ESO 202A/204: Mechanics of Solids (2016-17 II Semester)
Assignment No. – 2

2.1 A stiff beam is hinged at one end and supported by two springs of spring constant k. Where should a force P be applied (i.e., c/a = ?) so that the effective spring constant at the location of P is 20k/9 (Fig. 2.1)?

2.2 A rigid beam AC is supported at its left end A by a pin. At its right end C it is supported by another rigid bar CF, which is in turn supported by an aluminium rod at D and a steel rod at E. Before any load is applied the rigid bars both are level. A known load P is applied at point F and unknown load Q at point B. Find Q in terms of P if the rigid bar CF is to be level after the two loads are applied (Fig. 2.2).

2.3 Some miners are trapped 1830m below the surface. They make their way to the bottom of the abandoned shaft. At the surface is a hoist with 1824m of steel hoisting rope of 2.54cm dia. A one-meter length of rope weighs 23.38N and has a spring constant of 5.345×10^7 N/m. If you think miners can be hoisted to the surface, explain quantitatively how this can be done (Fig. 2.3).

2.4 Five steel rods each having cross-sectional area of 500 mm^2, are assembled in a symmetrical manner (Fig. 2.4). Determine the deflection of joint A due to downward force, P = 2 MN. Assume that initially the rods are taut, and E = 200 GPa. [Hint: Establish geometrical compatibility and then consider the equilibrium force at joint A]

2.5 When designing electric equipment it is necessary to consider the magnetic forces on the conductors. For instance, in a synchrotron the copper coils alternately expand and contract due to magnetic forces. Consider a case in which the copper coil is placed in a steel ring, as shown (Fig 2.5). Estimate the tangential force in the copper coil when the magnetic force reaches a value of 70 kN/m of circumference, directed radially outwards. E_{steel} =210 GPa, E_{copper} =117 GPa.

2.6 Lightweight rope of area A and modulus of elasticity E is hung over a stationary shaft. A weight W is attached to the longer end, and, at the same time, the rope is forced against the shaft with a horizontal force P just sufficient to prevent the weight from dropping. Find the value of P if the static coefficient of friction between the rope and the shaft is f (Fig 2.6).

2.7 A round disk is attached to three slender members 1, 2 and 3 (Fig.2.7) and it slides in vertical direction within a rigid slot with negligible friction. The bars are made from same material and have same area of cross-section. Determine the internal forces in the slender members and force between the round disk and the walls of the slot if a force P is applied at the pin A in the downward direction.

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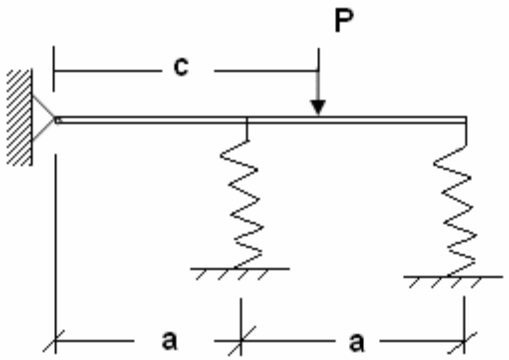

