ENVIRMONENTAL GEOTECHNICS MKAJ 1083

TOPIC 7: Vertical barrier walls

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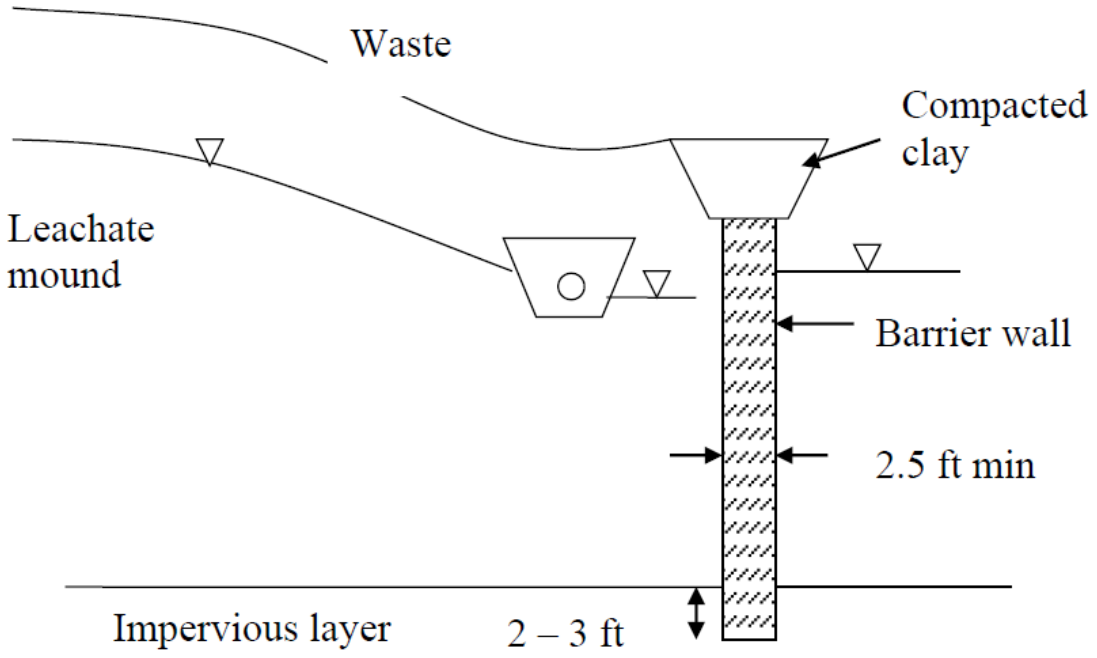
Vertical Barrier Wall



