

APLICAÇÕES DOS CONCEITOS DE PERCOLAÇÃO

Maria Eugenia Gimenez Boscov

Meio anisotrópico



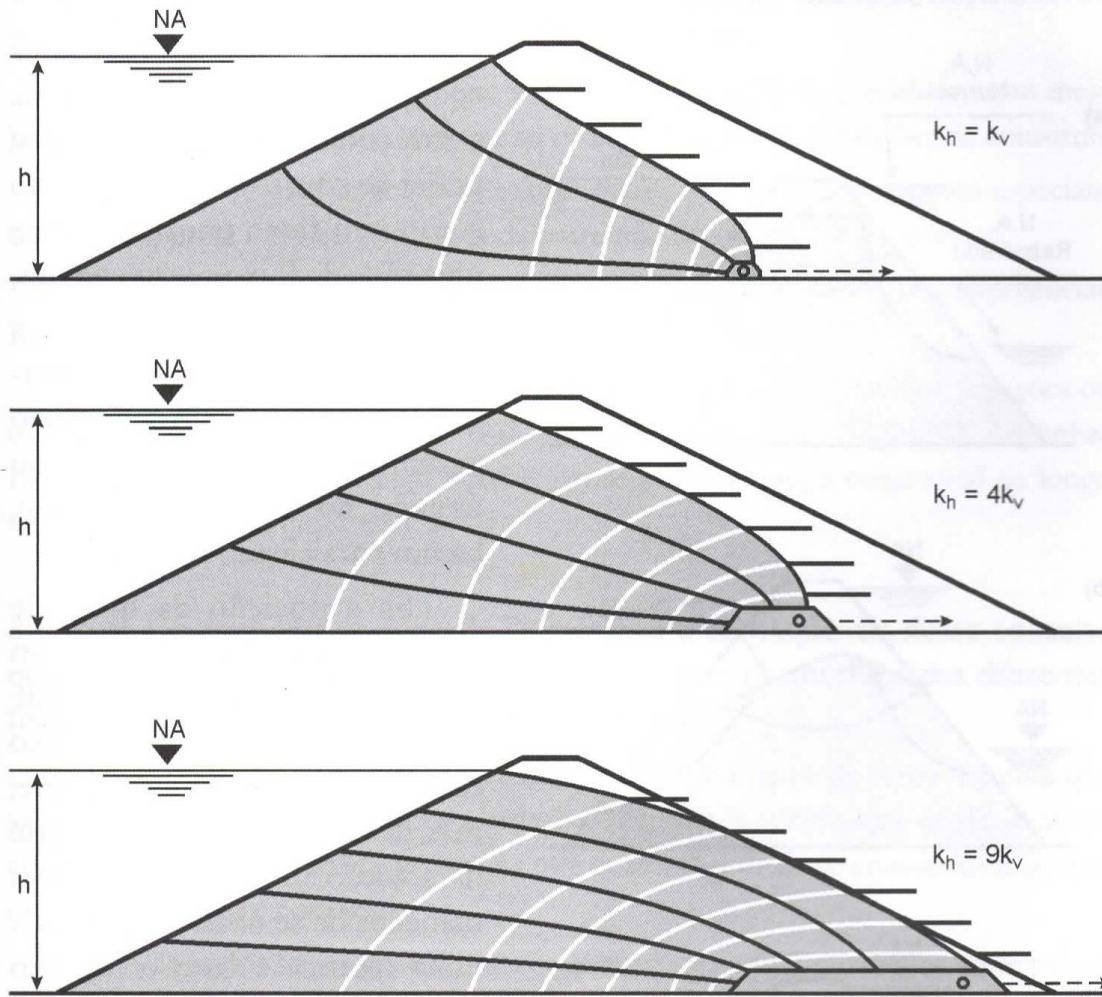
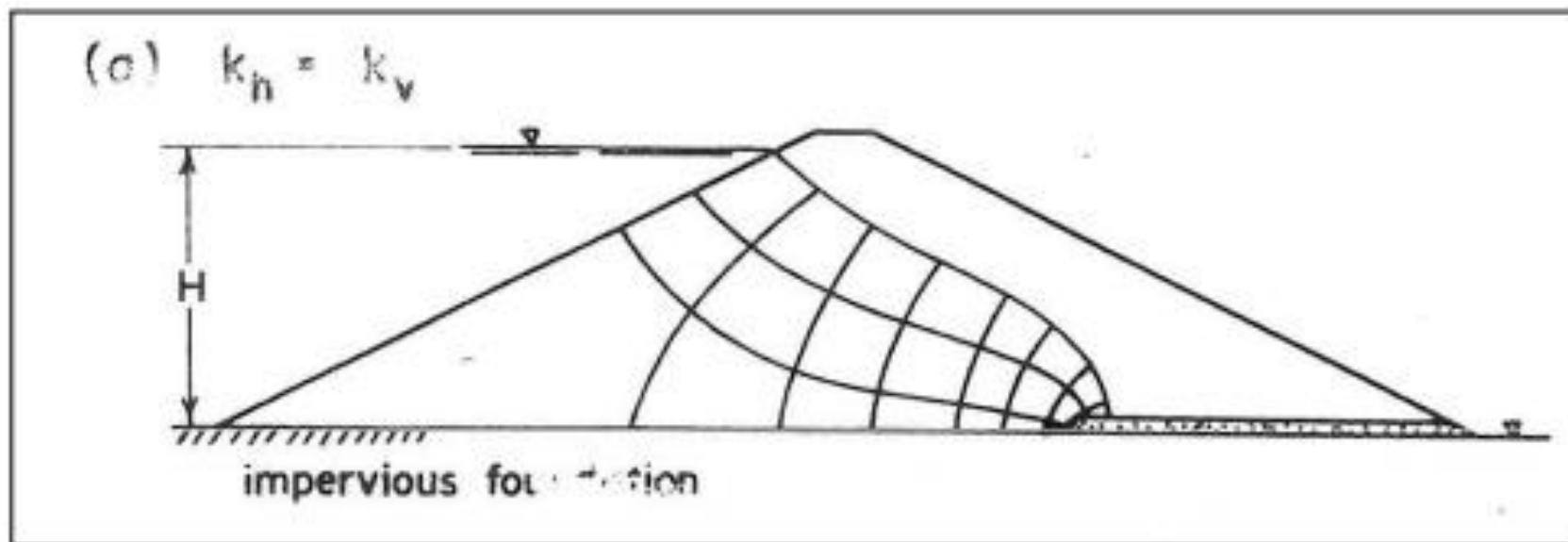


