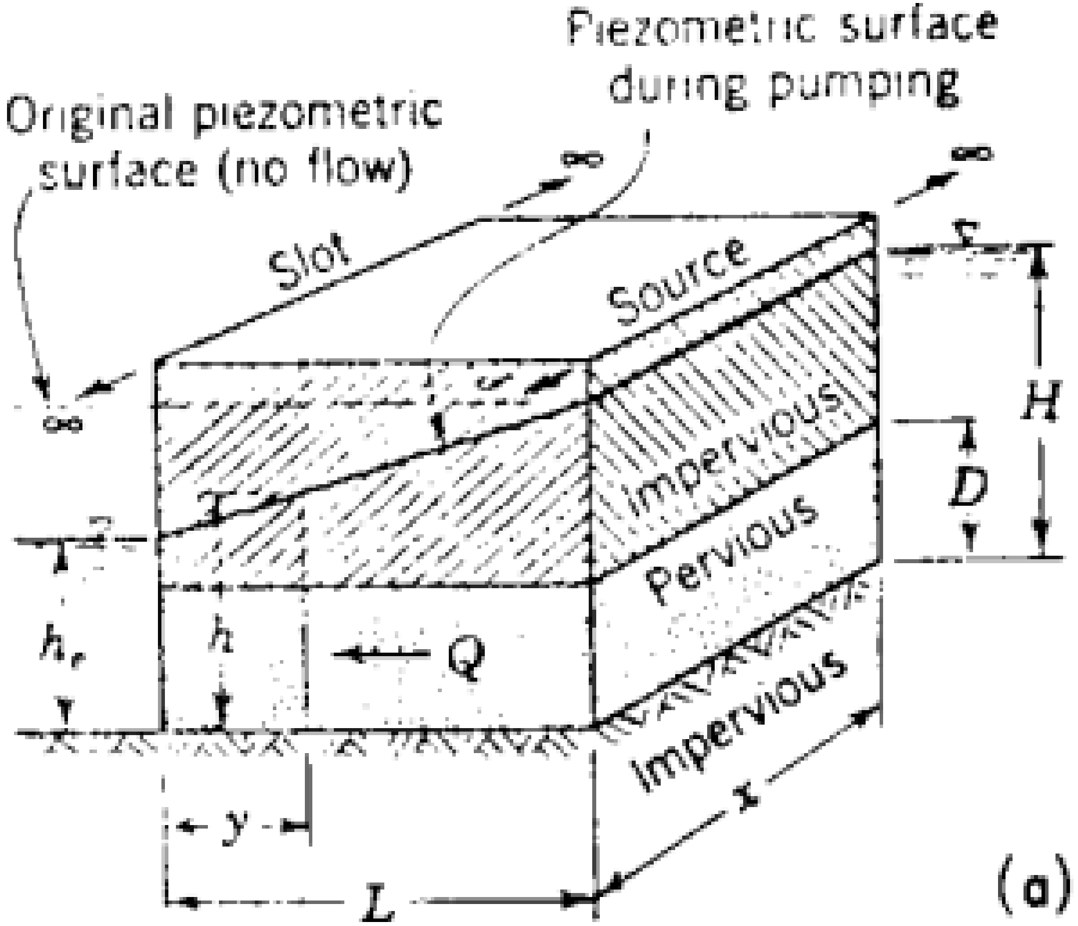
Dewatering

GRADUATION PROJECT

GEOTECHNICAL ENGINEERING

Contents

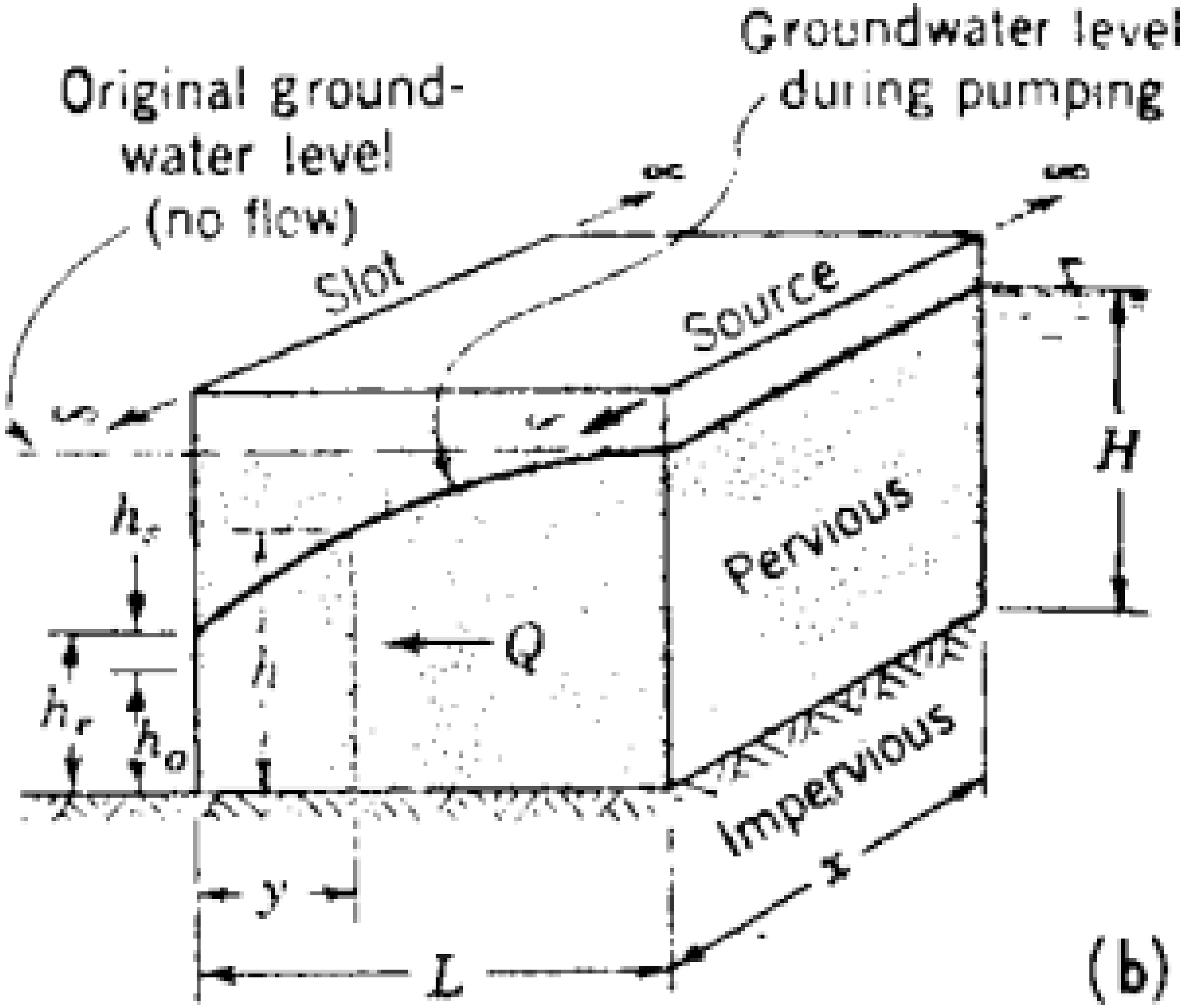
Flow and drawdown to Slots



$$Q = \frac{KD}{L}(H - h_e)$$

per meter length

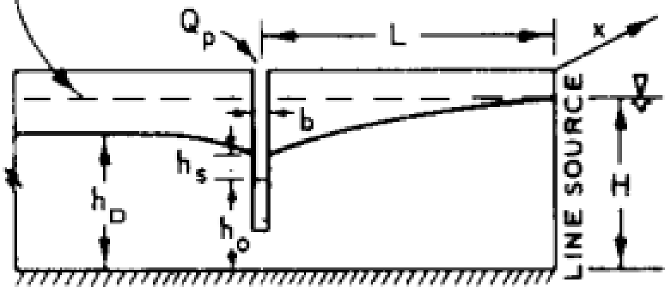
Flow and drawdown to Slots



$$Q = \frac{K}{2L}(H^2 - h_o^2)$$

per meter length

Partial Penetrating Slots



h_s IS OBTAINED FROM FIG. 4-2; (c)

