The head in the inlet reservoir on the left is 20 m and the outlet reservoir on the right is 12 m. Properties of the sand are: \( K = 1 \times 10^{-3} \text{ m/s} \). Draw and label a flow net. Calculate the discharge through the system using units of meters and seconds. What is the head at the location of the * at the top of the tank? What is the pressure at that location?

\[ K = 0.53 \text{ m/day} \]

**Draw the flow net**

**Calculate** \( Q = 0.53 \text{ m/day} \times 10 \text{ m} = 5.3 \text{ m}^2/\text{day} \)

**What is the maximum gradient?** \( \sim 1 \)

**What are the head and pressure at the *?** \( \sim 25 \text{ m and 8 m} \)

We can use the flow net to identify areas where critical gradients may occur and determine the magnitude of the gradient at those locations.

- equipotential lines parallel constant head boundaries
- flow lines parallel no-flow boundaries
- streamlines are perpendicular to equipotential lines
- equipotential lines are perpendicular to no-flow boundaries
- form squares by intersecting stream and equipotential lines
Stress caused in soil by flow  =  j  = i_{yw}
If flow is upward, stress is resisted by weight of soil
If j exceeds submerged weight of soil, soil will be uplifted

For uplift to occur  j > \gamma_{submerged soil} = \gamma_t - \gamma_w
where:  \gamma_t - unit saturated weight of soil
\gamma_w - unit weight of water
then for uplift to occur:
\[ i \gamma_w > (\gamma_t - \gamma_w) \]
the critical gradient for uplift then is:
\[ i_{critical} = \frac{\gamma_t - \gamma_w}{\gamma_w} \]

What is the critical gradient for a soil with 30% porosity and a particle density of 2.65 g/cc (165 lb/ft³)?
\[ \gamma_t = 0.7 \times 165 + 0.3 \times 62.4 = 134 \text{ lb/ft}^3 \]
\[ i_{critical} = \frac{134 - 62.4}{62.4} = 1.15 \]

What is the flux under the sheet pile wall if K=2ft/day?
Will piping occur?
\[ Q = q_A n_f = KH \frac{n_f}{n_d} \]

Q = KH(\gamma_t/\gamma_w) = 2 ft/d 10 ft 4/10 = ~ 8 ft³/day
Using:  \gamma_t = 0.7 \times 165 + 0.3 \times 62.4 = 134 \text{ lb/ft}^3 \]
\[ i_{critical} = \frac{134 - 62.4}{62.4} = 1.15 \]
gradient is ~1.0 at the critical location, so it looks OK
What could change that? How could you correct it?