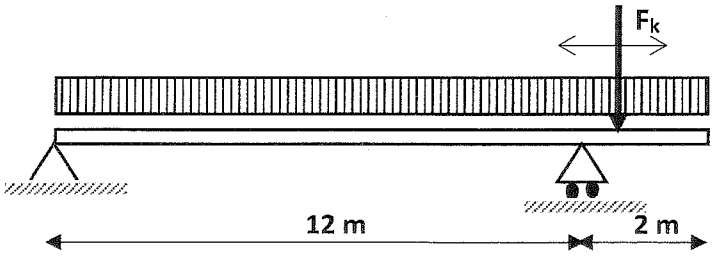
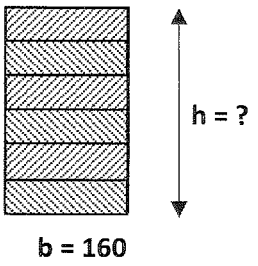
Aalto University
Department of Civil Engineering
CIV-E1030 Fundamentals of Structural Design **Examination 27.10.2017**
Write on each answer sheet Surname, First name and Study ID

1. Answer to the following questions shortly and use drawings if needed:

a) Describe differences between arch and Langer (= tied-arch) girders or bridges?
b) What are the demands of structural design according Eurocodes?
c) What things have to check when designing rigid retaining wall founded on the rock?
d) Explain sources of shear resistance at a cross-section of reinforced concrete beam:
e) What things have to be checked in the design of rigid retaining wall founded on the rock?
f) Explain the meaning of cross-section classes in steel beam design according EC.

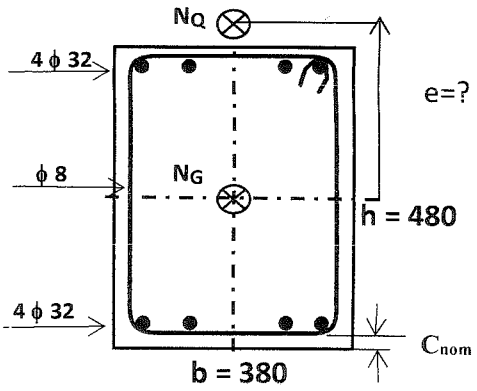
2. Glulam timber beam is supported and loaded as shown in the figure. Strength class of wood is GL30c, service class 2; k_{mod} = 0.8. The material factor γ_M = 1.2. Distributed permanent load on the beam g_k = 8 kN/m. Imposed point load is F_k = 10 kN and can freely travel on the beam. The width of the beam is 160 mm and height can vary in steps of lamella height of 45 mm from 270, 315, etc. Find the minimum height required according EC.
Load factors are: γ_G=1.15 , γ_Q = 1.5 and consequence class is CC2.
Note: deflection, shear or sideways buckling are not needed to analyze here.





3. The cross-section of symmetrically reinforced concrete column is shown in the figure. Strength class of the concrete is C40 and steel quality B500B. Compressive normal load consists of centric permanent load N_G = 700 kN and eccentric imposed load N_Q = 1000 kN. Determinate max. eccentricity (e = ?) of the force N_Q so that the ultimate capacity of the column is not exceeded according Eurocode 2.

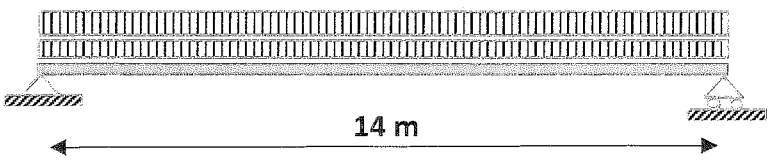
The concrete cover c_{nom} = 40 mm is overall the distance from the surface to the surface of nearest reinforcement. Material factors for concrete and reinforcement steel are 1.5 and 1.15. (Load factors and CC as in Prob 2).



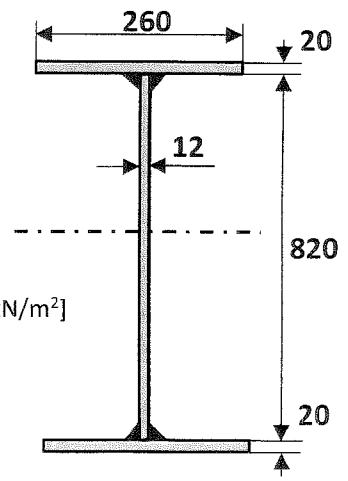
4. Calculate maximum characteristic live load q_k [kN/m^2] on the floor supported by welded beams of the figure. Profile is made of steel S355. Fillet welds between flanges and web are size a = 6 mm.

Spacing of the beams is 8 m. Self-weight of the floor g_f = 0,6 kN/m^2. Density of steel is 7850 kg/m^3 and material factor γ_M = 1,0.

(Load factors and CC as in Prob 2. Deflection, shear or sideways buckling analysis are not needed).

