \frac{B_h}{B_g} \leq 0.67$

- If you have 3 m. story height and (10+10) 20 step heights: $\text{Step height (s or } B_h) = \frac{300\ cm.}{20} = 15\ cm.$

- Select step width (a or B_g) such that $B_g + 2B_h = 63\ cm.$

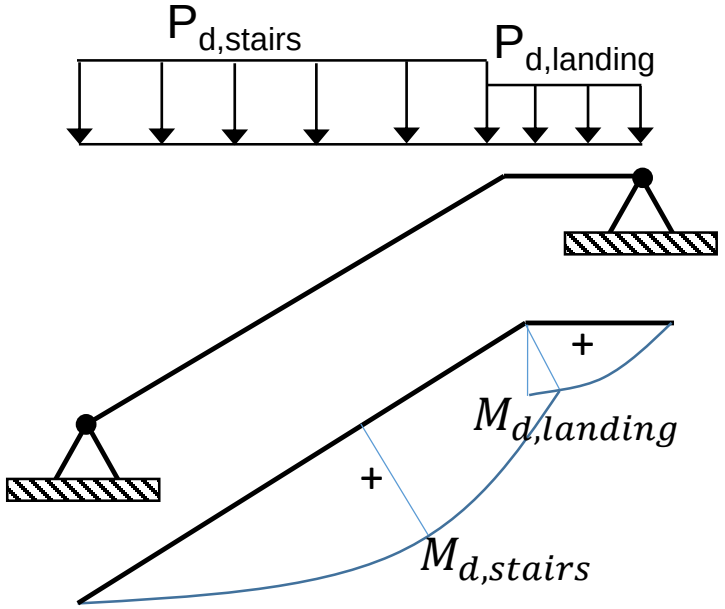
STAIRCASE-REINFORCEMENT / SOLUTION I

The stairs and landing are all supported by the beams along the short direction; no support along the long direction (flight of steps)



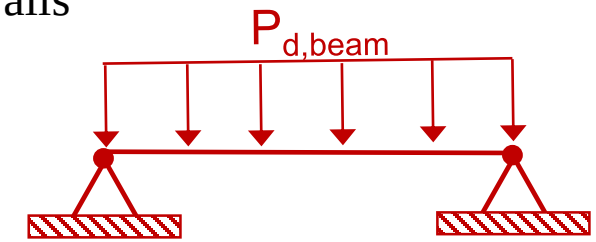
Finite element methods may be used for the structural analysis of the entire staircase or two seperate parts may be assumed as independent and behave similar to a simply supported beam.

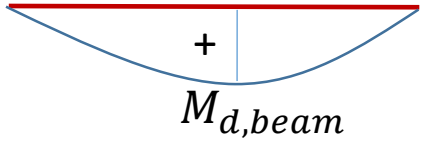
The design moments for the stairs and landing may be determined by a simple static solution.