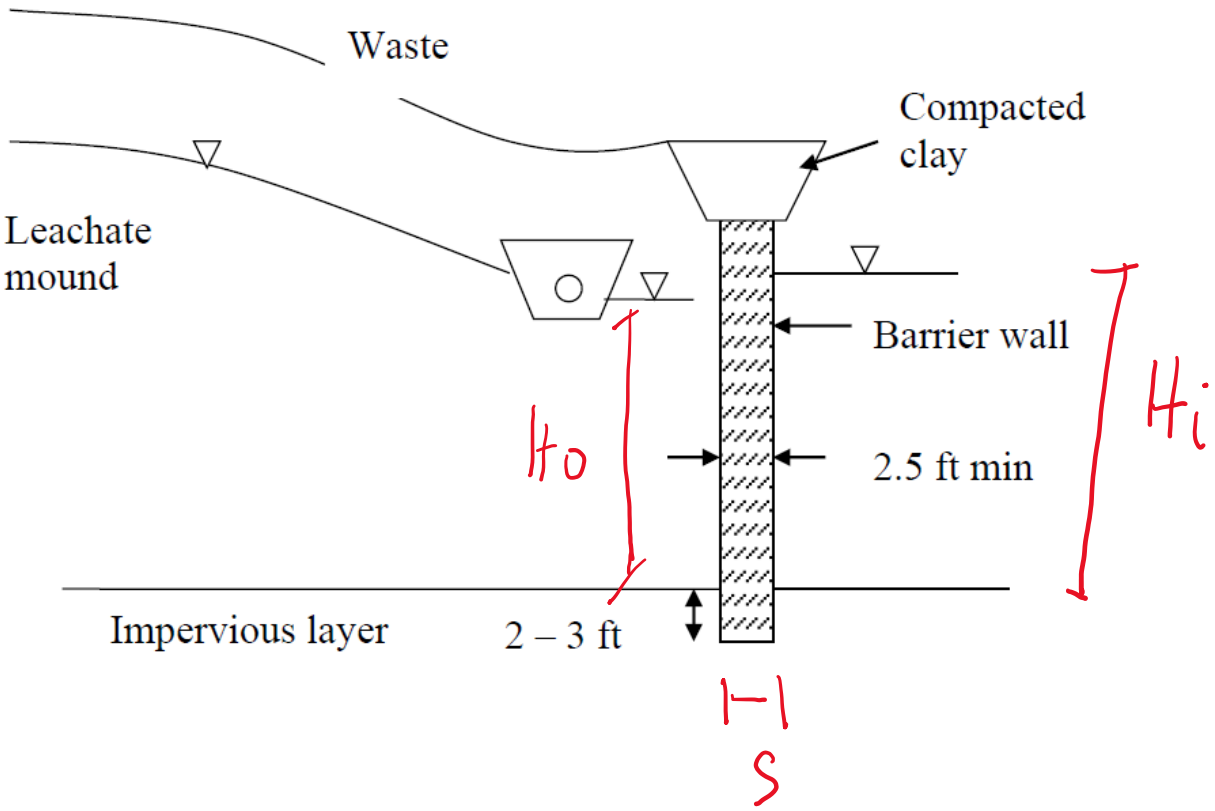
- Installed in old landfill
- Installed around the facility and is keyed into a low permeability soil.
- A leachate collection system is placed inward (landfill) side of the wall
- The type of wall:
  - soil-bentonite (SB) wall
  - mixed in place (MIP)
  - cement-bentonite (CB)
  - plastic concrete (PC)

