Aalto University
School of Engineering (ENG)
Department of Civil Engineering Final Exam 26.01.2021

COE-C2001 - Foundations of Solid Mechanics

Please write in every paper: -the name and the number of the course
-the date of the examination
-your name and the student ID
-the name of the department

Note: (1) Closed-book exam. Feel free to use calculator.
(2) Remote exam, as an assignment at MyCourses.
(3) Examination time: 16.30-19.50. 3 hours for the exam, and 20mins reserved for submission.
(4) Questions during exam: you may ask through Zoom chat.
(5) If you cannot submit through MyCourses, please submit by email to rui.hao@aalto.fi and weiwei.lin@aalto.fi, before the deadline.
(6) Q1(15 marks), Q2(15 marks), Q3(20 marks), Q4(20 marks), Q5(10 marks), Q6(20 marks)

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1. For the given state of stress, as shown in **Fig. 1**, determine
   (a) the principal planes;
   (b) the principal stresses;
   (c) the maximum shearing stress and the corresponding normal stress.

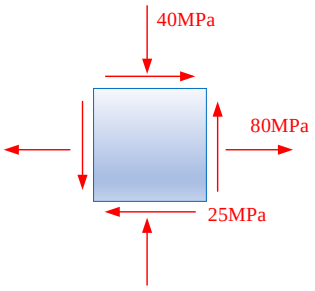

Fig. 1 for Q1

2. The diameters of Shaft AB, Shaft BC, and Shaft CD are d, $2d$, and $4d$, respectively. They are welded at section B and section C, and fixed at the end D. Three shafts are made of the same material with a shear modulus G. If they are subjected to the torques at sections A, B and D as shown in **Fig.2**, determine the (1) maximum absolute shear stress in the shaft, and (2) the angle of twist at section B.

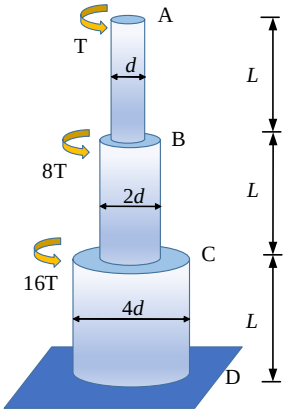

Fig. 2 for Q2

3. The simply supported beam is subjected to a concentrated load, as shown in **Fig.3**. The thickness of the top flange, web, and the bottom flange is taken as 0.01m. (1) Determine the reaction forces at A and B respectively; (2) Draw the shear force and bending moment diagrams; (3) Determine the maximum normal and shear stresses at point D in the given cross section.

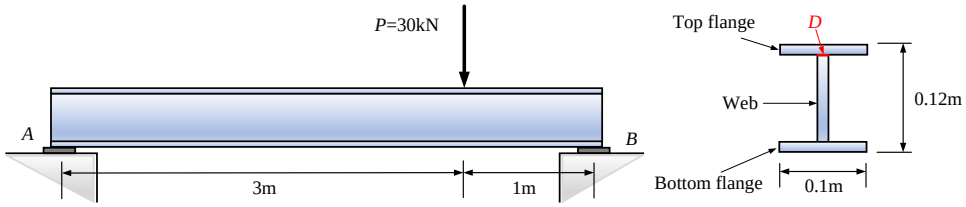

Fig. 3 for Q3

4. Determine the reactions at A and B for the steel bar and loading of **Fig.4**, assuming that a 2.50 mm clearance exists between the bar and the ground before the load was applied. Assume E=200 GPa. The load 600kN was applied at midpoint between C and B.

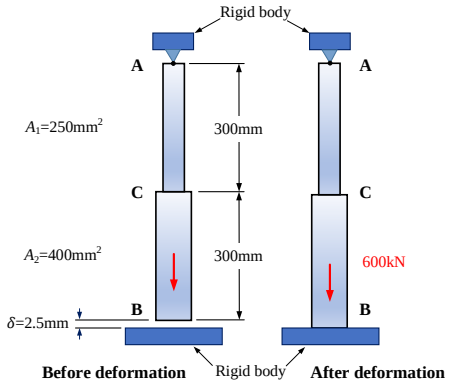

Fig. 4 for Q4

5. The rigid bar AD is attached to two springs of constant k and is in equilibrium in the position shown in **Fig. 5**. Knowing that the equal and opposite loads P and P' remain vertical, determine the magnitude P_{cr} of the critical load for the system. Each spring can act in either tension or compression.

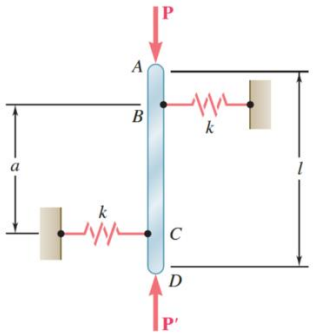

Fig. 5 for Q5

6. For the beam and loading shown in **Fig. 6**, determine the vertical reaction force and bending moment at the end B. (Use either method of superposition or integration)

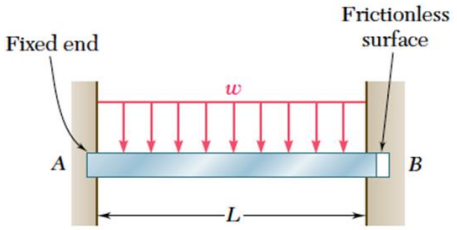

Fig. 6 for Q6