FLOW

$$Q_p = \left(0.73 + 0.27\frac{H - h_o}{H}\right)\frac{kx}{2L}\left(H^2 - h_o^2\right) \quad (3)$$

WHERE $L \geqq 3H$

MAX RESIDUAL HEAD DOWNSTREAM OF SLOT

$$h_D = h_o\left[\frac{1.48}{L}(H - h_o) + 1\right] \quad (4)$$

GRAVITY FLOW

$$R = C\,(H - h_w)\sqrt{k} \quad (1)$$

WHERE R, H, AND h_w ARE DEFINED PREVIOUSLY AND EXPRESSED IN FEET. COEFFICIENT OF PERMEABILITY, k, IS EXPRESSED IN 10^{-4} CM/SEC.

AND C = 3 FOR ARTESIAN AND GRAVITY FLOWS TO A WELL.

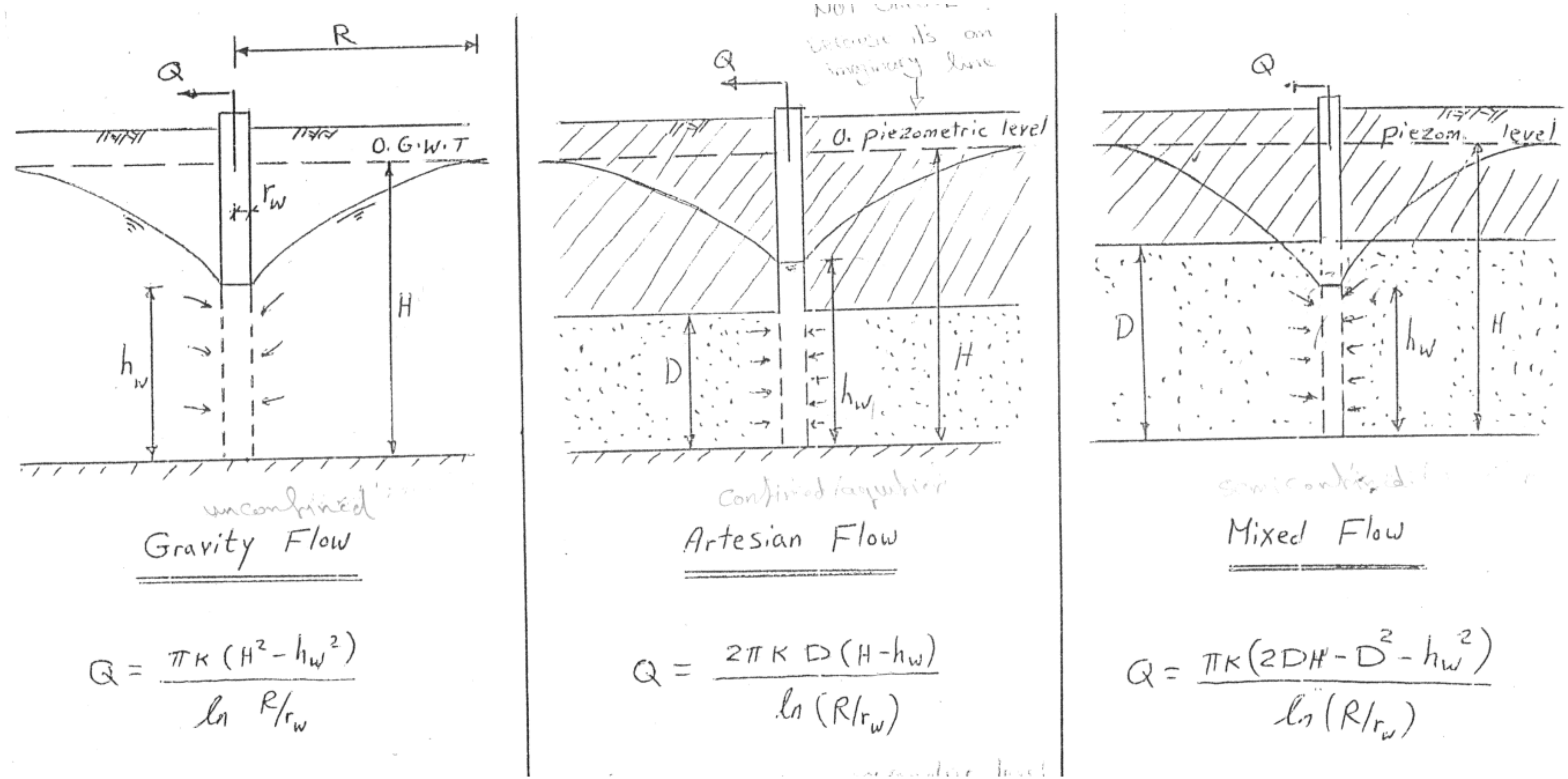
C = 1.5 TO 2.0 FOR A SINGLE LINE OF WELLPOINTS.

Equivalence to well point system

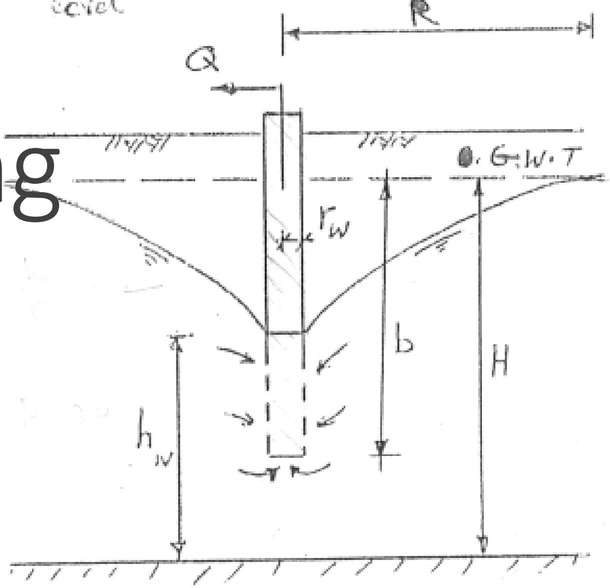
where L = distance to line source

OR $L \approx 150\,(H - h_0)\sqrt{k}$ .... (k in cm/sec)