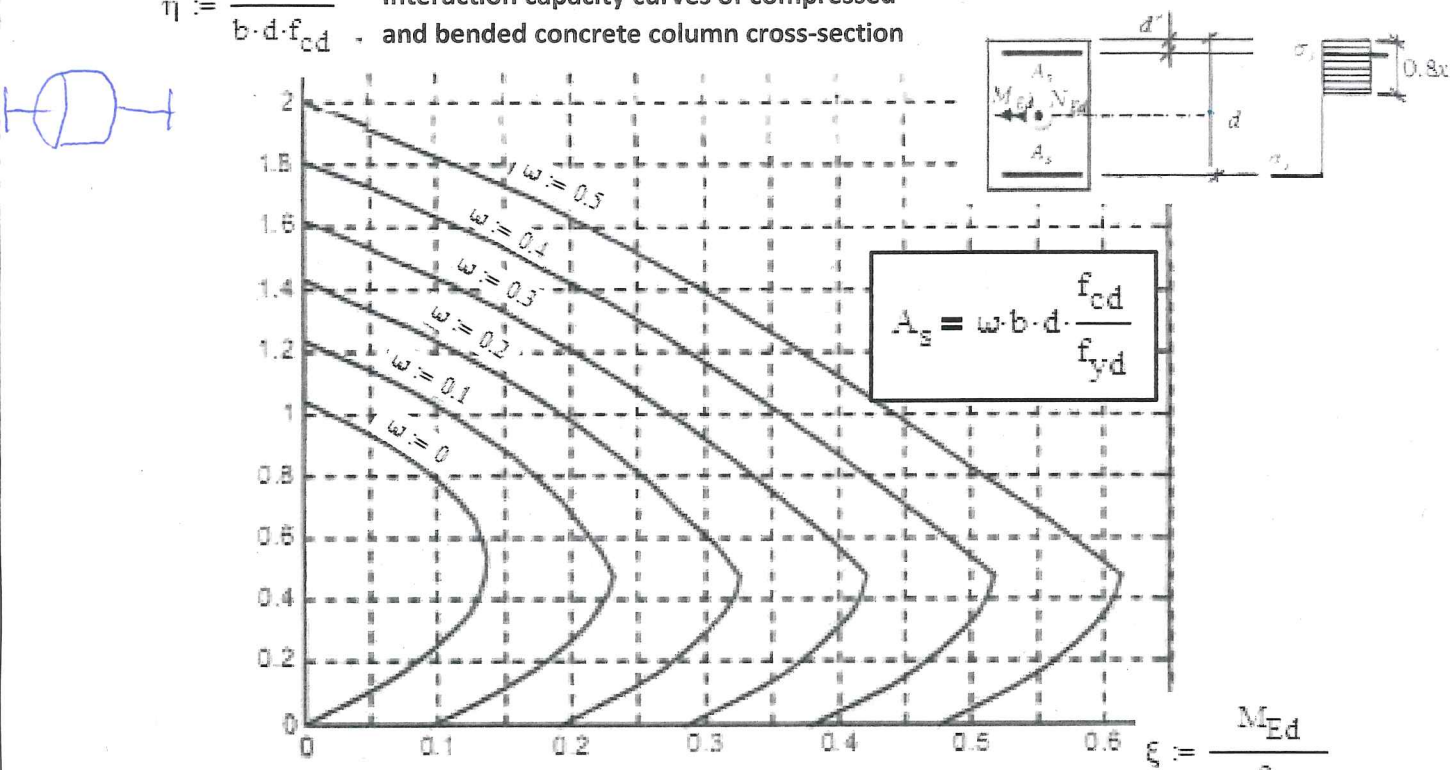


q_k = imposed load ? [kN/m^2]
g_f = floor self weight

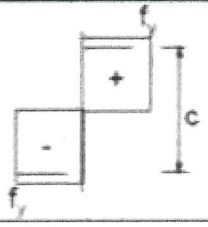
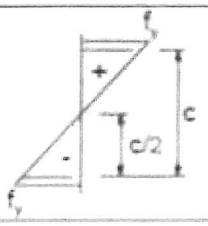


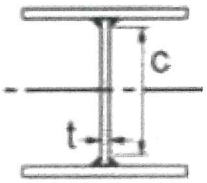
$$\eta := \frac{N_{Ed}}{b \cdot d \cdot f_{cd}}$$

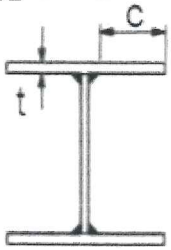
Interaction capacity curves of compressed and bended concrete column cross-section

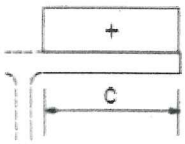
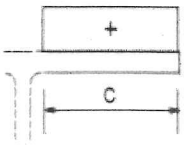


EC3: Tables 5.2

Class	Part subject to bending
Stress distribution in parts (compression positive)	
1	$c/t \le 72\varepsilon$
2	$c/t \le 83\varepsilon$
Stress distribution in parts (compression positive)	
3	$c/t \le 124\varepsilon$
$\varepsilon = \sqrt{235 / f_y}$	f_y





Class	Part subject to compression
Stress distribution in parts (compression positive)	
1	$c/t \le 9\varepsilon$
2	$c/t \le 10\varepsilon$
Stress distribution in parts (compression positive)	
3	$c/t \le 14\varepsilon$
$\varepsilon = \sqrt{235 / f_y}$	f_y 235 / ε 1.00