Flow across slurry wall

Based on Darcy's law,

$$q = k_w i$$

$$= [(H_i - H_o)/s]k_w$$



q = volume of flow per unit area of the

k_w = hydraulic conductivity of the wall

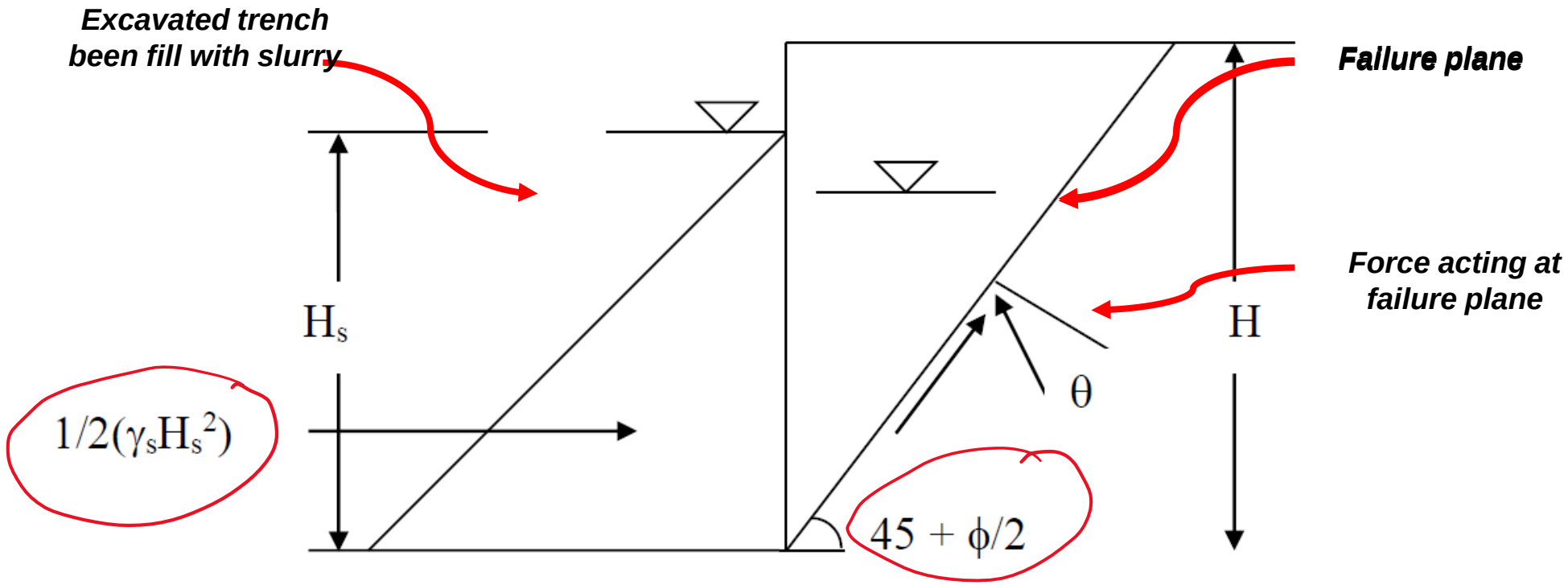
i = hydraulic gradient

H_i = hydraulic head of the inboard side

H_o = hydraulic head of the outboard side

s = thickness of the wall

Stability of vertical wall



$$\left[\frac{1}{2}\left(\gamma H^2\right)\cot\alpha - P_w\cos\alpha\right]M + P_w\sin\alpha = \frac{1}{2}\gamma_s H^2$$

$$M = \frac{\left[\tan\alpha - \frac{\tan\phi}{F}\right]}{\left[1 + \frac{\tan\alpha\tan\phi}{F}\right]}$$

Slurry properties

$$\gamma_s = 7.48 m_b + \gamma_w / \left(1 + \left(7.48 m_b / G_s \gamma_w\right)\right)$$

Where

- mb = bentonite content (lb bentonite/gal of water)
- Gs = specific gravity of bentonite 2.77
- γw = unit weight of water (62.4 lb/ft3)
- γ s = unit weight of slurry

Transit time

- Contaminants in leachate can penetrate and exit the liner by advection or seepage of fluid thru the liner under hydraulic gradient, or by chemical diffusion (under concentration gradient) or both.
- Necessary to limit the transit times to no less than 30 – 50 years to assess the liner thickness.
- For transport by seepage thru the liner (advection), assuming the suction head at the wetting zone front is zero
- The hydraulic gradient is :

$$i = (y_{max} + d)/d$$

and the specific discharge (Darcy velocity) is

$$q_1 = k_1 i$$

Seepage velocity is

$$v_s = q_1 / n_e$$

Where

d = liner thickness

n_e = effective porosity available for flow

y_{max} = maximum leachate depth above liner

The transit time then is

$$t = d/v_s = \frac{n_e d^2}{(k_1(d + y_{max}))}$$

If suction is considered at the base of the liner

$$t = \frac{n_e d^2}{(k_1(d + y_{max} - h_s))}$$

Where h_s is the suction head ($h_s \leq 0$)