Flow to Wells



Partially Penetrating Wells

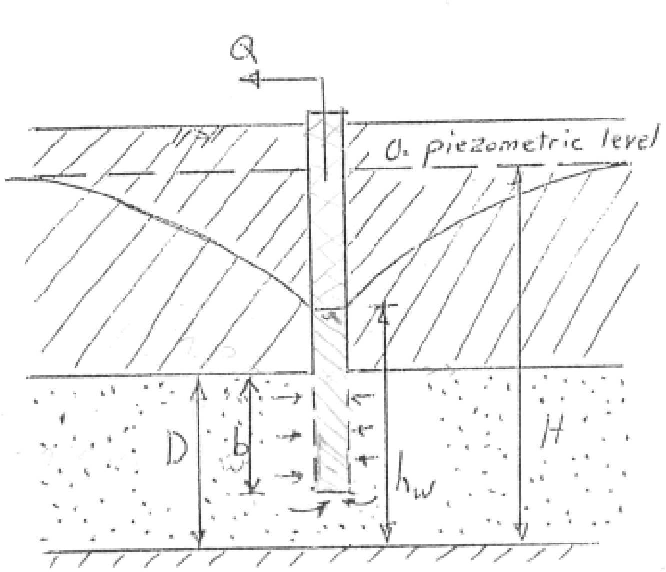


Gravity Flow

$$Q = \frac{\pi K \beta (H^2 - h_w^2)}{\ln R/r_w} \cdot G$$

$$\beta = \frac{b}{H}$$

↓ penetration ratio

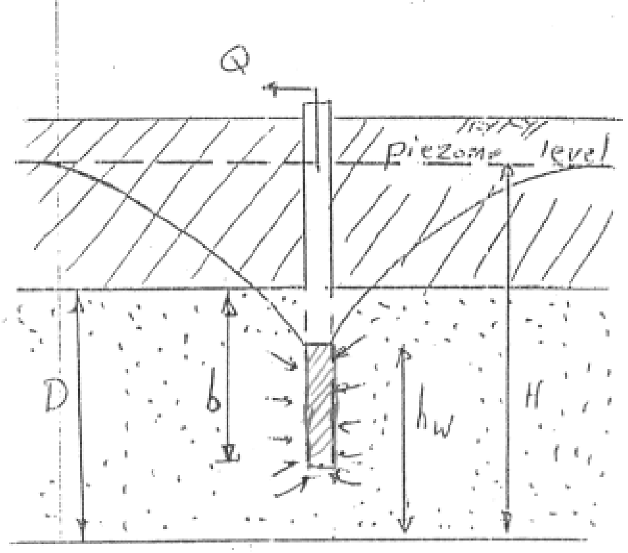


Artesian Flow

$$Q = \frac{2\pi K \beta D (H - h_w)}{\ln (R/r_w)} \cdot G$$

$$\beta = \frac{b}{D}$$

↓ penetration ratio



Mixed Flow

$$Q = \frac{\beta \pi K (2DH - D^2 - h_w^2)}{\ln (R/r_w)} \cdot G$$

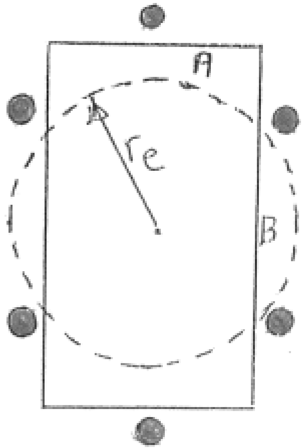
$$\beta = \frac{b}{D}$$

↓ penetration ratio

$$G = 1 + 7\sqrt{\frac{r_w}{2b}} \cdot \cos\left(\frac{\pi \beta}{2}\right) > 1$$

↳ consider water enters from the Bottom of the well.

Design Process for Multiple Wells



$$r_e = \sqrt{\frac{A \times B}{\pi}}$$

$$R \simeq 300\,(H - h_w)\sqrt{K}$$

$$H^2 - h_p^2 = \frac{1}{\pi k}\sum_{i=1}^{n} q_{wi}\ \ell n\frac{R}{r_i} \quad \text{.......................(Gravity) ...}$$

$$H - h_p = \frac{1}{2\pi k D}\sum_{i=1}^{n} q_{wi}\ \ell n\frac{R}{r_i} \quad \text{.......................(Artesian) ..}$$

$$2DH - D^2 - h_p^2 = \frac{1}{\pi k}\sum_{i=1}^{n} q_{wi}\ \ell n\frac{R}{r_i} \quad \text{...............(Mixed) ....}$$

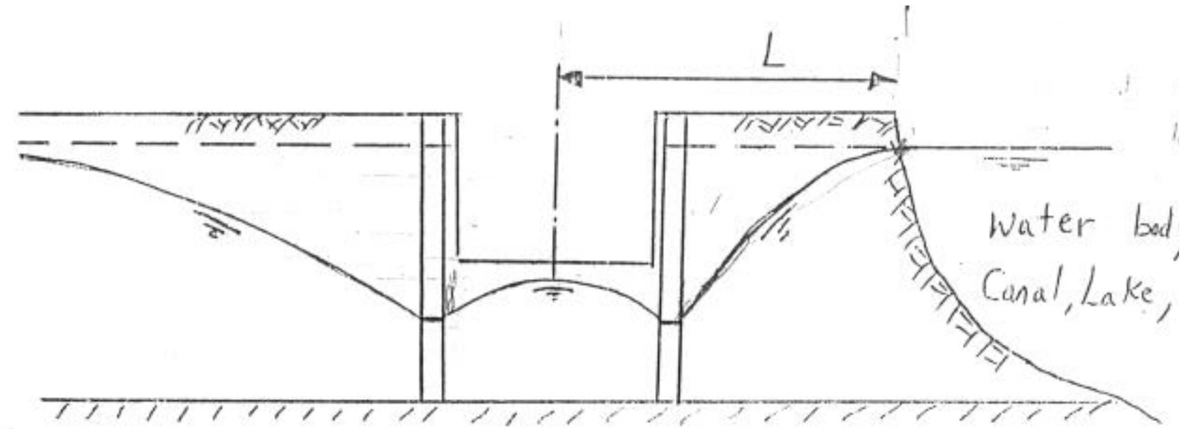
$$Q_T = \frac{\pi k\left(H^2 - h_w^2\right)}{\ell n(R/r_e)} \quad \text{..............................(Gravity flow)}$$

