CIV-E4050 Prestressed and Precast Concrete Structures

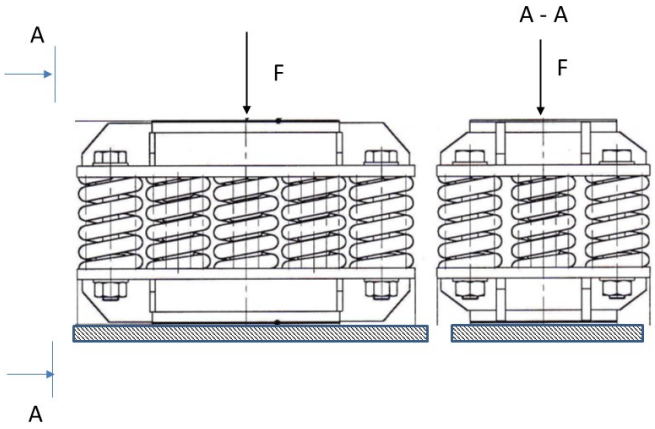
Examination 27.10.2021 (remote examination using My Course)

A precondition for the participation in the examination is the fulfilment of compulsory parts of the course in the autumn 2021 or earlier.

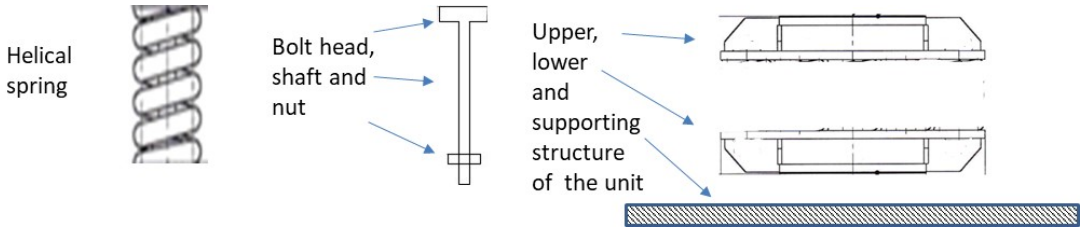
Question 1 (altogether 8 p)

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

1. The figure below represents a prestressed spring unit used for supporting structures and foundations. During the transport and assembly of the unit, it is prestressed upto 70% of its nominal load by four bolts in the corners of the unit.



a) To describe the effect of bolt prestressing (F=0) on the spring unit, the unit can be divided into three main parts. Construct free-body diagrams to describe the effect of prestressing on the spring unit and its support by adding vertical reaction forces to the figures below. (**4p**)



b) Assuming that the total vertical stiffness of springs and bolts is k_s and k_b, respectively, determine the change of axial force in the bolts and springs caused by the compressive force F. (**3p**)

c) Why is it important that during the assembly of the units and construction phase, the force F should usually be smaller than the force caused to the springs by prepressing (**1p**)?

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Question 2

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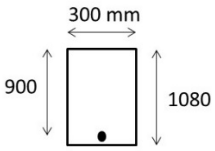
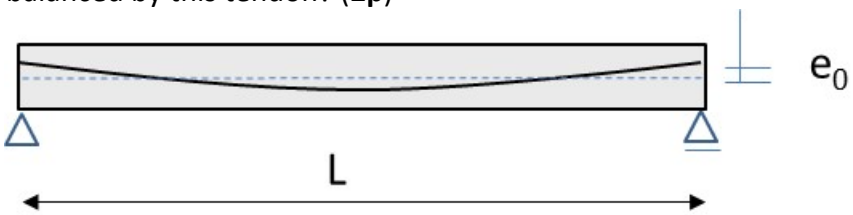
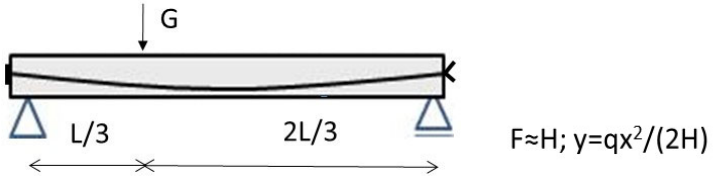
a) The figure represents a section of a concrete beam and the location of a pretressing force of 1500 kN. The external moment creates tension in the lower part of the section. Determine the maximum external moment that the section can carry without any axial tension stresses. The elastic modulus of the concrete is 40000 MPa (**3p**).



b) The figure represents the concrete beam prestressed with a parabolic tendon. At the beam ends, the eccentricity of the tendon from the section neutral plane is e_o. Specify if there are any external vertical loading or combinations of vertical loads that can be balanced by this tendon? (**2p**)

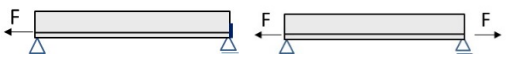


c) Define support reactions of the force G and prestressing force F. The tendon is parabobolic. (**2p**)



d) The equation below can be used for calculating friction losses. Explain why in some cases frictional losses can be decreased by jacking the tendon from its both ends. (**1p**)

$$F = \left(F_0 e^{-\mu\theta}\right) e^{-\mu k x} = F_0 e^{-\mu(\theta + kx)}$$



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Question 3

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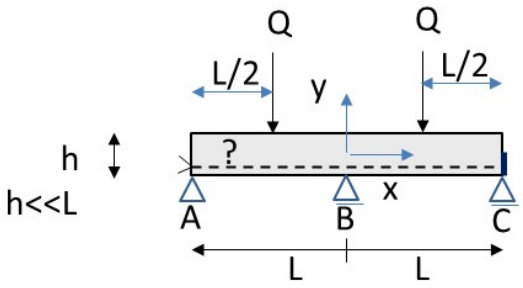
a) The figure below represents a beam supporting two point-loads of Q. Determine the tendon profile y(x) that balances the effect of the point loads on the beam. Express the y(x) as functions of the tendon force F and the allowable maximum excentricity e_0. (**4p**). How does the excentricity e_0 depend on Q, L, F, and the height h. (**1p**)



Support reactions caused by Q
A=C=10*Q/32
B=22*Q/16

b) Justify, if the tendon profile y(x) is concordant or non-concordant. (**3p**)