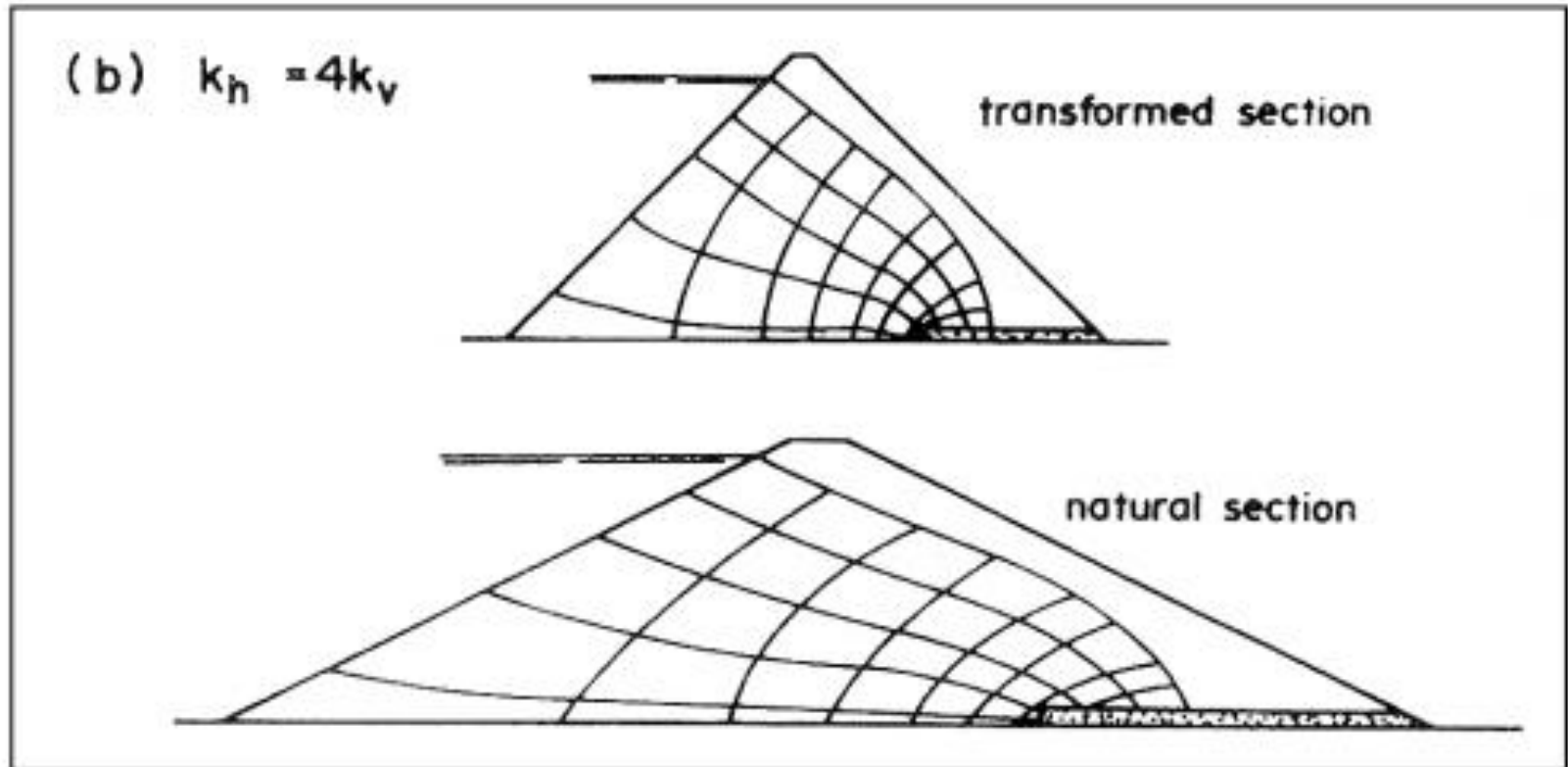
Fig. 1.20

Exemplos de redes de fluxo bidimensionais, não confinadas, em meios anisotrópicos (Cedergren, 1967)

