Aalto University
School of Engineering (ENG)
Department of Civil Engineering Final Exam 16.12.2021

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: 17:30-20:45. 3 hours for the exam, and 15 mins 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(20 marks), Q2(20 marks), Q3(20 marks), Q4(20 marks), Q5(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.

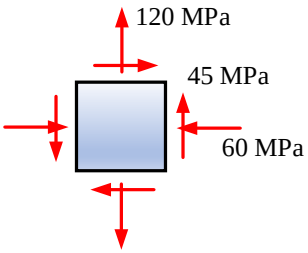

Fig. 1 for Q1

2. Shaft *AC* has a *d* diameter and shaft *CD* has a 2*d* diameter, and they are welded at section *C* and fixed at their ends *A* and *D*. Both are made of the same material with a shear modulus *G*. If they are subjected to a torque *T* at section *B* and a torque 2*T* at section *C* as shown in **Fig. 2**, determine the absolute maximum shear stress in the shaft.

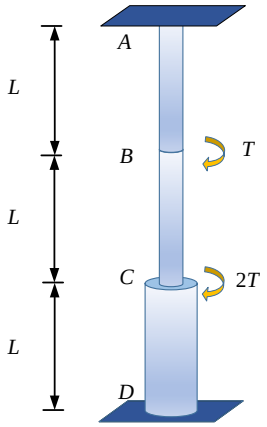

Fig. 2 for Q2

3. As shown in **Fig. 3**, if the bearing plates at *A* and *B* support only vertical forces, a uniform distributed load w = 5 kN/m and a concentrated load P = 15 kN are applied to the I shaped beam (the thickness of the flange is the same as that of web, which is 30 mm), determine
   (a) the maximum and minimum normal stress;
   (b) the maximum shear stress.

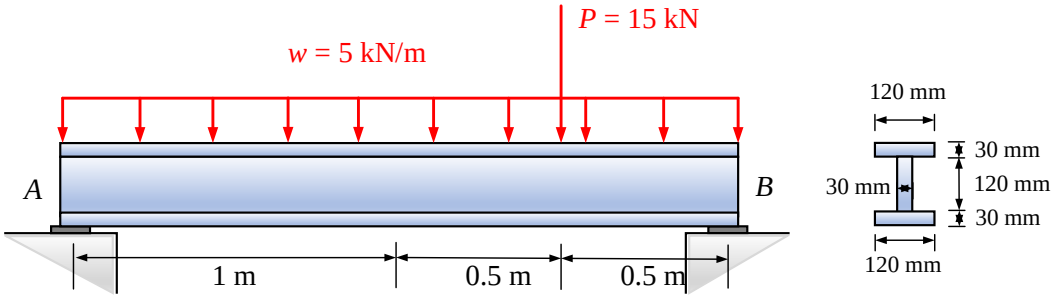

Fig. 3 for Q3

4. A gap δ = 3 mm exists between the ends of the two rods shown in **Fig. 4**, and a force P is applied at the bottom end of rod *A*. Determine the normal stress in the rod *A* and *B* when (a) P=100 kN; (b) P=200 kN.

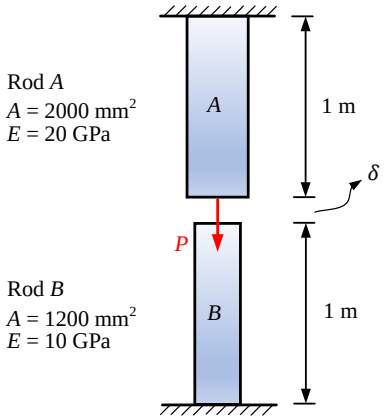

Fig. 4 for Q4

5. Determine the reaction force at roller support *C* and draw the bending moment diagram of the beam shown in **Fig.5**.

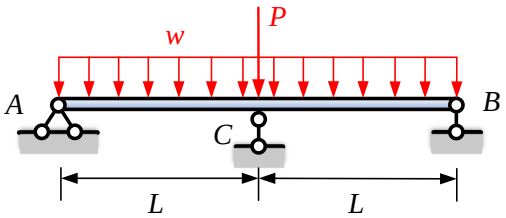

Fig. 5 for Q5