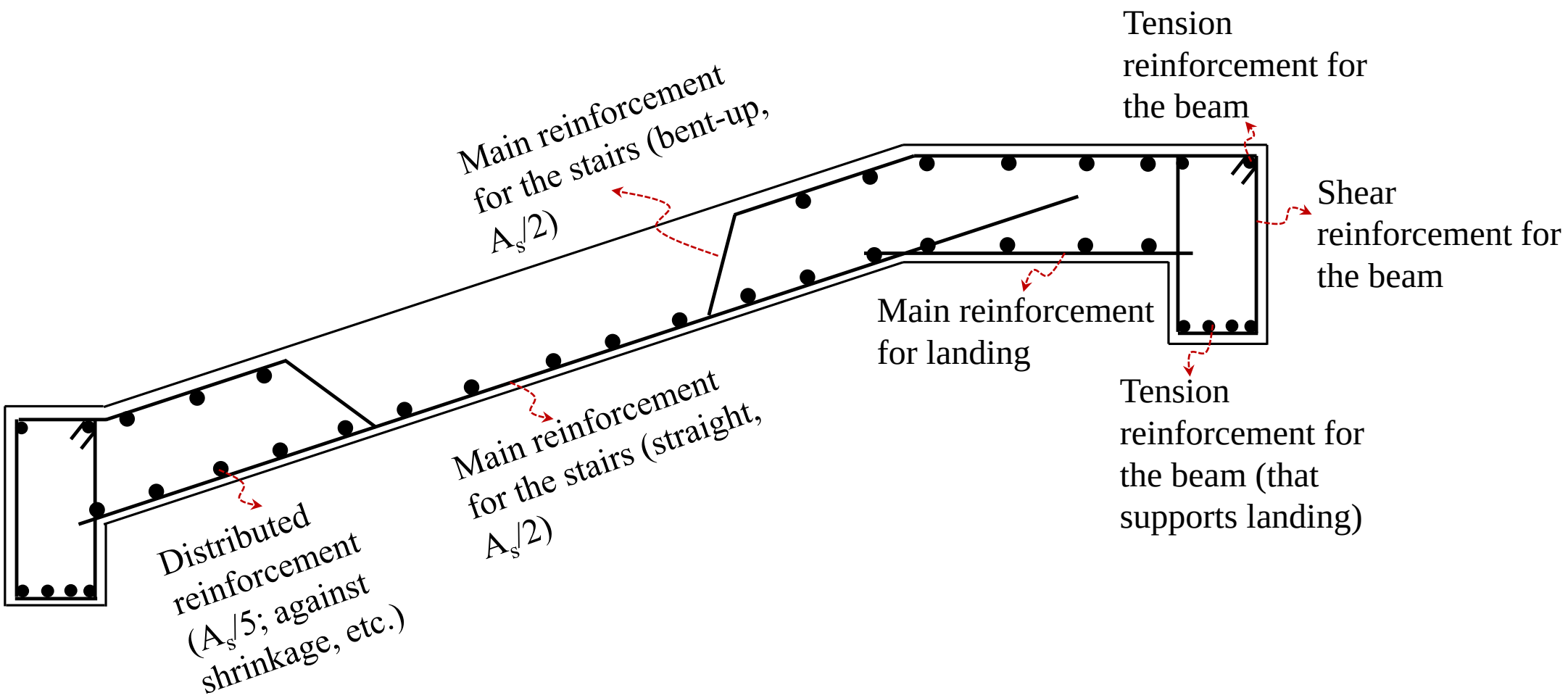
$$A_s \cong \frac{M_d}{f_{yd} \times j_l \times d}$$

The beam that supports the landing may also be designed by simply supported beam assumption. The load on this beam is composed of weight of stairs and landing, self-weight of beam and weight of infill walls