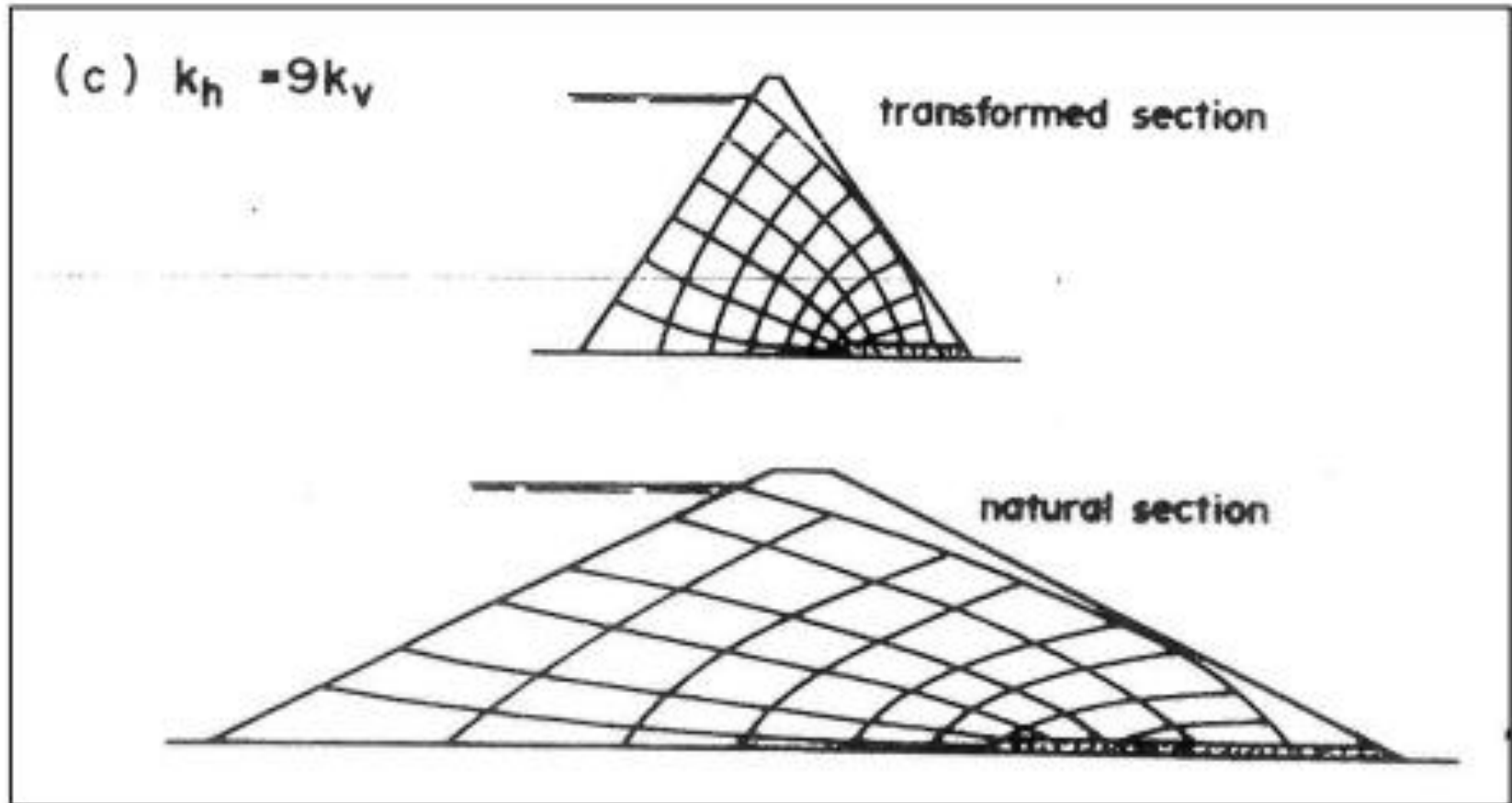
Influência da Anisotropia na Rede de Fluxo Através da Barragem

