

CIV-E4040 Reinforced Concrete Structures

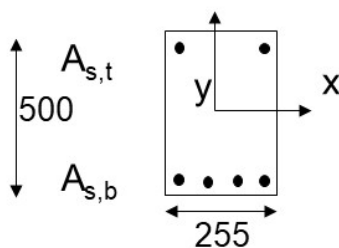
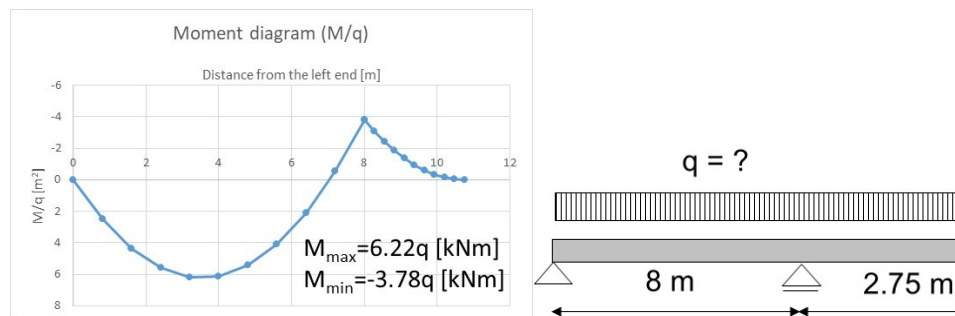
Examination 16.4.2020 (remote examination using My Course)

A precondition for the participation in the examination is the fulfilment of compulsory parts of the course in the spring 2020 or earlier.

Scan your handwritten answers and upload the scanned document as a pdf-file within the period given for this task.

Questions 2 b-d

2. The reinforced concrete beam below has a cross-section $b \times h = 255 \times 500 \text{ mm}^2$. The maximum value for the compression of the concrete is 0.35%. The permanent load q [kN/m] acts downward and includes the mass of the beam. The moment diagram to be used in the items b-d is given below. **(Items b-d altogether 8p)**



- concrete cover 30 mm
- $A_{s,t}$: 402.12 mm²
- $A_{s,b}$: 1963.50 mm²
- diameter of stirrups: 8 mm
- E_s : 200000 MPa
- E_c : 33000 MPa
- ϵ_{cu} : 0.35%
- f_{cd} : 17 MPa
- f_{sd} : 434.78 MPa
- $n = E_s/E_c = 17$ (with the effect of creep)
- partial safety factor of q : 1.35

- b) The beam has a design criterion that the moments caused by the load q shall not exceed cracking moments during the lifetime of the beam. Define the maximum allowable value for the load q by the method of transformed section using a value of 2 MPa for the tension capacity of concrete. **(4p)**
- c) Define the bending capacities of the section and evaluate the ductility of the section. (N.B. to simplify calculations the effect of compressed bars can be ignored in the item c). Compare the section reinforcement to the required minimum reinforcement $A_{s,min} = 0.26 \cdot f_{ctm} \cdot b \cdot d / f_{yk}$, if f_{ctm} is 2.9 MPa and f_{yk} is 500 MPa. **(3 p)**
- d) Conclude if the maximum value for the load q should be selected based on the ultimate limit state capacity (item c) or the allowable cracking moment criterion (item b) in this case. **(1p)**