5/181 The barge crane of rectangular proportions has a 12-ft by 30-ft cross section over its entire length of 80 ft. If the maximum permissible submerged weight in sea water is represented by the position shown, determine the corresponding maximum safe load $w$ which the crane can handle at the 20-ft extended position of the boom. Also find the total displacement $W$ in long tons of the unloaded barge (1 long ton equals 2040 lb). The distribution of machinery and ballast places the center of gravity $G$ of the barge, minus the load $w$, at the center of the hull.

Ans. $w = 100,600$ lb, $W = 306$ long tons

$W = B - w = 921600 - 100,765 = 820,835$ lb

or $W = 820,835 \text{ lb} = 366.4$ long tons

5/211 The figure shows the cross section of a rectangular gate 4 m high and 6 m long (perpendicular to the paper) which blocks a fresh-water channel. The gate has a mass of 8.5 Mg and is hinged about a horizontal axis through $C$. Compute the vertical force $P$ exerted by the foundation on the lower edge $A$ of the gate. Neglect the mass of the frame to which the gate is attached.

Ans. $P = 348$ kN
6.7 The light bar is used to support the 50-kg block in its vertical guides. If the coefficient of static friction is 0.30 at the upper end of the bar and 0.40 at the lower end of the bar, find the friction force acting at each end for $x = 75$ mm. Also find the maximum value of $x$ for which the bar will not slip.

Ans. $F_A = F_B = 126.6$ N, $x_{max} = 86.2$ mm

To calculate $x_{max}$ when bar will not slip

Bar first slips at $B$ when $\theta = \phi_B = 16.7^\circ$

$\therefore x_{max} = \frac{300 \sin 16.7^\circ}{16.7^\circ} \approx 86.2$ mm

$\Rightarrow x_{max} = 86.2$ mm

6.13 The uniform pole of length $l$ and mass $m$ is placed against the supporting surfaces shown. If the coefficient of static friction is $\mu_s = 0.25$ at both $A$ and $B$, determine the maximum angle $\theta$ at which the pole can be placed before it begins to slip.

Ans. $\theta = 59.9^\circ$

FBD of the light bar:

- From action reaction, $W$ is the vertical component of the force of block on rod.
- $W = 50 \times 9.81 \text{ N} = 490.5$ N

Problem 6/7

FBD of block:

$\therefore F_A = F_B = W \tan \theta = 126.6$ N

(Continued)
6.13 (cont'd)

Solving 1 and 2, we get

\[ N_A = 0.244 \text{mg}, \quad N_B = 0.878 \text{mg} \]

\[ \Sigma M_c = 0: -N_A \left( \frac{L \sin \alpha}{\sin 10^\circ} \right) + N_B \left( \frac{L \sin (75^\circ - \alpha)}{\sin 10^\circ} \right) - mg \left( \frac{L \sin (75^\circ - \alpha)}{\sin 10^\circ} \right) - \frac{L}{2} \cos \alpha = 0 \]

\[ \Rightarrow 0 \]

Solving 3, we obtain \[ \theta = 59.9^\circ \]

6.29

The movable left-hand jaw of the C-clamp can be slid along the frame to increase the capacity of the clamp.

To prevent slipping of the jaw on the frame when the clamp is under load, the dimension \( x \) must exceed a certain minimum value. For given values of \( a \) and \( b \) and a static friction coefficient \( \mu_s \), specify this design minimum value of \( x \) to prevent slipping of the jaw.

Annotated:

\[ x = \frac{a - b \mu_s}{2 \mu_s} \]

![Diagram of C-clamp with dimensions labeled]

Problem 6.29

FBD:

There are only 3 forces acting: Horizontal force \( P \), forces \( R_1 \) and \( R_2 \) as shown.

Since it is a 3-force member for equilibrium, \( P, R_1, \) and \( R_2 \) must be concurrent at \( O \).

When the jaw starts to slip, \( \phi = \tan^{-1}(\mu_s) \) and \( x = x_{\text{min}} \).