1. As shown in Fig. 1, beam *ACB* is subjected to a concentrated load *P* at point *B*. Point *A* is supported with a hinge, and there is a roller support at point *C*. Beam *ACB* has a flexural rigidity of *EI*. Determine the deflection at point *B* using the Moment-area theorem.
(Ignore the self-weight of the beam, and express the answer in terms of *P*, *EI* and *L*.) (25%)

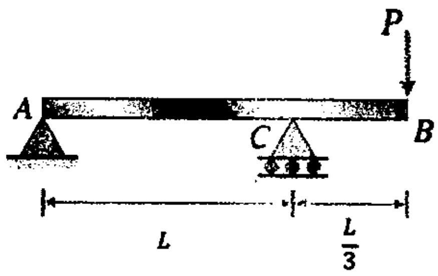

Fig. 1

2. Two cylindrical rods made of the same steel material, are jointed at point C and restrained by fixed ends at point A and D. As shown in Fig. 2, there is an external torque $T = 2$(kN-m) carried at point B. Determine the reactions at point A and D.
(Given $L = 50$(cm), $G = 78$(GPa), $d_1 = 80$(mm), $d_2 = 50$(mm).) (25%)

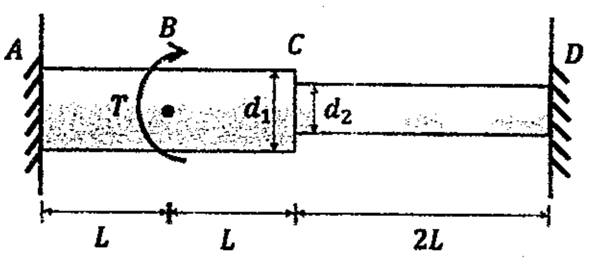

Fig. 2

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3. As shown in Fig. 3, a beam is subjected to a concentrated load P at point D, and the beam has a fixed end at point A, a moment release (i.e., internal hinge) at point B, and a roller support at point C. The beam has flexural rigidity EI, and there is an axial spring with stiffness $k = \frac{EI}{L^3}$ placed at point B to further reduce the deflection at point B.

(a) Draw the shear diagram of the beam. (12%)

(b) Draw the moment diagram of the beam. (13%)

(Express all the answers in terms of E, I, P and L.)

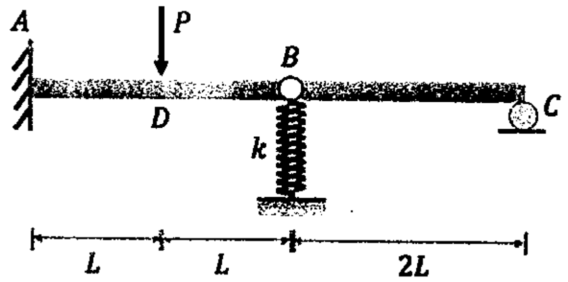

Fig. 3

4. Consider a simply-supported beam with overhang, where point A is pinned support, and point C is a roller, as shown in Fig. 4. Before the concentrated load P is applied at segment AC, beam ACB just rests on top of an axial member BD. Therefore, once the load P is applied, the deflection at point B will induce an axial force for member BD. Assume beam ACB and member BD have the same Young's modulus E, and beam ACB has a flexural rigidity of EI.

(a) Assume that the maximum allowable shortening of member BD is 0.05(mm), what is the maximum permissible concentrated load P?

(Given $E = 200(GPa)$, $L = 1(m)$, $L_c = 1(m)$, $b = 15(mm)$, $h = 30(mm)$, $I = 227630.67(cm^4)$.) (20%)

(b) Will member BD buckle under this maximum permissible concentrated load P? (Hint: consider member BD with a boundary condition of free-pinned column.) (5%)

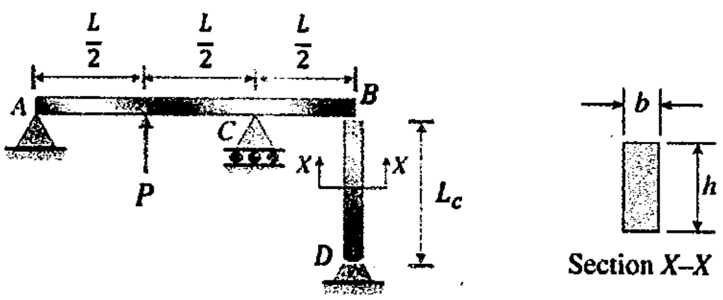

Fig. 4

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