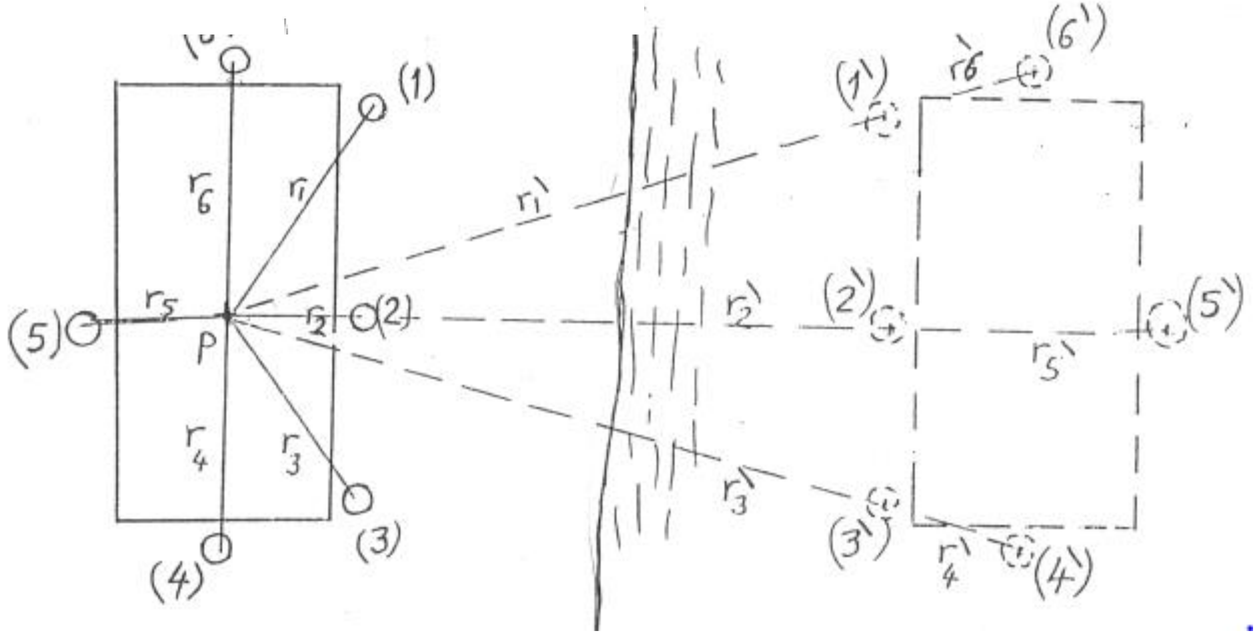
$$= \frac{2\pi Dk(H - h_w)}{\ell n(R/r_e)} \quad \text{...........................(Artesian flow)}$$

$$= \frac{\pi k\left(2DH - D^2 - h_w^2\right)}{\ell n(R/r_e)} \quad \text{.......................(Mixed flow)}$$

Dealing with a nearby line source

There exists a water body (Sea - River, Canal - lake) near the dewatered area at distance L < R





Modified Design Process

$$Q_T = \frac{\pi k\left(H^2 - h_w^2\right)}{\ell n\left(2L/r_e\right)} \quad \text{............... (Gravity)}$$

$$= \frac{2\pi Dk\left(H - h_w\right)}{\ell n\left(2L/r_e\right)} \quad \text{............... (Artesian)}$$

$$= \frac{\pi k\left(2DH - D^2 - h_w^2\right)}{\ell n\left(2L/r_e\right)} \quad \text{.......... (Mixed)}$$

$$H^2 - h_p^2 = \frac{1}{\pi k}\sum_{i=1}^{n} q_{wi} \quad \ell n\frac{r_i'}{r_i} \quad \text{.................... (Gravity)}$$

$$H - h_p = \frac{1}{2\pi kD}\sum_{i=1}^{n} q_{wi} \quad \ell n\frac{r_i'}{r_i} \quad \text{.................... (Artesian)}$$

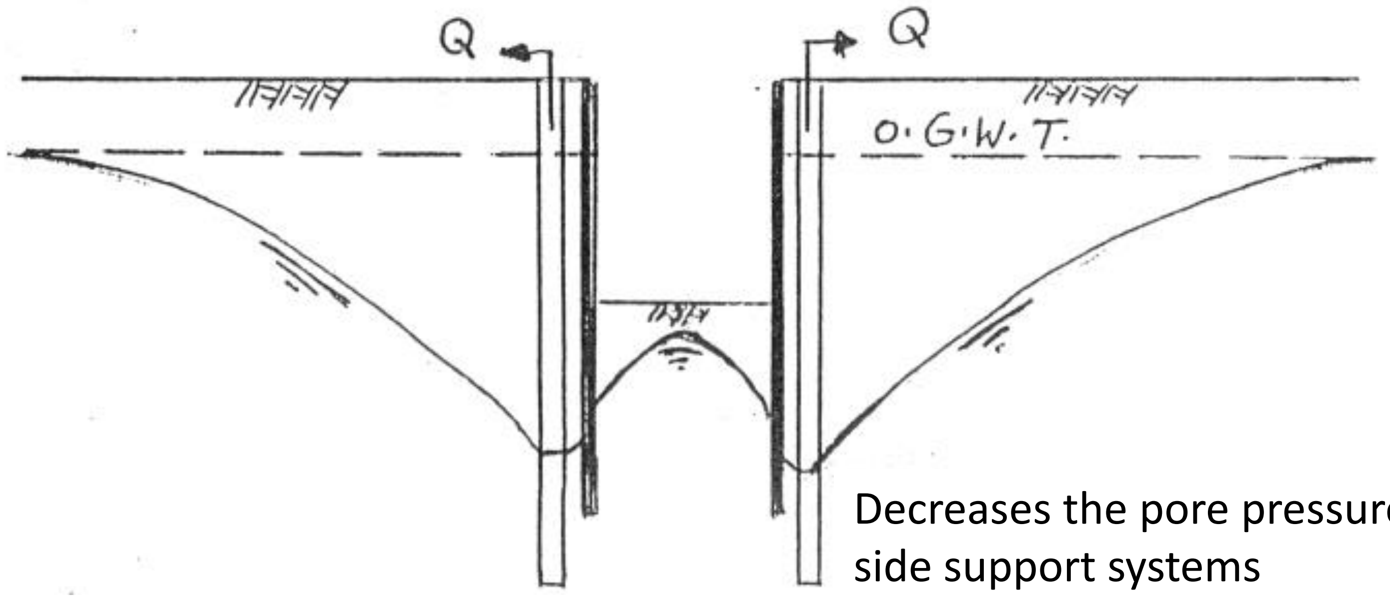
$$2DH - D^2 - h_p^2 = \frac{1}{\pi k}\sum_{i=1}^{n} q_{wi} \quad \ell n\frac{r_i'}{r_i} \quad \text{.............. (Mixed)}$$