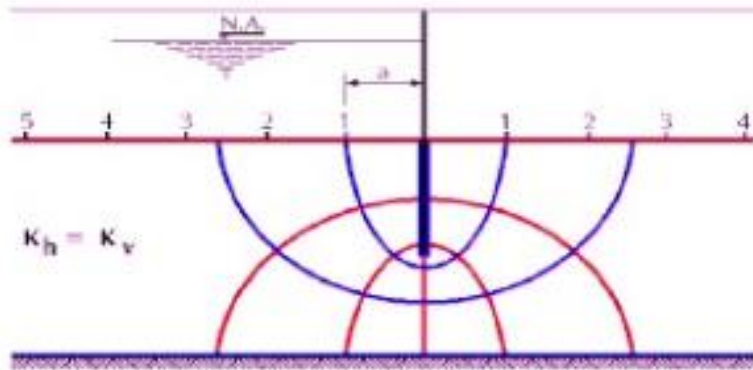


Influência da Anisotropia na Rede de Fluxo Através da Barragem

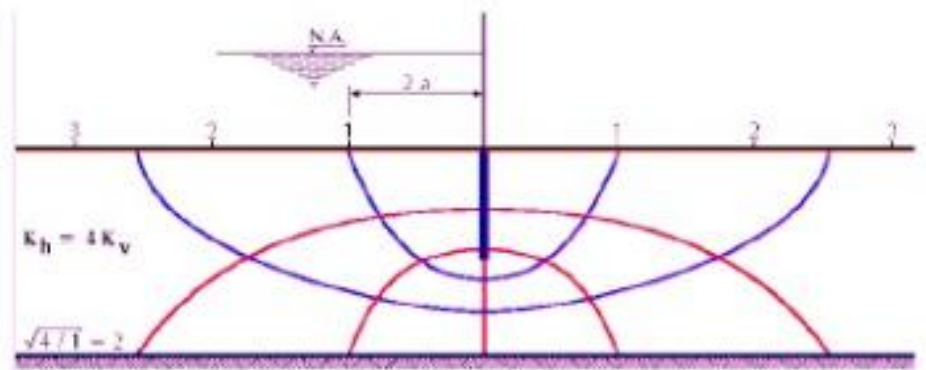


Influência da anisotropia na rede de fluxo através da barragem

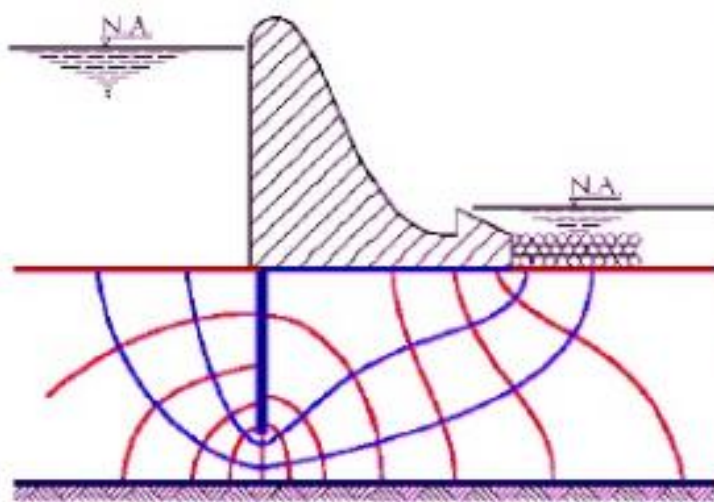




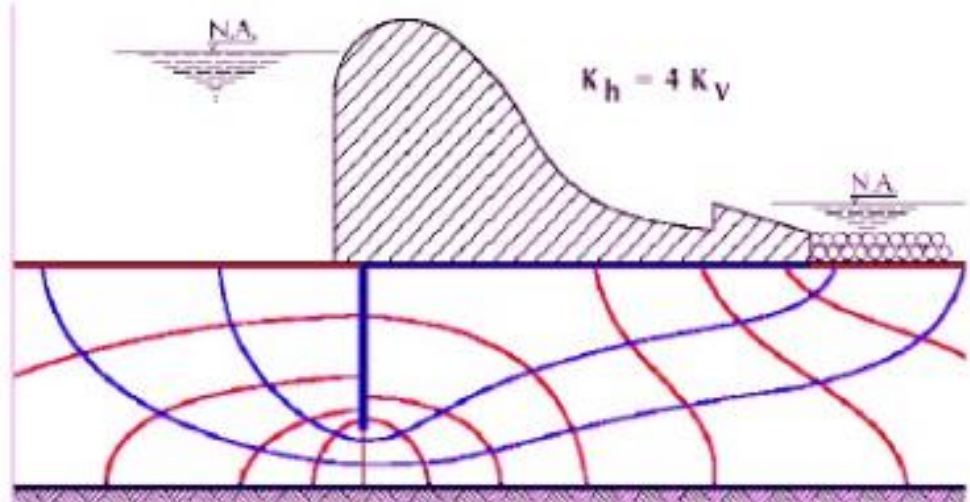
(a) seção transformada



(b) Seção real

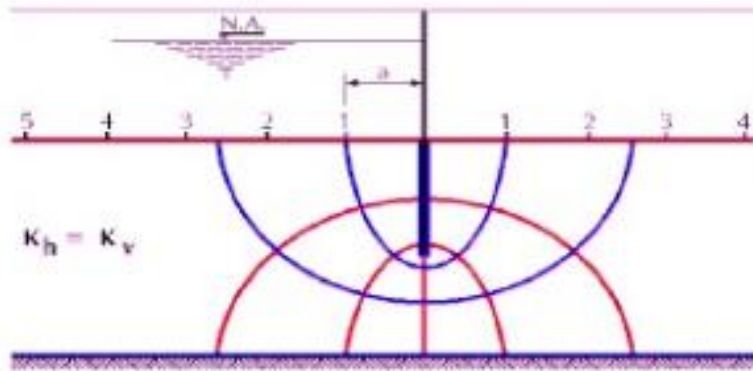


(a) seção transformada

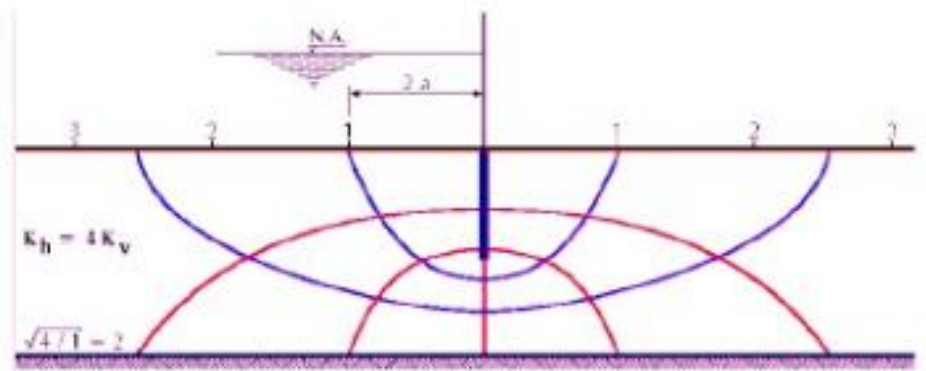


(b) Seção real

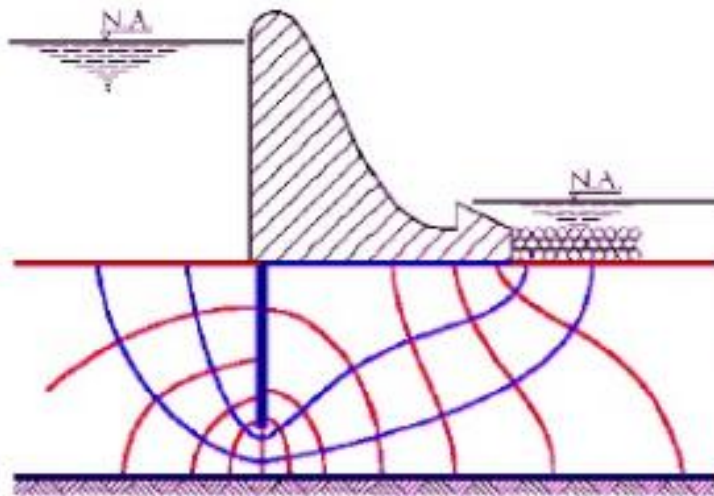
Figura 3.20 – Exemplos de rede de fluxo em meios anisotrópicos. Modificado de Stancati (1984).