Fig 2. 1

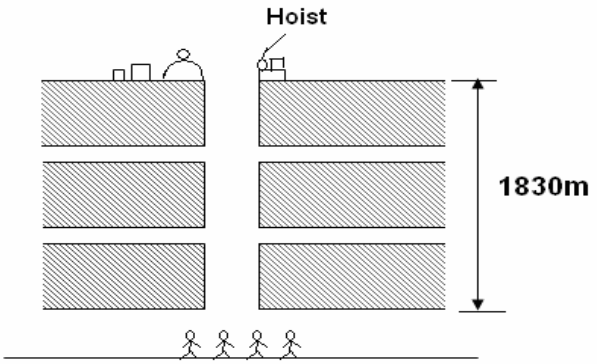

Fig 2.3

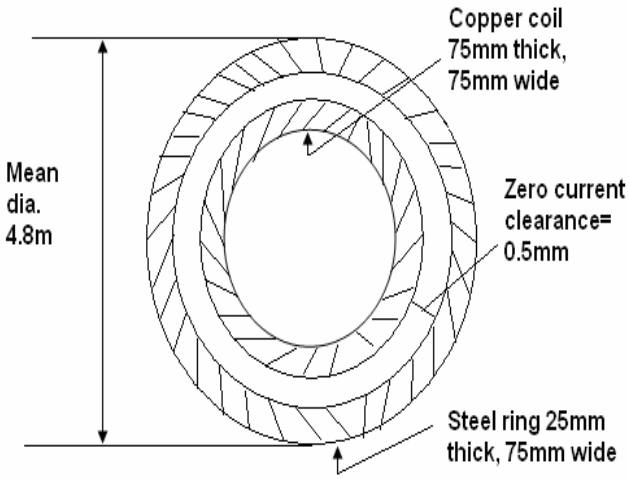

Fig. 2.5

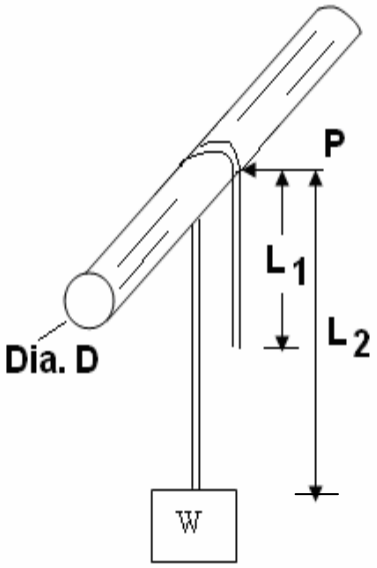

Fig. 2. 6

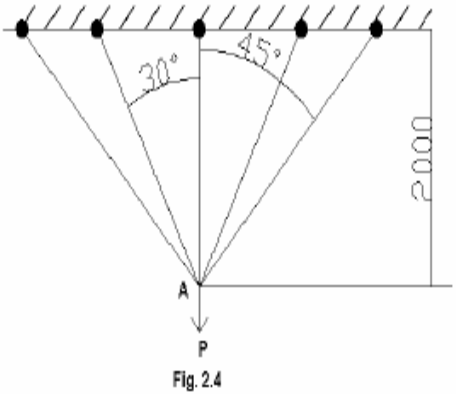

Fig. 2.4

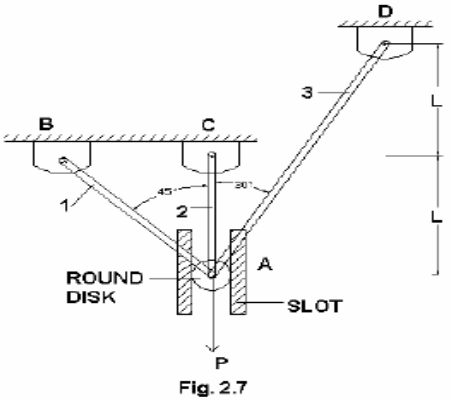

Fig. 2.7

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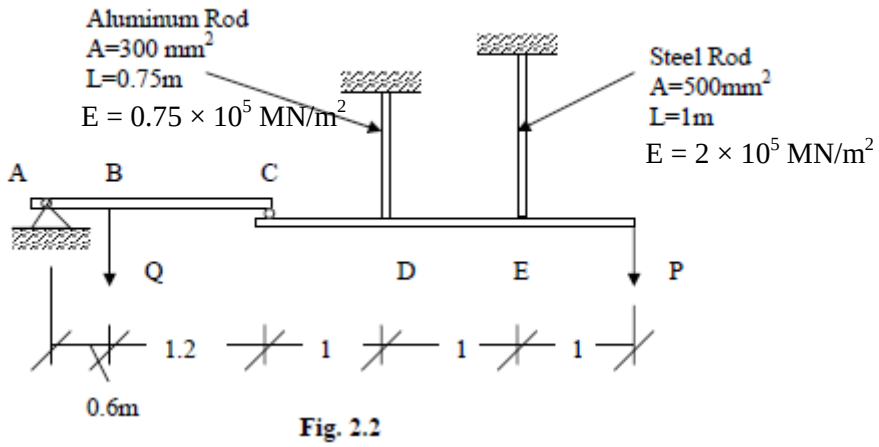

Fig. 2.2