A small navigation channel of rectangular x-section contains still water 6’ deep. The sudden opening of a lock gate sends a surge 1.0’ high moving down the channel with a velocity of 15.6 fps; find the mean velocity of the water behind the surge.

SOLUTION:

Governing principle is conservation of mass. Observer is located on the surge crest and moving with it.

\[ d_1 := 6 \text{ ft} \quad d_{\text{surge}} := 1.0 \text{ ft} \]

\[ v_{\text{pt}_1} := -15.6 \text{ ft/sec} \quad \text{to the left based on observer on wave} \]

\[ v_{\text{pt}_2} = v_{\text{pt}_1} + \Delta V \]

Mass of water is conserved between point 1 and 2.

\[ d_1 \cdot v_{\text{pt}_1} = (d_1 + d_{\text{surge}}) \left( v_{\text{pt}_1} + \Delta V \right) \]

\[ \Delta V := d_{\text{surge}} \cdot \frac{v_{\text{pt}_1}}{-(d_1 + d_{\text{surge}})} \]

\[ \Delta V = 2.229 \text{ ft/sec} \]

\[ v_{\text{pt}_2} := v_{\text{pt}_1} + \Delta V \]
velocity_{pt2} = \frac{-13.371}{\text{sec}} \text{ ft/ sec}

Direction of travel is to the left based on the observer on the wave front, to the right based on observer on the shore.

**NOTES:** In order to conserve mass from the point of view of the observer, the water behind the surge must be moving with a velocity less than the water in front of the wave since the depth is greater.