5.5 EXERCISES

Static equilibrium

Ex 5.5.1. A diving board of mass 100 kg and length 4 meters is bolted to two supports separated by 1 meter, one of the support being at the end. A diver of mass 50 kg is standing at the other end of the board. Find the forces at the two support. Ans: 2450 N, down; 3930 N, up.

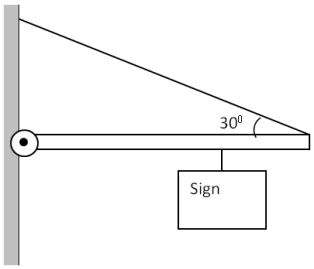

Figure 5.14: Exercise 5.5.2.

Ex 5.5.2. A sign of mass 300 kg is hanging 1 m from the end of a horizontal beam of mass 50 kg and length 3 m held in place by a pin and a cable as shown in the Fig. 5.14. The cable makes an angle of 30° with the beam. Find the tension in the cable and the net force applied by the pin.

Ans: T=4410N, F_{pin} = (4011 N, 17.8°).

Ex 5.5.3. A beam of mass 200 kg and length 3 m is hanging from two cables. One of the cable is attached at the end and the other to the middle of the beam. Find the tension in each cable.

Ans: $T_1 = 0$, T_2 = 1,960 N.

Ex 5.5.4. A traffic signal of mass 20 kg is suspended over a road by the structure shown in Fig. 5.15. The entire structure is secured by the four bolts at the base. What is the tension in the bolts?

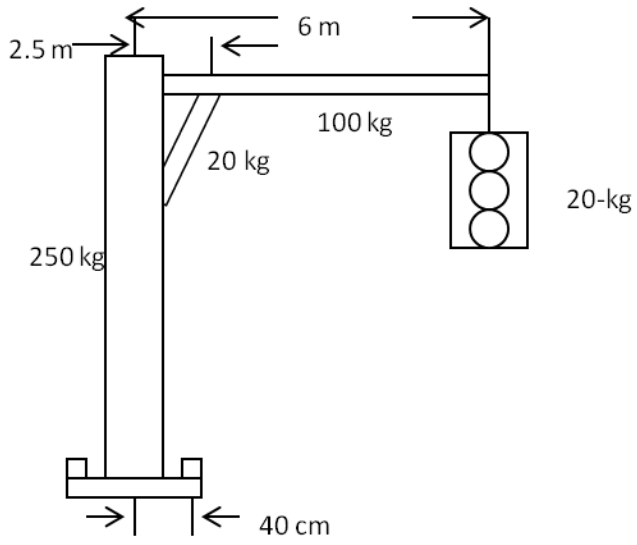

Figure 5.15: Exercise 5.5.4

Stress

Ex 5.5.5. A 30 kg mass is hung from a 1-mm diameter steel wire. Find the stress in the wire and the percent elongation. Young's modulus of steel = 2.15×10^{11} Pa

Ans: 3.75×10^8 Pa; 0.175%

Ex 5.5.6. How much mass must be hung from a 1-mm diameter steel wire before it breaks? Use breaking stress = 400 MPa.

Ans: 32 kg.

Ex 5.5.7. While deep sea diving, one must take into account the enormous pressure at great depths under water. At 3000 m depth, the pressure would be approximately 30 MPa, which will crush a ball of steel. (a) What is the percentage change in volume of a spherical solid ball of steel when it is sent to a depth of 3000 m in water? (b) What is the percentage change in diameter?

Ans: (a) 0.018%; (b) 0.006%

Ex 5.5.8. What is the tallest building one can build using concrete wall of thickness 10 cm? Assume 2400 kg/m^3 for the density of concrete. Use 20 MPa for the breaking stress.

Ans: 850 meters.

Ex 5.5.9. A rectangular parallelepiped shaped jello with dimensions 5 cm $\times$ 4 cm $\times$ 3 cm is resting on a plate. A glass slide is glued to the top surface. A force of 30 mN is applied to the glass plate deforming the jello sideways. What is the angle of deformation if the jello has a shear modulus of 1000 Pa?

Ans: 0.015 rad.

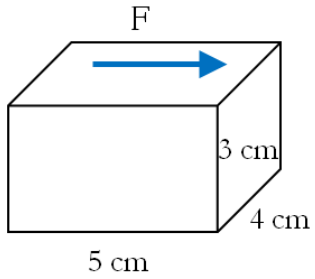

Figure 5.16: Exercise 5.5.9.