where r_i = distance from point "P" to the i^{th} real well

r_i' = distance from point "P" to the i^{th} image well

Dealing with Side support systems

Outside the excavation



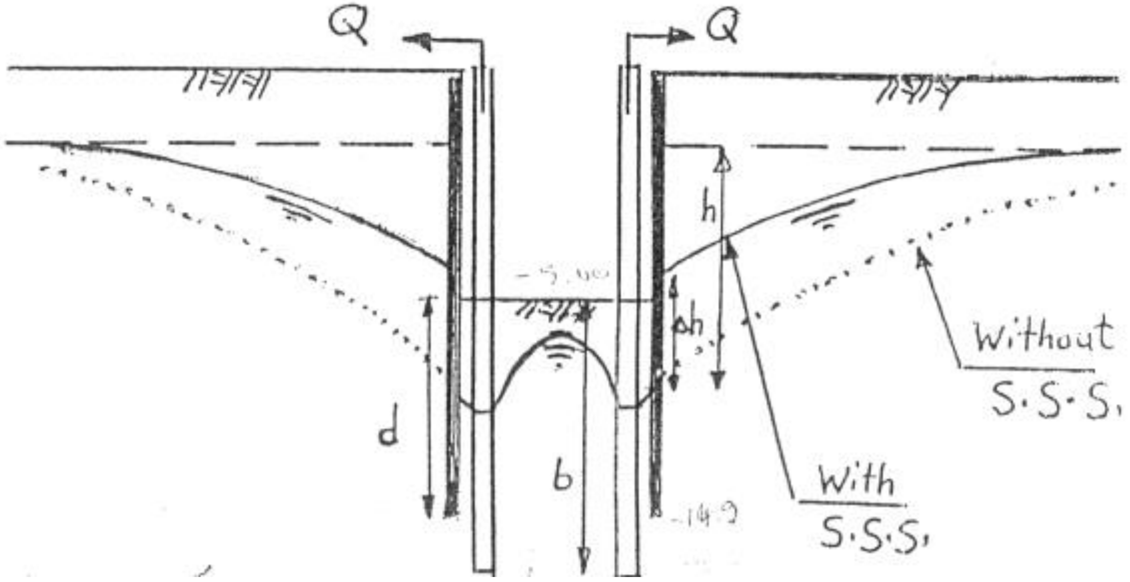
Issues

- Intrusion on the neighbors
- Affecting neighboring structures

Decreases the pore pressure acting on side support systems

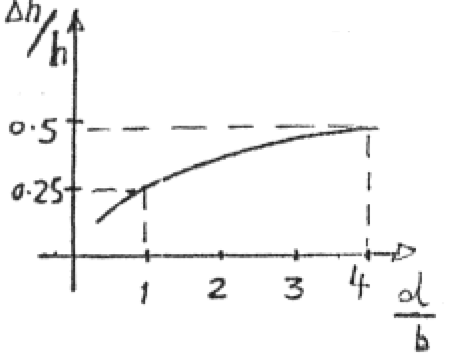
Dealing with Side support systems

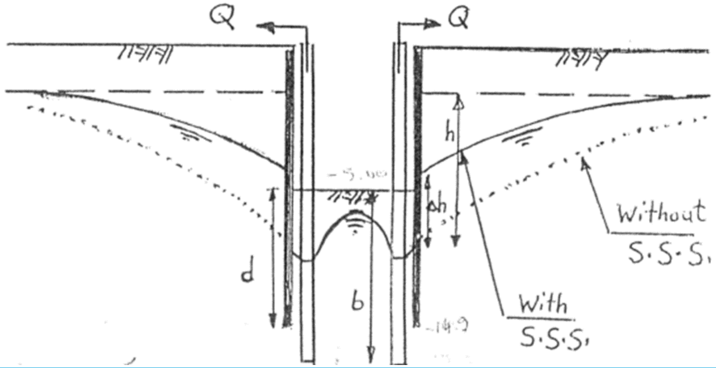
Inside the excavation



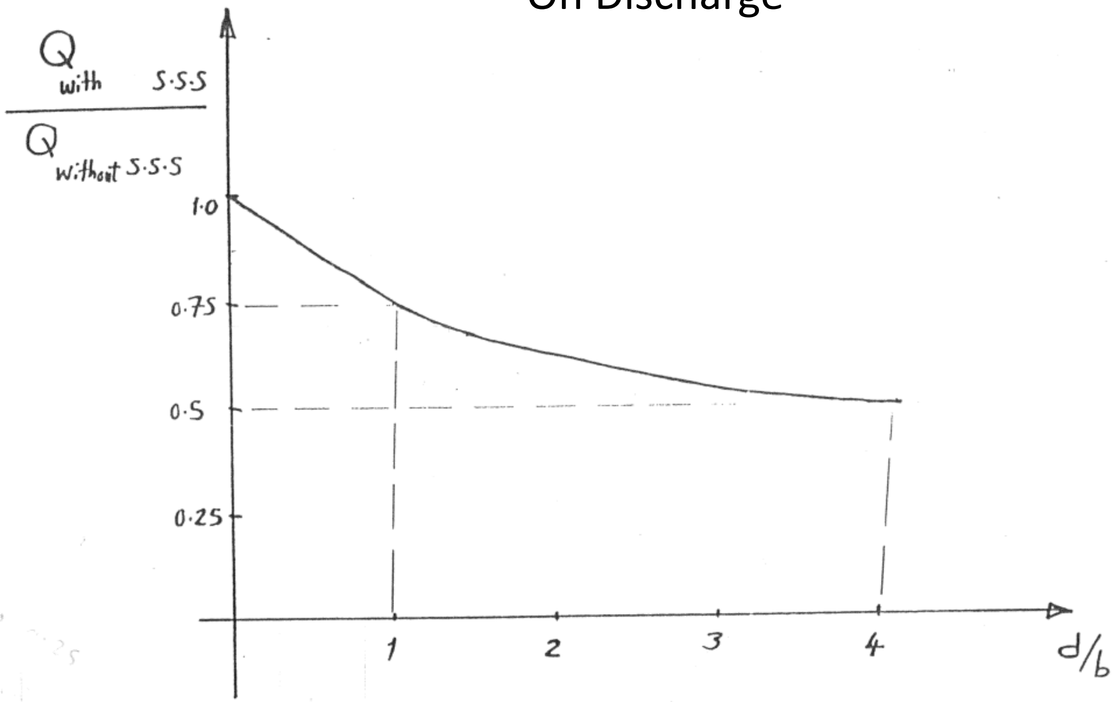
Effect of Side Support System

On drawdown

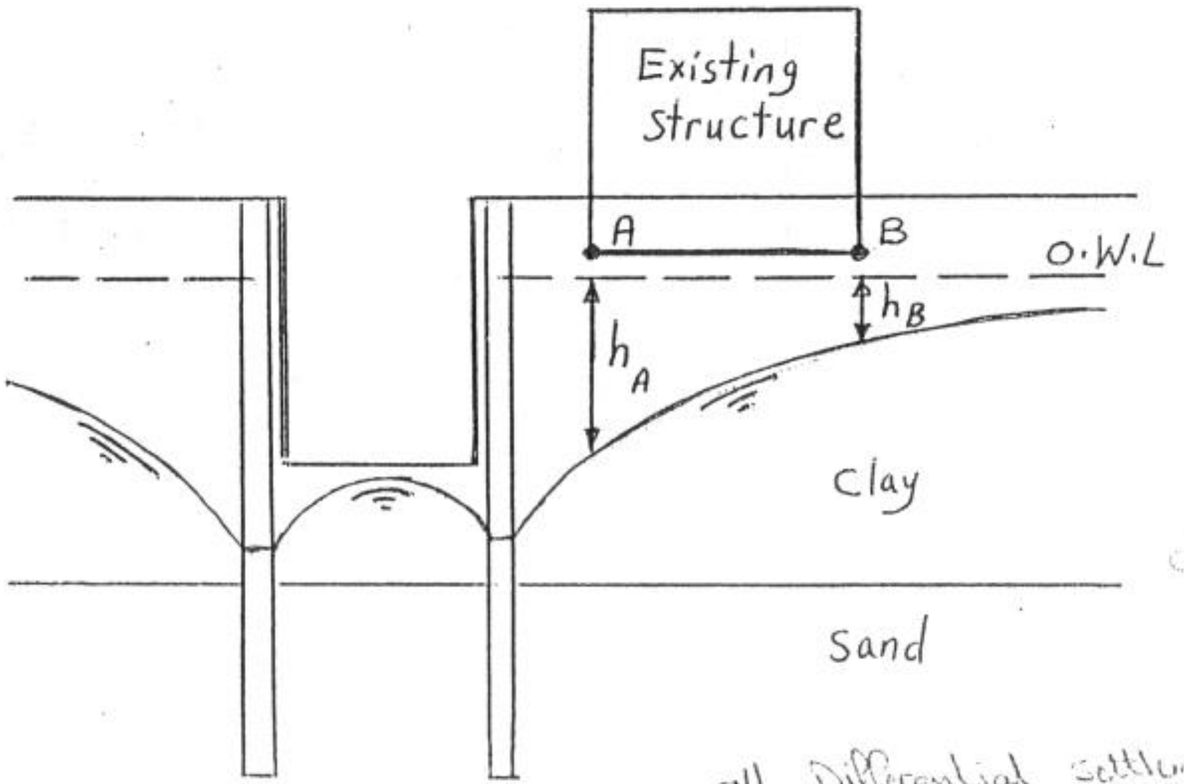




On Discharge

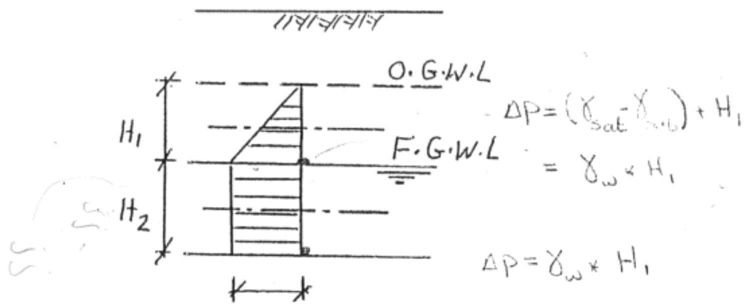


Neighboring Structures



