2.146

2.146 A 2-ft-thick block constructed of wood ($SG = 0.6$) is submerged in oil ($SG = 0.8$). and has a 2-ft-thick aluminum (specific weight = 168 lb/ft^3) plate attached to the bottom as indicated in Fig. P2.146. Determine completely the force required to hold the block in the position shown. Locate the force with respect to point A.

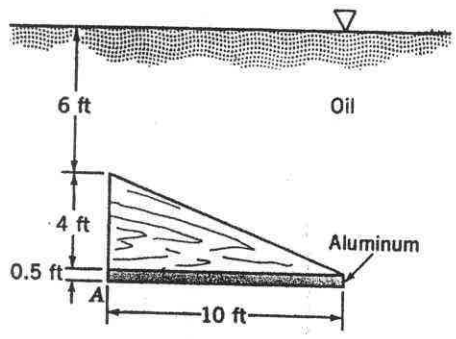
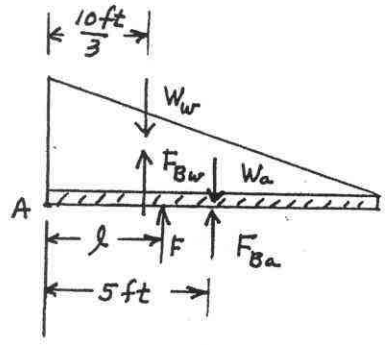


FIGURE P2.146



w ~ wood
a ~ aluminum
F ~ force to hold block

For equilibrium,

$$\Sigma F_{vertical} = 0$$

so that

$$F = W_w - F_{Bw} + W_a - F_{Ba}$$

where:

$$W_w = (SG_w)(\gamma_{H_2O})\forall_w$$

$$= (0.6)\left(62.4\frac{lb}{ft^3}\right)\left(\frac{1}{2}\right)(10ft \times 4ft \times 2ft) = 1500\ lb$$

$$W_a = \left(168\frac{lb}{ft^3}\right)(0.5ft \times 10ft \times 2ft) = 1680\ lb$$

$$F_{Bw} = (SG_{oil})(\gamma_{H_2O})\forall_w = (0.8)\left(62.4\frac{lb}{ft^3}\right)\left(\frac{1}{2}\right)(10ft \times 4ft \times 2ft) = 2000\ lb$$

$$F_{Ba} = (SG_{oil})(\gamma_{H_2O})\forall_a = (0.8)\left(62.4\frac{lb}{ft^3}\right)(0.5ft \times 10ft \times 2ft) = 499\ lb$$

Thus,

$$F = 1500\ lb - 2000\ lb + 1680\ lb - 499\ lb = \underline{681\ lb\ upward}$$

Also,

$$\Sigma M_A = 0$$

so that

$$\ell F = \left(\frac{10}{3}ft\right)(W_w - F_{Bw}) + (5ft)(W_a - F_{Ba})$$

or

$$\ell\,(681\ lb) = \left(\frac{10}{3}ft\right)(1500\ lb - 2000\ lb) + (5ft)(1680\ lb - 499\ lb)$$

and

$$\underline{\ell = 6.22\ ft\ \text{to right of point A}}$$