

Exam 1, March 30, 2011

90 minutes

There are 4 pages, 4 problems. Exam is Closed book, closed notes; time yourself....and Good Luck

I)

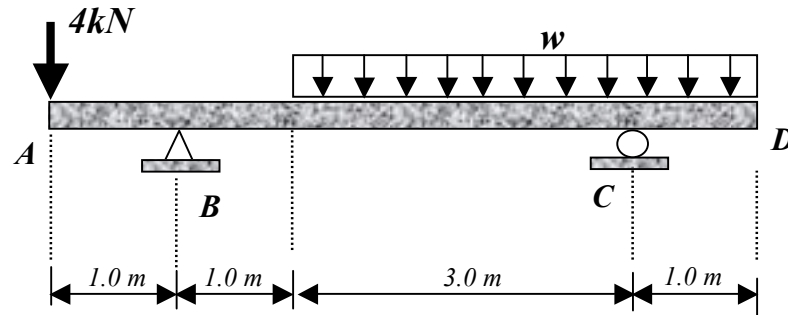


Figure I-a

The rigid beam ABCD shown Figure (I-a) is subjected to a uniform distributed load w and a concentrated load of 4 kN as shown. **Ignore the own weight of the beam and assume linear elastic behavior and small deformations.**

PART [A]: Knowing that $w = 4\text{ kN/m}$, determine the following:

- 1) The support reactions at B and C. (10 points)
- 2) The shearing force diagram (S.F.D) and bending moment diagram (B.M.D) of the beam ABCD. (20 points)

PART [B]

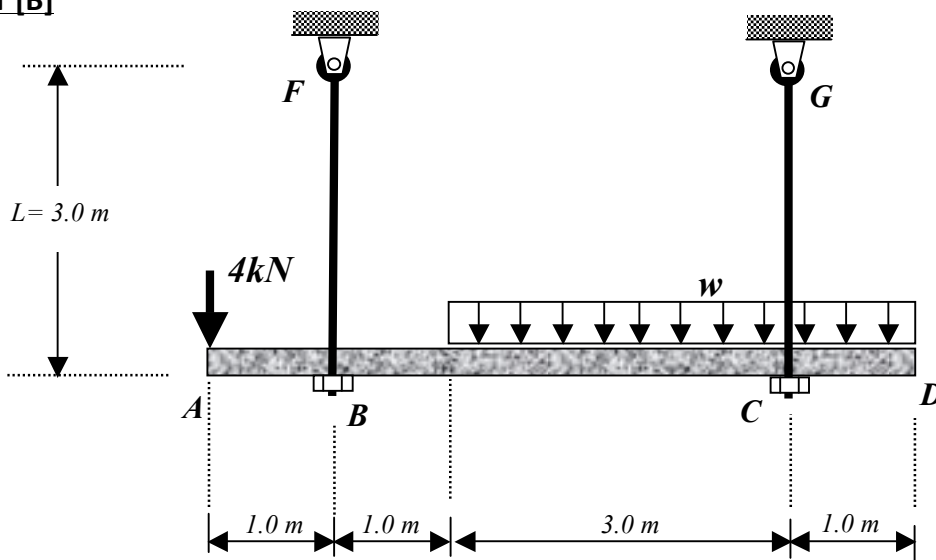


Figure I-b

The structure given in Part [1] was modified such that the supports at B and C were replaced by steel rods BF and CG as shown in Figure (I-b). Rods BF and CG are pin connected at both ends thus resist only axial loads (Beam ABCD will behave the same as in Part 1). The rods have the following properties:

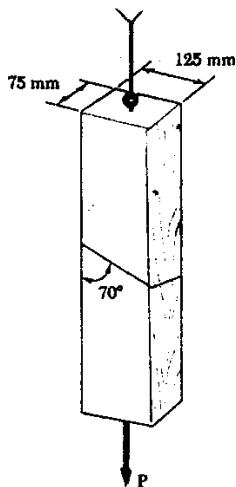
- d_1 : Diameter of Bar BF
- d_2 : Diameter of Bar CG
- $L = 3.0$ m. : Length of Bars BF and CG
- $E = 200 \times 10^6$ kPa (kN/m^2) : Modulus of elasticity of steel
- $\sigma_y = 250,000$ kPa : Yield stress of steel in tension and compression
- F.S = 2.0 : Factor of safety

Solve the following:

The maximum value of w that the structure can safely carry if the diameter of rod BF is 10mm and the diameter of rod CG is twice as much; i.e., $d_2 = 2d_1 = 20\text{mm}$. Assume the beam is always safe. (15 points)

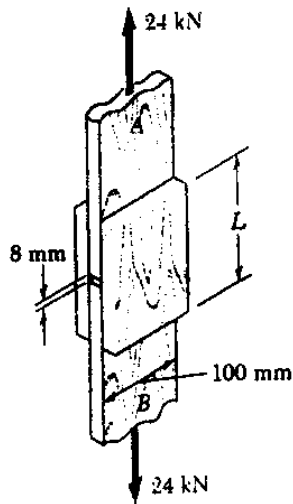
II) The 6- kN load P is supported by two wooden members of 75×125 - mm uniform rectangular cross section which are joined by the simple glued scarf splice shown. Determine the normal and shearing stresses in the glued splice.

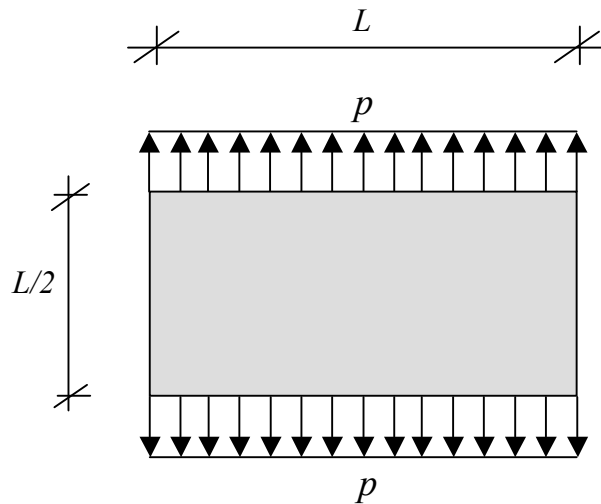
(12 points)



III) The wooden members *A* and *B* are to be joined by plywood splice plates which will be fully glued on the surfaces in contact. As part of the design of the joint and knowing that the clearance between the ends of the members is to be 8 mm, determine the smallest allowable length *L* if the average shearing stress in the glue is not to exceed 800 kPa.

(13 points)



IV:**Figure II**

The thin steel plate of dimensions $L \times 0.5L$ and uniform thickness t , is subjected to a constant pressure p , as shown in Figure II. Assume linear elastic behavior and neglect the own weight of the plate.

The **dimensions** and **properties** of the plate are given as follows:

- $L = 2 \text{ m}$ $t = 2 \text{ cm}$
- $E = 200 \times 10^6 \text{ kPa (kN/m}^2\text{)}$: Modulus of elasticity
- ν : Poisson's ratio

1. Let $p = 3 \times 10^5 \text{ kPa}$ and $\nu = 0.3$

Describe and evaluate the state of stress and strain and compute the final volume of the plate. (15 points)

2. Let $p = 30 \times 10^6 \text{ kPa}$ and $\nu = 0.3$

Explain (maximum 2 lines) how you would evaluate the final volume of the plate. Compute this volume. (10 points)

3. Let $\nu = 0.5$

What is the final volume of the plate? (5 points)