clay ال consolidating

all. Differential settlement $\Theta = \frac{1}{300}$



H_1 = lowering distance مقدار التخفيض

$$\Delta p = \gamma_w \cdot H_1$$

$$S_1 = m_{v_1} \cdot \frac{1}{2} \Delta p \cdot H_1$$

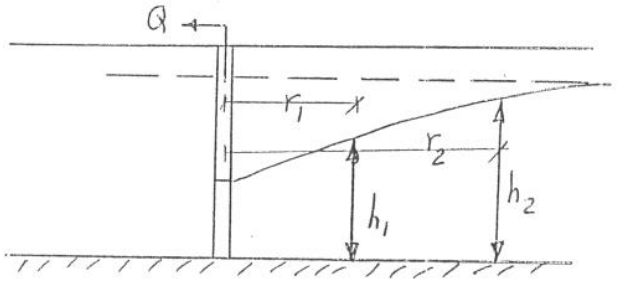
$$S_2 = m_{v_2} \cdot \Delta p \cdot H_2$$

$$S = S_1 + S_2$$

Permeability Estimation

- Field Methods

$$Q = \frac{\pi K (h_2^2 - h_1^2)}{\ln r_2/r_1} \longrightarrow K$$



- Laboratory Methods

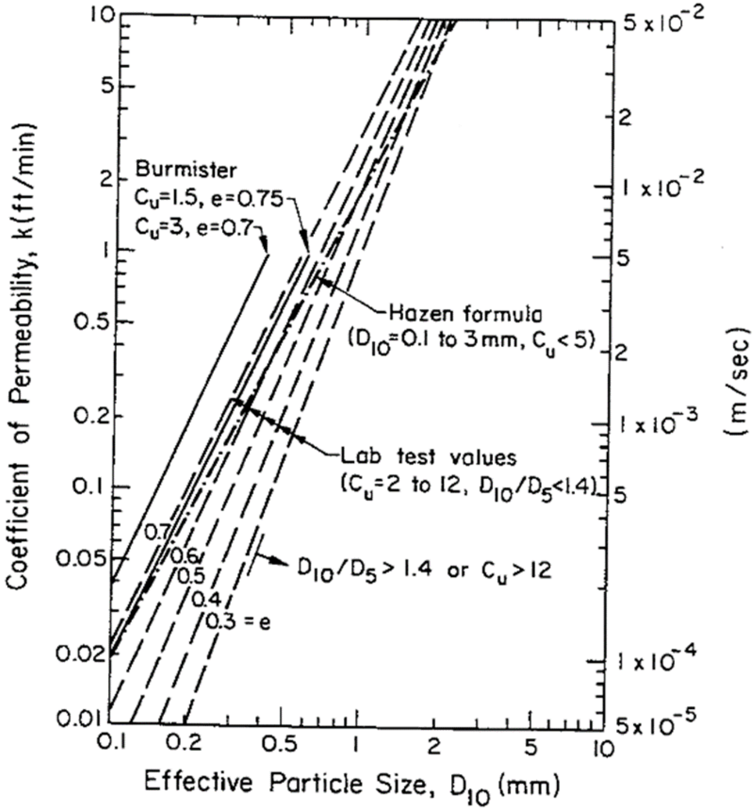
Constant head (Sand)
Falling head (clay

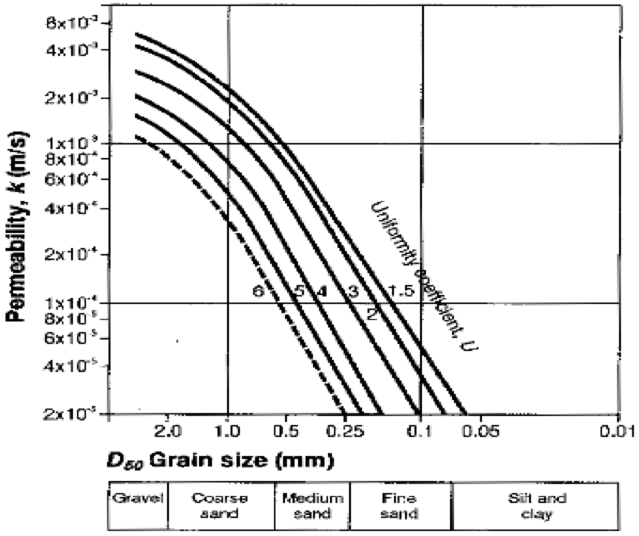
- Correlations

Hazen Formula $K \simeq 100\, d_{10}^2$

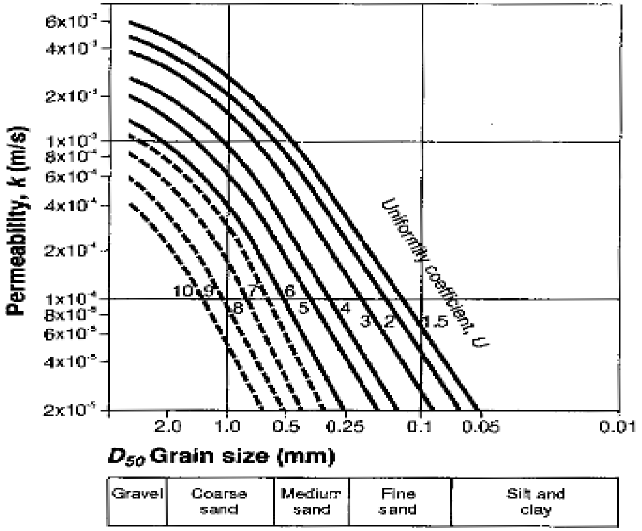
K (cm/sec) d_{10} (cm)