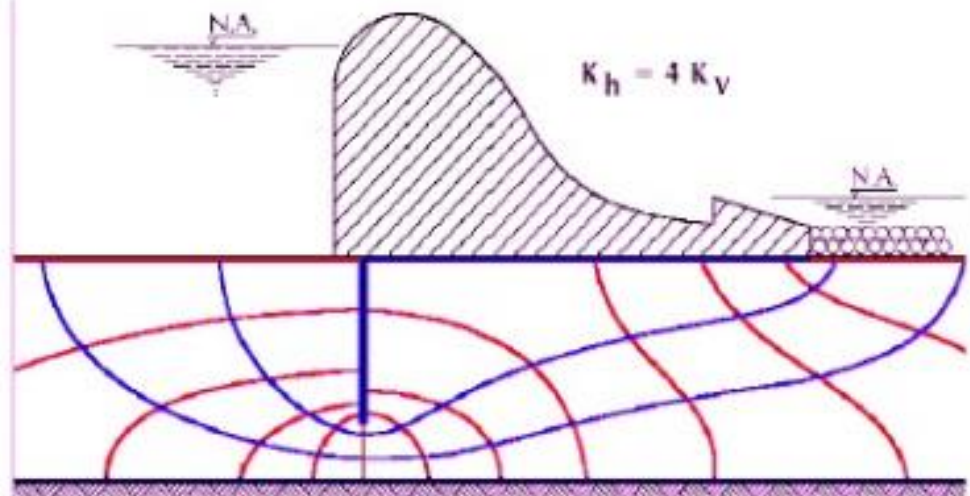
(a) seção transformada



(b) Seção real



(a) seção transformada

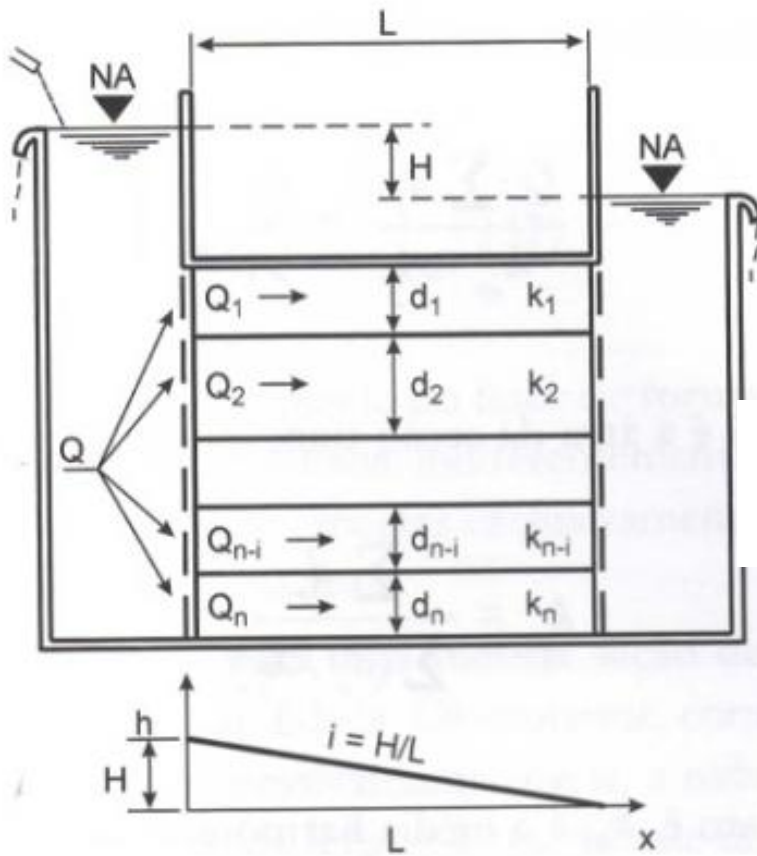


(b) Seção real

Figura 3.20 – Exemplos de rede de fluxo em meios anisotrópicos. Modificado de Stancati (1984).

Meio heterogêneo



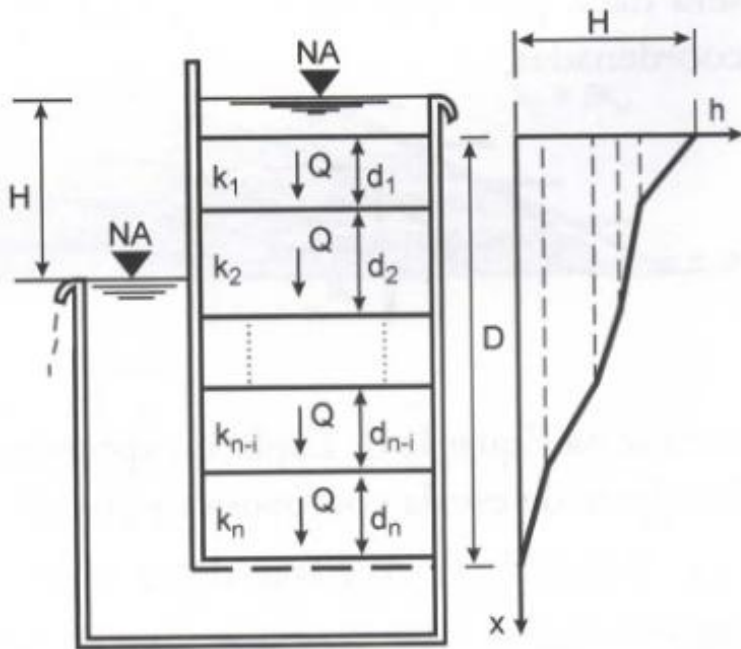


$$Q = \sum Q_i = \sum \left(k_i \cdot \frac{H}{L} \cdot d_i \right) = \left(\frac{H}{L} \right) \cdot \sum (k_i \cdot d_i)$$

$$Q = k_m \cdot \left(\frac{H}{L} \right) \cdot \sum d_i$$

$$k_m = \frac{\sum (k_i \cdot d_i)}{\sum d_i}$$

(Massad, 2010)



$$H = \sum b_i$$

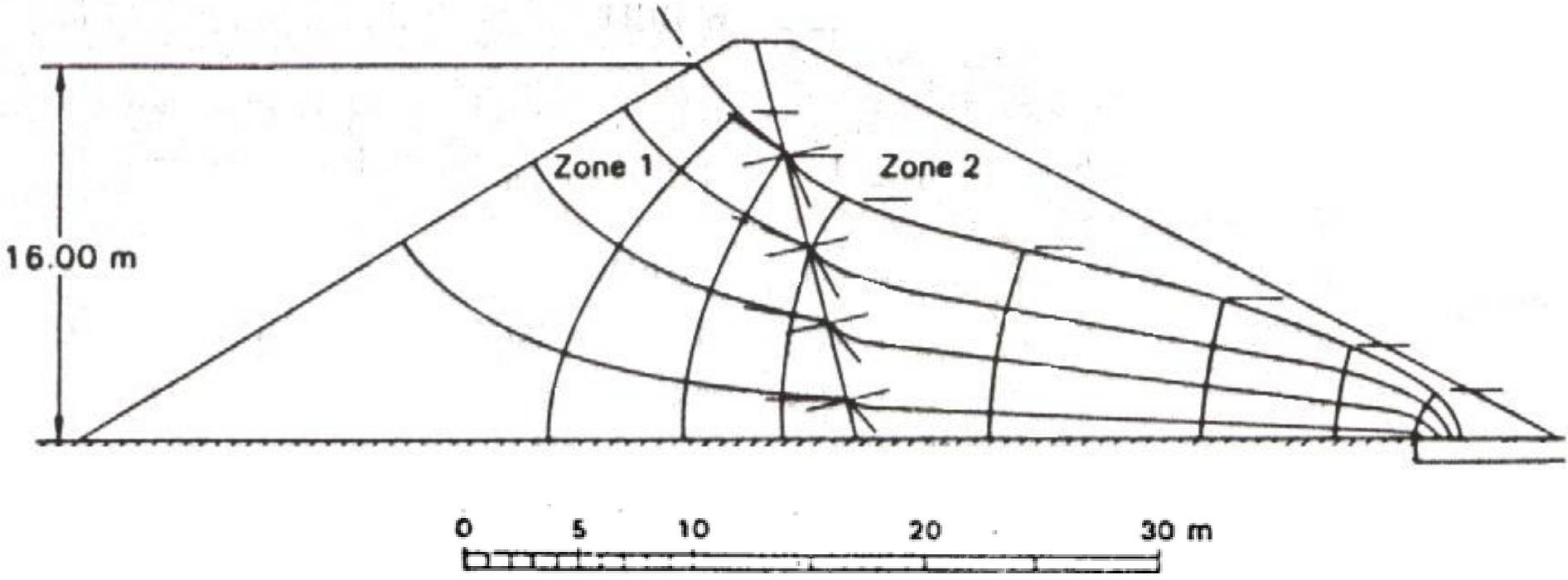
$$\frac{b_i}{d_i} = \frac{Q}{k_i \cdot A}$$

