Exercise 1. Review of the simply supported and two-span continuous beam

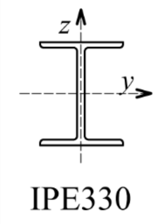
Loads

p_{ed}= 3,0 kN/m^2

p_{qp}= 2,0 kN/m^2 (for calculation of the deformations)

Initial data

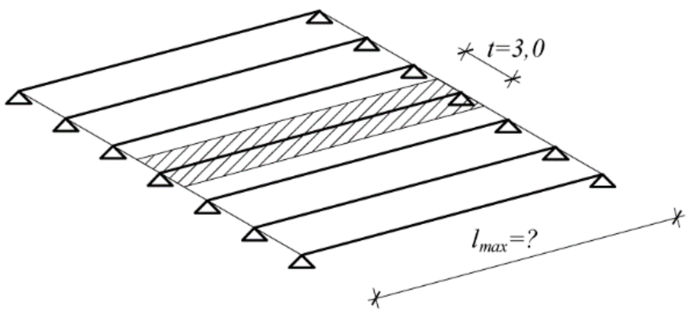
Section: **IPE330**
classification: 1 → plastic analysis
material: S235 → f_{yd}=235 N/mm^2
E = 210 000 N/mm^2
A= 6261 mm^2
$W_{pl,y}$= 804,3·10^3 mm^3
I_y = 11770·10^4 mm^4
i_y = 137,1 mm

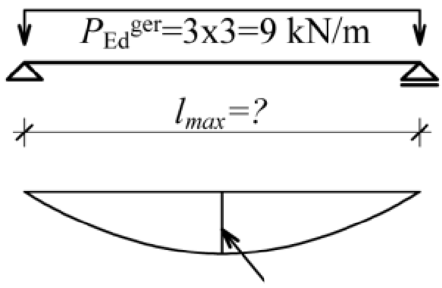


a) Determine the maximal span of the given simply supported beam! The cross-section is IPE330. Maximum allowed deflection: l/250. Lateral torsional buckling is prevented by supports.

The deflection of the beam can be calculated using the following formula:

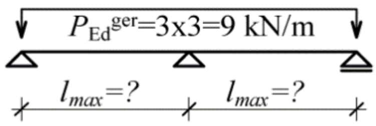
$$w = \frac{5}{384}\frac{p l_{max}^4}{E I_y}$$





(l_{max}=10,8 m)

b) Determine the maximal span of the given two-span continuous beam. Data are given in example a) In the calculation of the resistance take into consideration the plastic rearrangement of the moments!

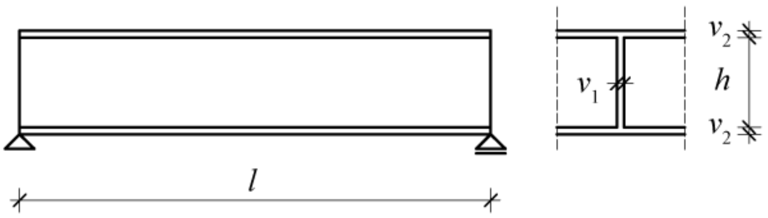


(l_{max}=14,4 m)

Exercise 2. Determination of the reinforcement of a wall beam

a) Determine the bending reinforcement for the given wall beam in case of uniformly distributed load!

b) Calculate the height of the compressed zone in the axis of symmetry and in the quarter point (the steel reinforcing bars are continuous through the structure).



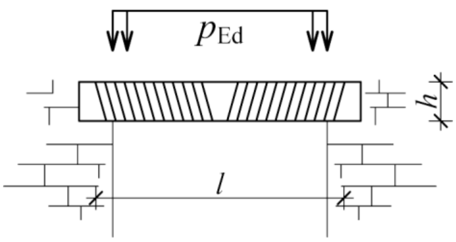
*The slab works together with the wall and the effective width of the compressed zone can be approximated by 6*v_2 on both sides.*

Data: P_{Ed}=170 kN/m; l=18 m; h=3,2 m; v_1=25 cm; v_2=23 cm.
steel: f_{yd}=435 N/mm^2; beton: f_{cd}=16,6 N/mm^2

(15 db ϕ20 (4710 mm2), x_c=41 mm; x_{cn}=483 mm)

Exercise 3. Flat arch

What is the minimal height h of the flat arch i the opening is l = 1,80 m, if the vertical load is P_{Ed} = 25 kN/m and the maximal horizontal load can be carried by the shoulders is H_{max} = 60 kN? The strength of the material is $f_{m,cd}$ = 1,2 N/mm^2 and the thickness of the arch is b = 50 cm.