thank you

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TOPIC 8: Liner Efficiency

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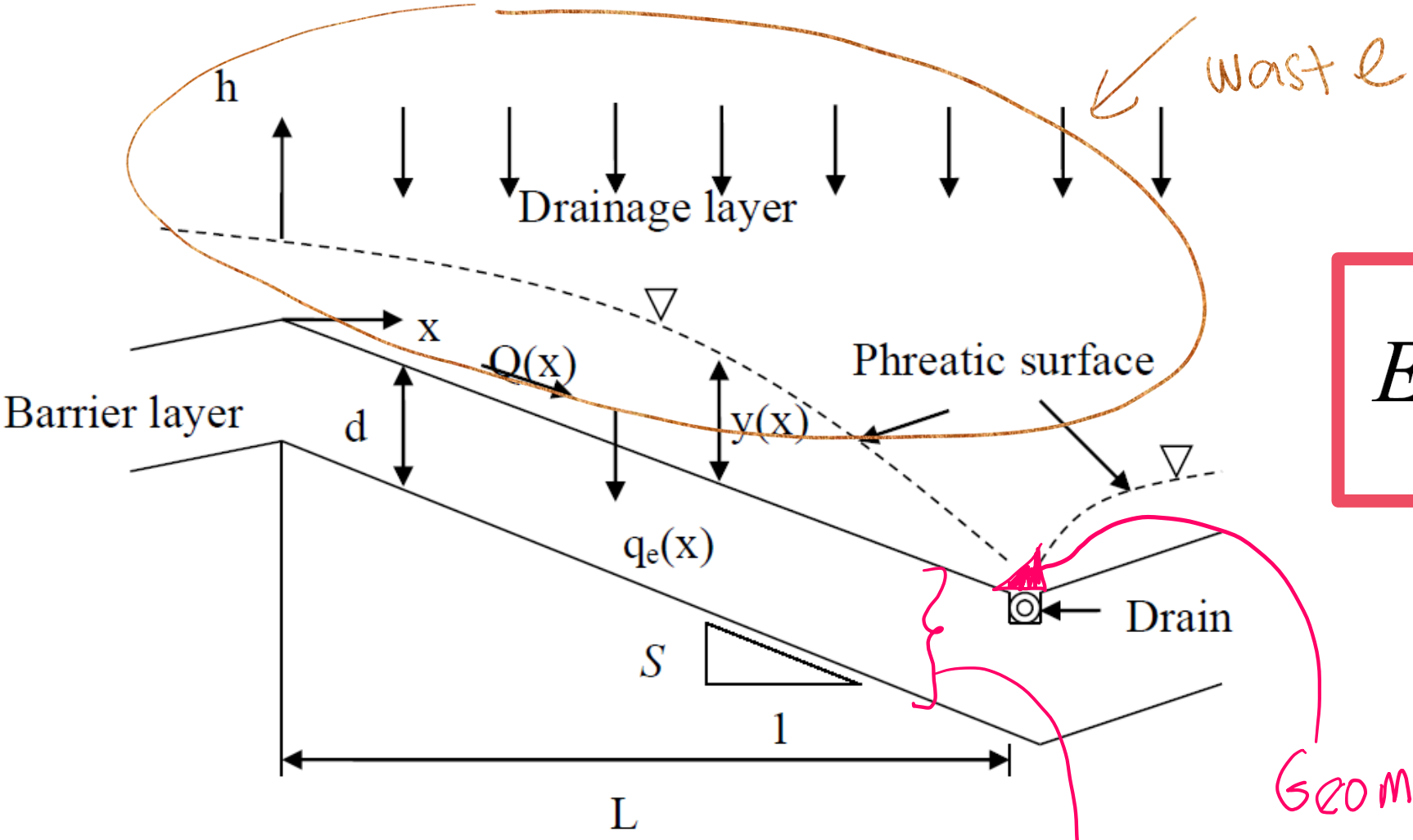
Liner efficiency



$$E = 100\left(1 - \frac{q_1}{q_o}\right)$$

Waste

Geomembrane

Soil liner

$$E = 100\left(1 - \frac{q_1}{q_o}\right)$$

$$\frac{q_1}{q_0} = \left(1 + \frac{y_{av}}{d}\right)\left(\frac{k_1 t_0}{q_0} + 0.64\frac{n_e y_{av}}{q_0} M_0^{0.91}\right)$$

$$M_0 = \frac{k_1 L}{k_d S y_{av}}$$

$$y_{av} = y_s\left[1 - \exp\frac{(k_1 - e)}{n_e y_s} t_0\right]$$

$$y_s = \frac{\pi L}{4}\sqrt{\frac{e - k_1}{k_d}}(0.403)^{m'}$$

$m = (e\text{-}k_1)/(0.4S^2k_d)$

$if\ m \le 1.0,\ y_s = [(e\text{-}k_1)L]/(2Sk_d)$

$m' = (m)^{-0.55}$

q_o = inflow volume per unit horizontal area

= et_o [L]

e = inflow rate to the drainage layer (discharge per unit horizont

area) [L/T]

t_o = duration of inflow period [T]

q_1 = leakage volume per unit horizontal area [L]

y_{av} = average saturated depth during time t_o [L]

y_s = steady state average saturated depth [L]

d = thickness of liner [L]

k_1 = vertical hydraulic conductivity of the liner [L/T]

k_d = lateral hydraulic conductivity of the drainage layer [L/T]

n_e = effective porosity of the drainage layer

L = max horizontal drainage distance [L]

S = slope of liner


thank you