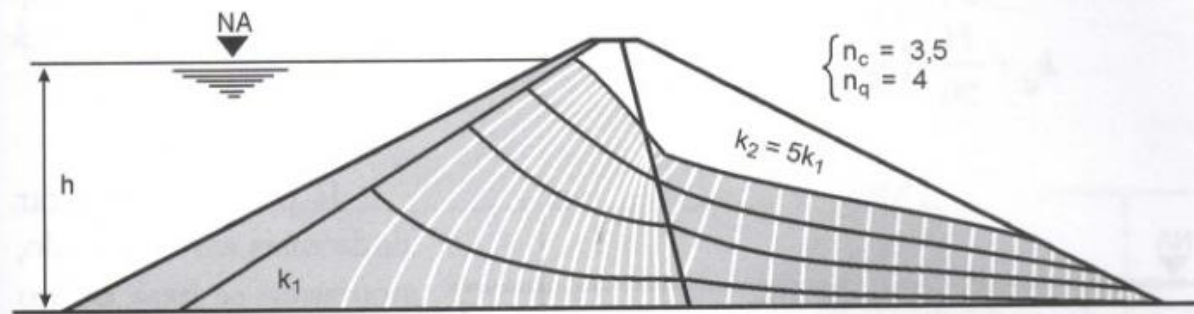
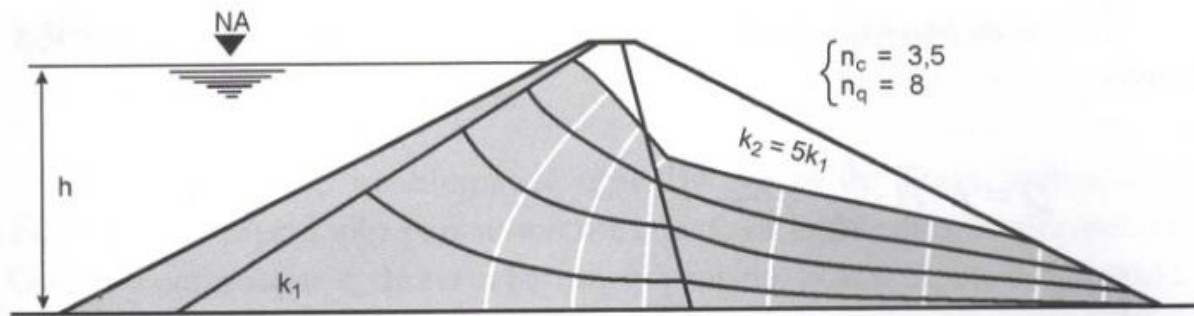
$$\frac{Q \sum d_i}{k_m A} = \frac{Q}{A} \sum \frac{d_i}{k_i}$$

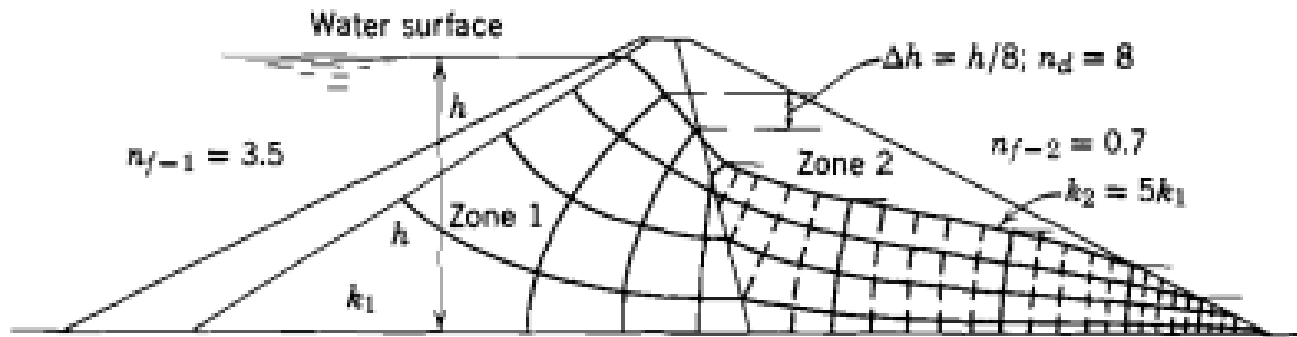
$$k_m = \frac{\sum d_i}{\sum \frac{d_i}{k_i}}$$

(Massad, 2010)