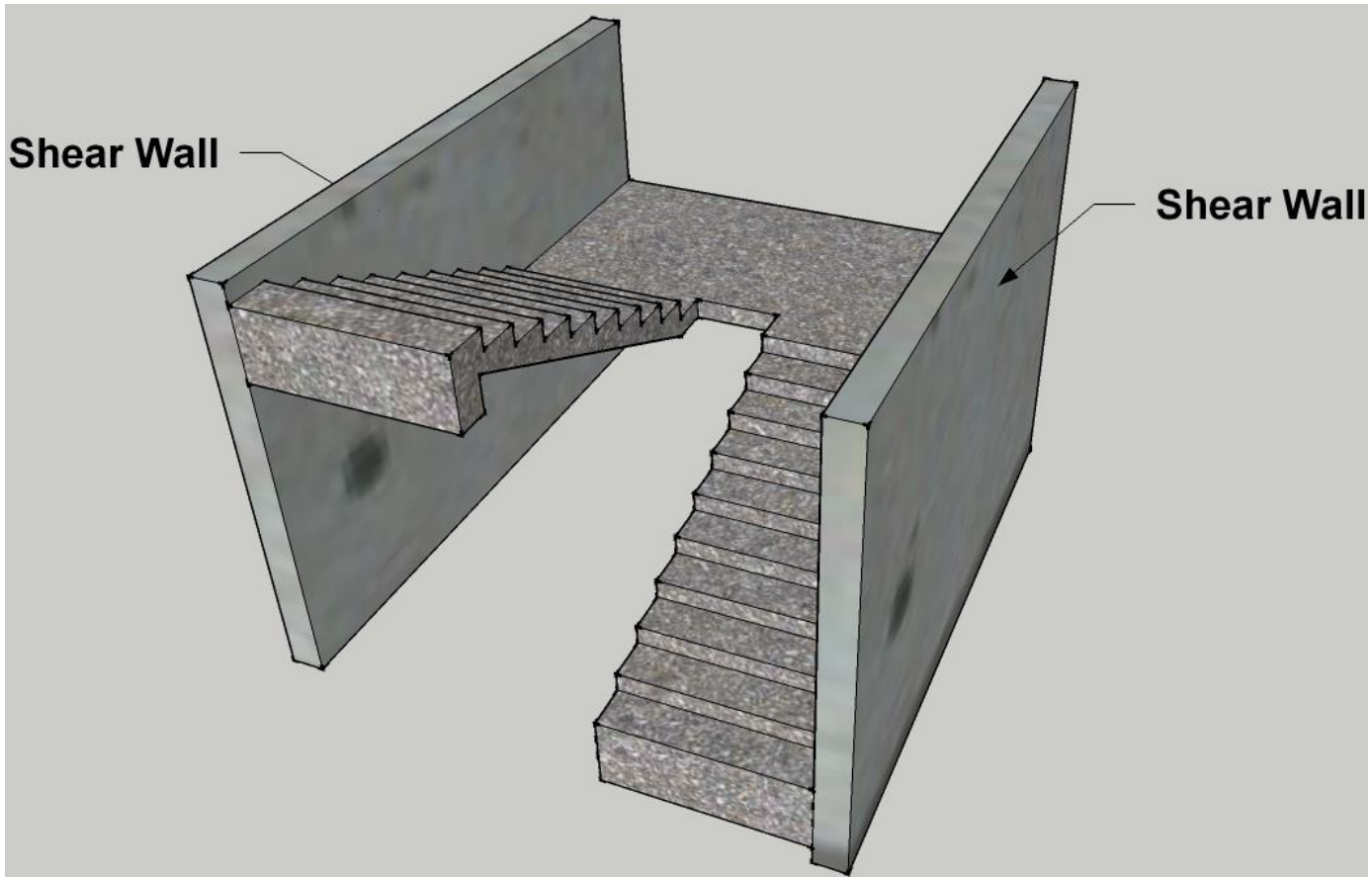




STAIRCASE-REINFORCEMENT / SOLUTION I



STAIRCASE-REINFORCEMENT / SOLUTION 2

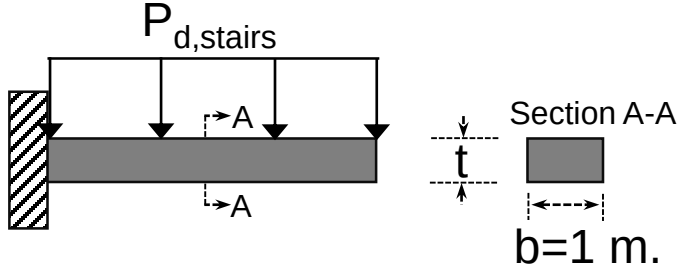


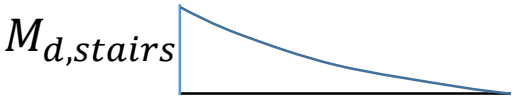
The stairs and landing are all supported by the shear walls. Stairs may then be modeled as cantilever one-way slabs (with a width of 1 m.). The thickness of stairs will be determined for the conditions defined for cantilever one-way slabs:

$$t\ (or\ h_f) \geq \frac{l_n}{12}$$

$$t\ \left(or\ h_f\right) \geq \frac{l_n}{10} \quad (no\ need\ to\ check\ deflection)$$

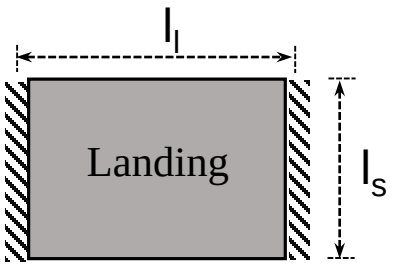
The design moment for the stairs:





STAIRCASE-REINFORCEMENT / SOLUTION 2

The landing may be modeled as a slab (one-way or two-way) with two continuous and two discontinuous sides. The thickness of the landing should be determined by the conditions of either one-way or two-slab with the given support conditions. The design bending moment of this one-way/two-way slab should be determined and reinforcements should be calculated (as we learned previously in slab design).



<u>If the landing becomes to be a two-way slab ($m=l_l/l_s<2$):</u>

$$t\ (or\ h_f) \geq 80\ mm.$$

$$t\ (or\ h_f) \geq \frac{l_{sn}}{15 + \frac{20}{m}} \times \left(1 - \frac{\alpha_s}{4}\right)$$

$$t\ (or\ h_f) \geq \frac{l_n}{30} \quad (no\ need\ to\ check\ deflection)$$

<u>Note:</u> You may assume landing as a continuous slab / outer span

STAIRCASE-REINFORCEMENT / SOLUTION 2