Correlations

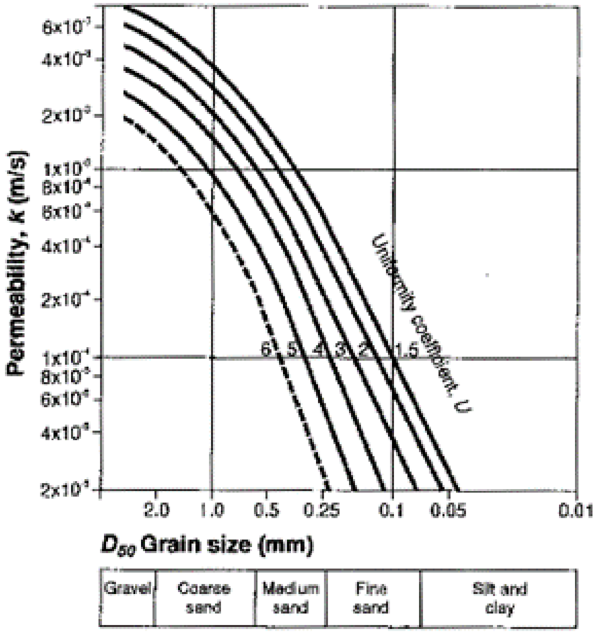




a) Dense soils



b) Medium dense soils

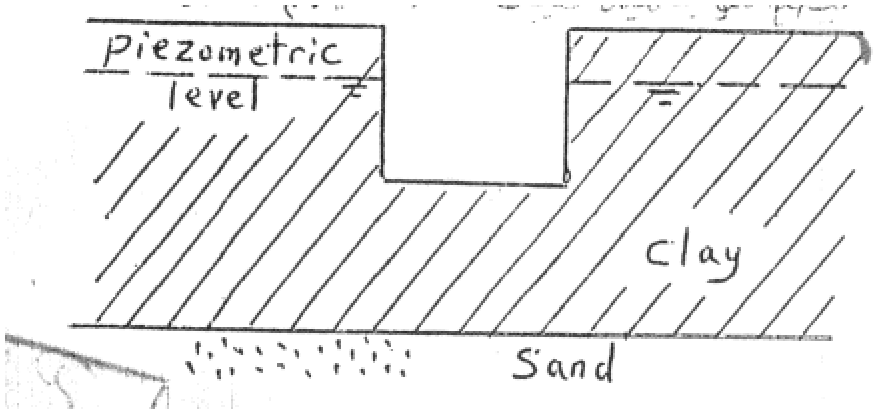


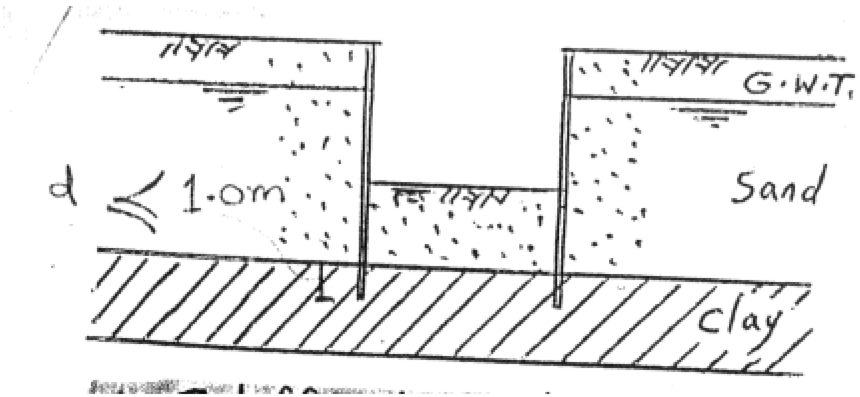
c) Loose soils

D_{50} Grain size (mm)