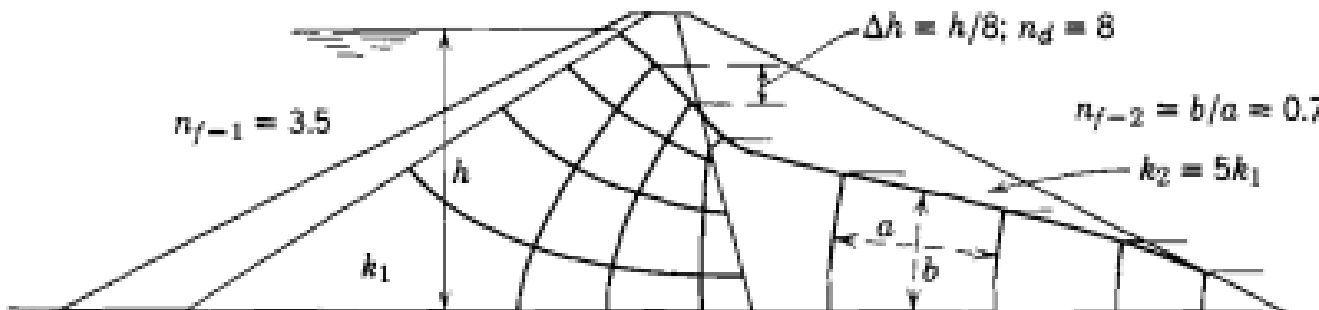
Influência da heterogeneidade na rede de fluxo através da barragem



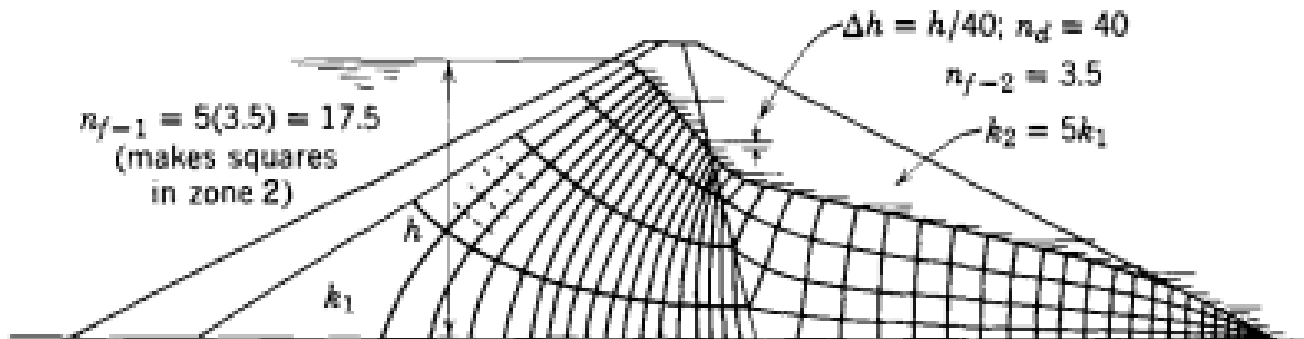




(a)



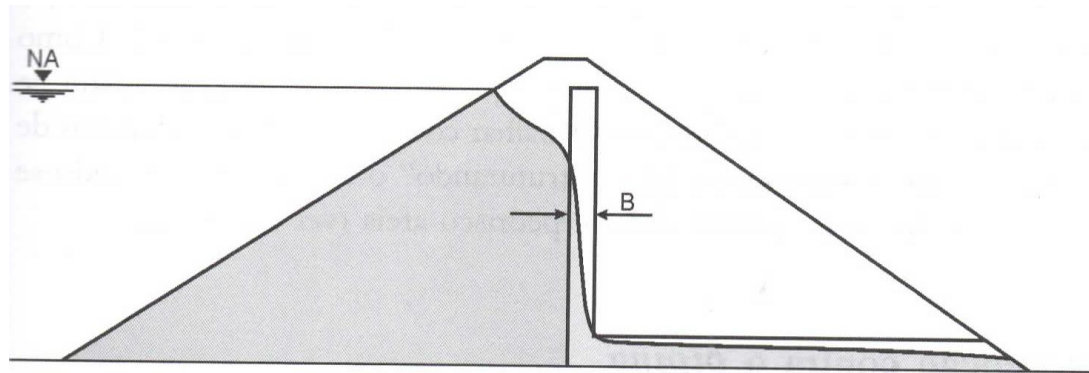
(b)



(c)

Três formas
para uma só
rede de fluxo

Filtro vertical

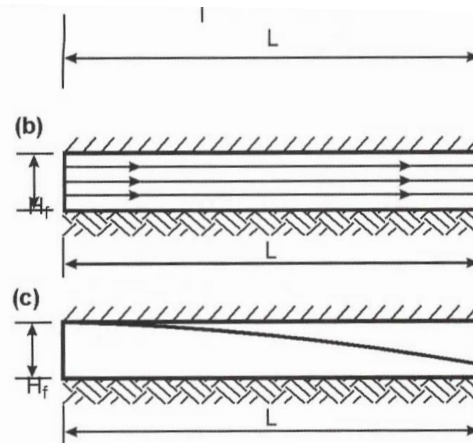
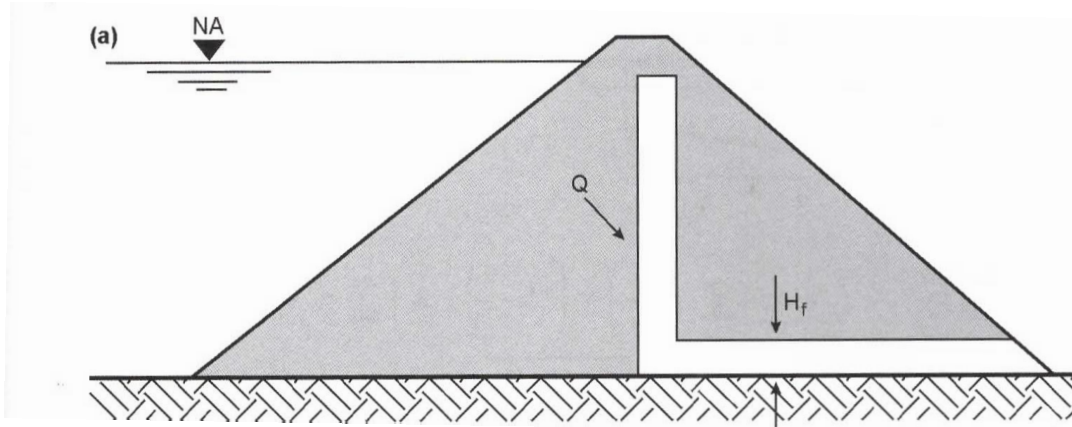


$$Q_{\text{maciço}} = k_{fv} iA = k_{fv} \cdot 1 \cdot (B \cdot 1) = k_{fv} B$$

$$b = \frac{Q_{\text{maciço}}}{k_{fv}}$$

(Massad, 2010)