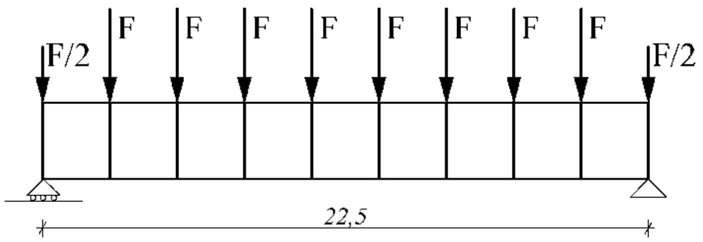


Note, that the flat arch can be modeled by an arch and a tie bar, but here we model it with an A-frame without a tie-bar. The shape of the arch is parabola.

(22 (25) cm)

Exercise 4. Vierendeel structure

a) Check the elements of the Vierendeel truss using the approximate method introduced at the 1st practical in case of the Picture Window House! Geometry and loads are given in the figure. Cross-section of the elements: HEB 700. Draw the internal force diagrams and the moment diagram!



b) Point on the relevant cross-sections and internal forces and calculate the utilization of the members according to the Dunkerley equation (MEd/MRd+NEd/NRd<1)!

Data: *F=325 kN, width of the structure is 9*2,5=22,5 m, the height of the structure is 3 m.*

(beam: -2708 kN, 0kNm, 54%;-541 kN,812,5 kNm, 63%;
column: -1300 kN, 812,5 kNm, 78%, -162,5 kN, 1422 kNm, 94%)

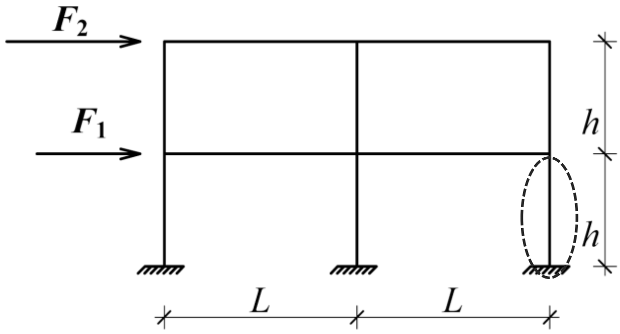
Exercise 5. Frame

Determine the maximal internal forces arising in the signed element collectively from the horizontal and vertical loads! Draw the normal force diagram and the moment diagram for the marked element!

Horizontal forces: F_1 = 50 kN, F_2 = 25 kN. (The figure is not proportional!)
Internal force and moment from the dead loads are N_{Ed} =-500 kN and M_{Ed} = 50 kNm (the inner part of the column is under tension).

Data: h = 3,0 m, L = 5,0 m

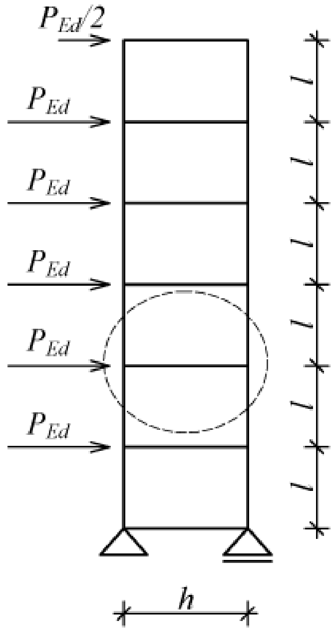
(N=-518,75kN, M=87,5 kNm)



Exercise 6. Frame

Determine the utilization of the signed element HEA 240 if the value of the horizontal forces: PEd=40 kN! For the calculation use the Dunkerley formula (MEd/MRd+NEd/NRd<1)!

Data: l=2,5 m; h=3 m.
HEA240 A=76,84 cm^2; W_{pl} = 744,62 cm^3; χ_B=0,7 (buckling reduction factor); χ_{LT}=0,85 (lateral-torsional buckling reduction factor); S355.



(N_{Ed}=-20 kN, M_{Ed}=200kNm, N_{Rd}=1909,5 kN, M_{Rd}=224,7 kNm, utilization 91%)