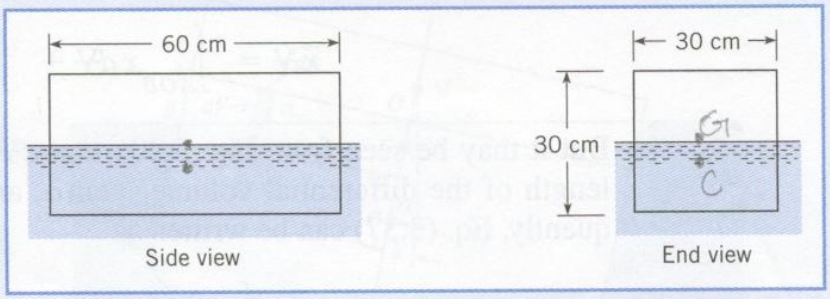
example 3.15

A block of wood 30 cm square in cross section and 60 cm long weighs 318 N. Will the block float with sides vertical as shown?



Solution First determine the depth of submergence of the block. This is calculated by applying the equation of equilibrium in the vertical direction.

$$\Sigma F_y = 0$$

$$-\text{weight} + \text{buoyant force} = 0$$

$$-318\ \text{N} + 9810\ \text{N/m}^3 \times 0.30\ \text{m} \times 0.60\ \text{m} \times d = 0$$

$$d = 0.18\ \text{m} = 18\ \text{cm}$$

Determine whether the block is stable about the longitudinal axis:

$$GM = \frac{I_{00}}{\forall} - CG = \frac{\frac{1}{12} \times 60 \times 30^3}{18 \times 60 \times 30} - (15 - 9)$$

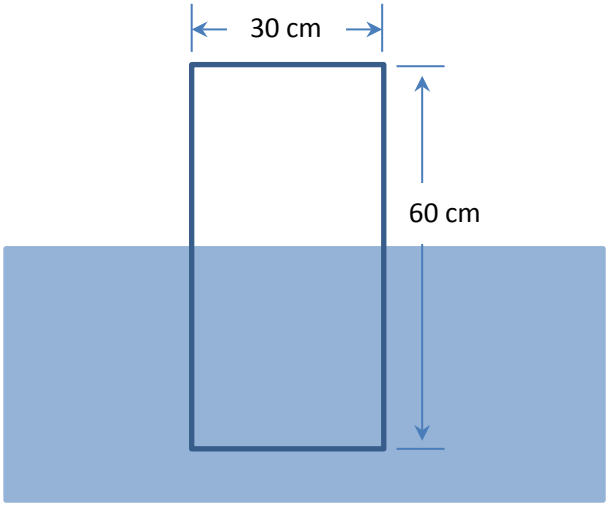
$$= 4.167 - 6 = -1.833\ \text{cm}$$

Because the metacentric height is negative, the block is not stable about the longitudinal axis. Thus a slight disturbance will make it tip. Next, check to see if the block is stable about the transverse axis:

$$GM = \frac{\frac{1}{12} \times 30 \times 60^3}{18 \times 30 \times 60} - 6 = 10.67\ \text{cm}$$ ◁

The block is stable about the transverse axis and will float with the short sides vertical.

Continued from Example 3.15



$$\sum F_y = 0$$

$$-W + F_B = 0$$

$$-318\ N + 9810\ N/m^3 \times 0.3\ m \times 0.3\ m \times d = 0$$

$$d = 0.36\ m = 36\ cm$$

$$GM = \frac{I_{OO}}{\forall} - CG = \frac{\frac{1}{12}\times 30\times 30^3}{36 \times 30 \times 30} - (30 - 18)$$

$$= 2.08 - 22 = -19.92\ cm$$

Thus, the block is unstable.