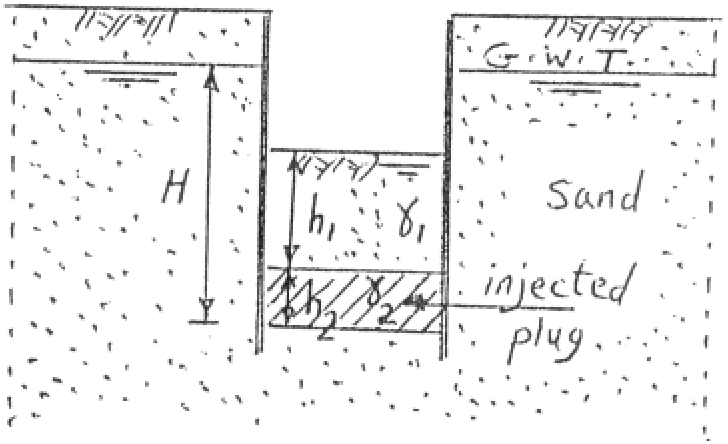
Cut off Systems

Natural Plugs



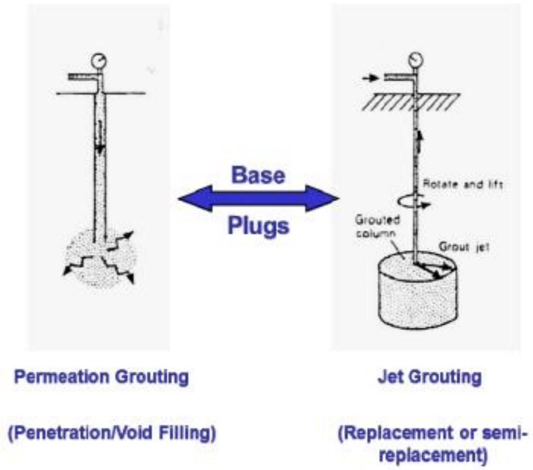


Grouting

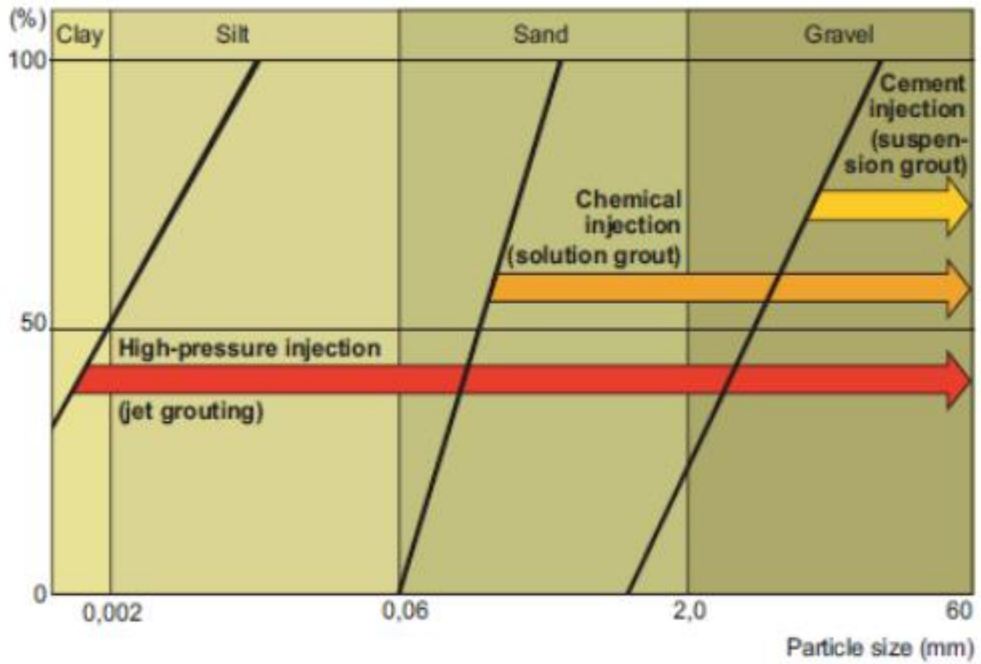


Check safety against uplift is necessary

$$F.S._{uplift} = \frac{\gamma_{t1} \cdot h_1 + \gamma_{t2} \cdot h_2}{\gamma_W \cdot H} \geq 1.2 \quad o.K.$$



Groutability



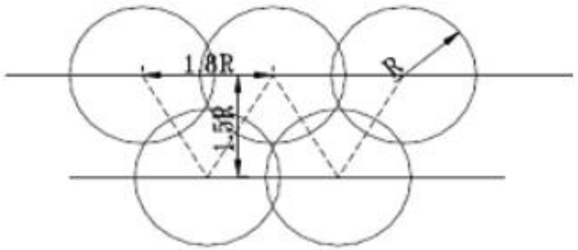
$$N = (D_{15})_{soil} / (D_{85})_{grout} \quad (6.1)$$

Where:

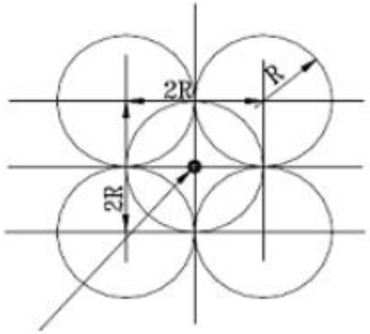
$(D_{15})_{soil}$	The soil particle size corresponds to accumulative passing of 15%
$(D_{85})_{grout}$	The grout particle size corresponds to accumulative passing of 85%
$N > 24$	The range for groutable soils using cement grout
$N < 11$	The range for non-groutable soils using cement grout

- Fine content < 12% Groutable
- Fine content < 12% to 20% Groutable with difficulty
- Fine content > 20% Non Groutable

Plug thickness



a- Triangular Pattern.



b- Square Pattern.

$$Simple\ Method, \qquad th = \frac{\Delta h}{5}$$

As long as the plug material is stable against erosion, its thickness is determined based on the allowable amount of water allowed to seep into the site, which depends on possibility of disposal. The minimum thickness is 1.50 to 2.00m, depending on depth of excavation. Also, the possibility and impact of drop of water level behind the wall should be studied.

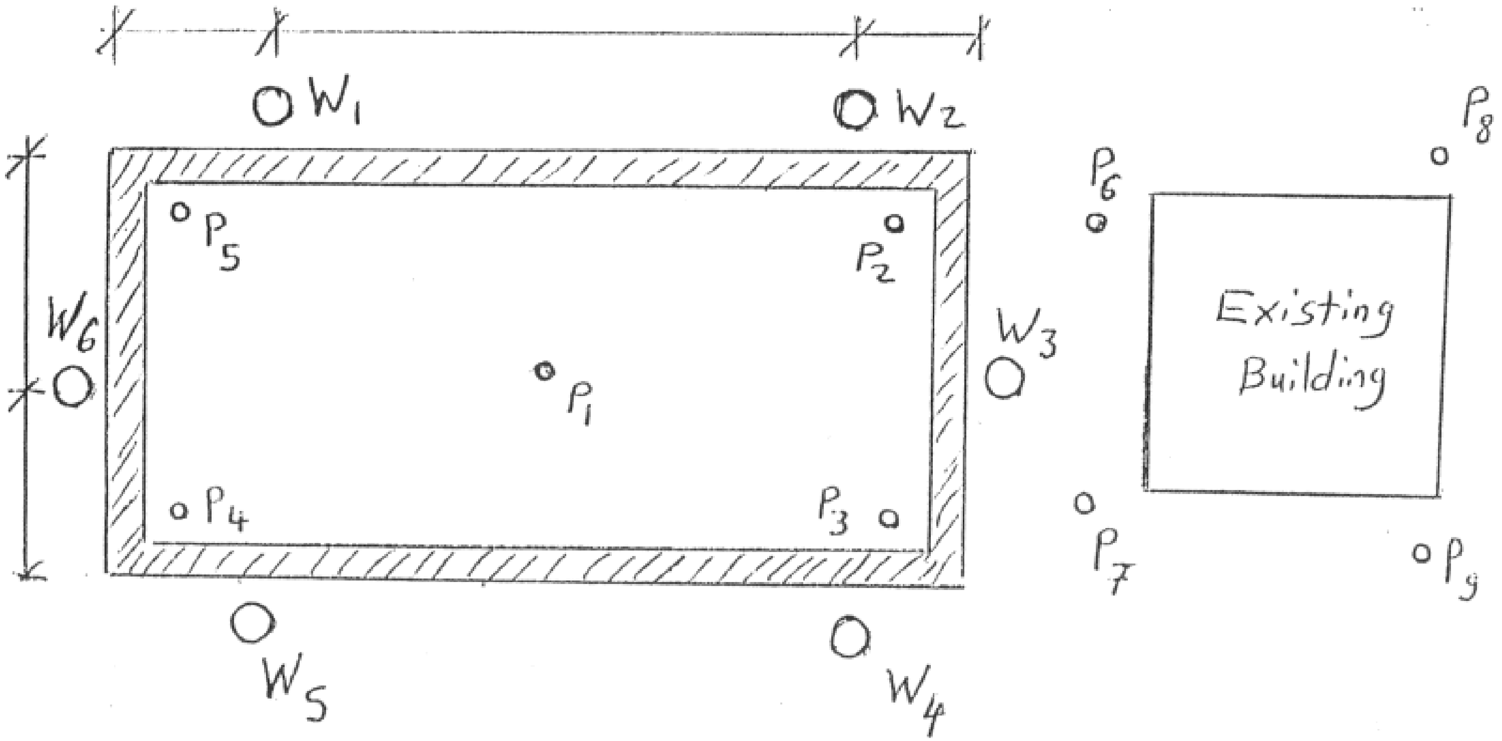
Based on the above criteria, the plug thickness is determined considering the expected permeability of the grouted soil and the hydraulic gradient along the plug thickness. For the detailed method of calculation, refer to (ECP 202-2002 Part 7, Earth Retaining Structures). The amount of water seeping through the grout plug may be estimated as follows:

$$Q = k\ i\ A \qquad (6.3)$$

Where:

Q	Amount of water seeping through plug.
k	Plug permeability.
i	Hydraulic gradient along the plug thickness
A	Planar area of the grout plug

Details: Well and Piezometer Locations



Details: Filter