Filtro horizontal



(Massad, 2010)

Hipótese: filtro trabalha em carga, utilizando toda a sua seção para o fluxo d'água

$$Q = k_f \cdot \frac{H_f}{r} \cdot H_f = k_f \cdot \frac{H_f^2}{L}$$

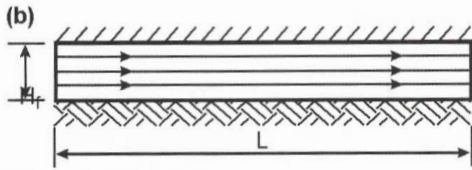
$$H_f^{real} > \sqrt{\frac{Q \cdot L}{k_f}}$$

Hipótese: filtro trabalha livremente, com a existência de uma linha freática

$$Q = \frac{k \cdot (b_1^2 - b_2^2)}{2 \cdot L}$$

Filtro horizontal

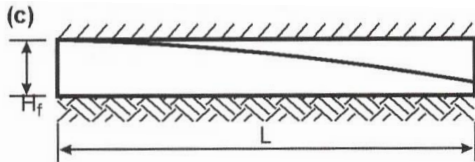
- Hipótese: filtro trabalha em carga, utilizando toda a seção para o fluxo d'água



$$Q = k_f \cdot \frac{H_f}{L} \cdot H_f = k_f \cdot \frac{H_f^2}{L}$$

$$H_f^{real} > \sqrt{\frac{Q \cdot L}{k_f}}$$

- Hipótese: filtro trabalha livremente, com a existência de uma linha freática

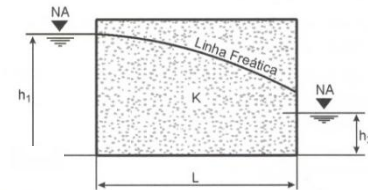


Equação de Dupuit

$$Q = \frac{k \cdot (h_1^2 - h_2^2)}{2 \cdot L}$$

$$Q = \frac{k_f \cdot H_f^2}{2 \cdot L}$$

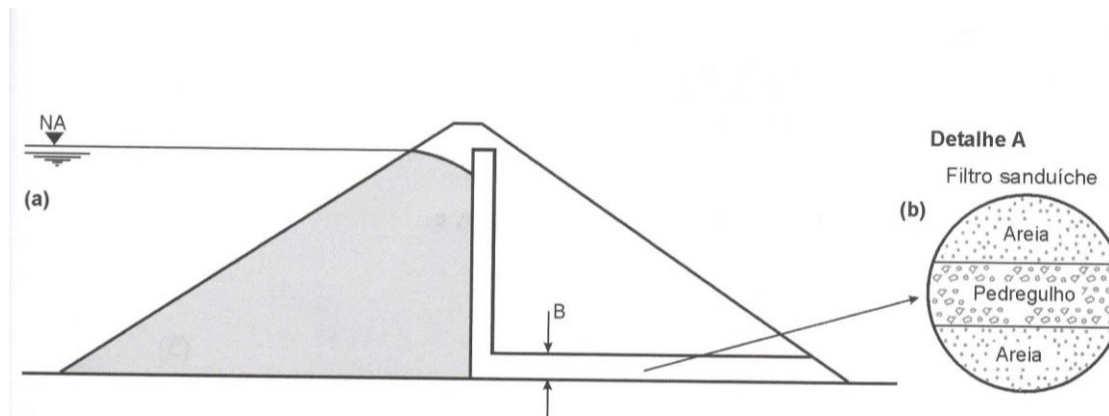
$$H_f^{real} < \sqrt{\frac{2 \cdot Q \cdot L}{k_f}}$$



- Portanto:

$$\sqrt{\frac{Q \cdot L}{k_f}} < H_f^{real} < \sqrt{\frac{2 \cdot Q \cdot L}{k_f}}$$

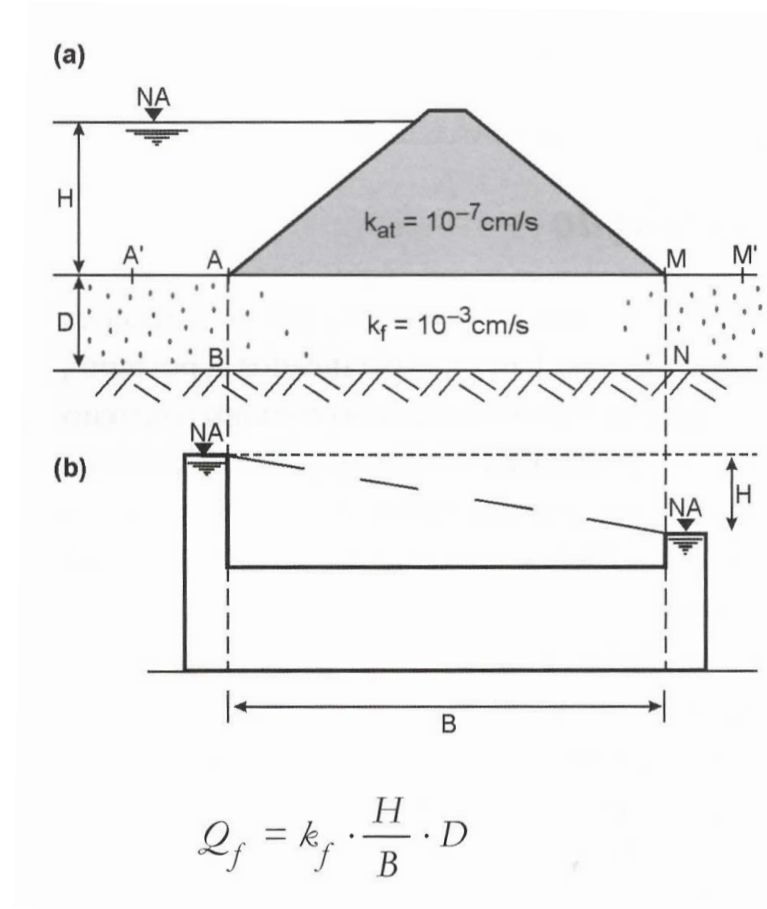
Filtro horizontal



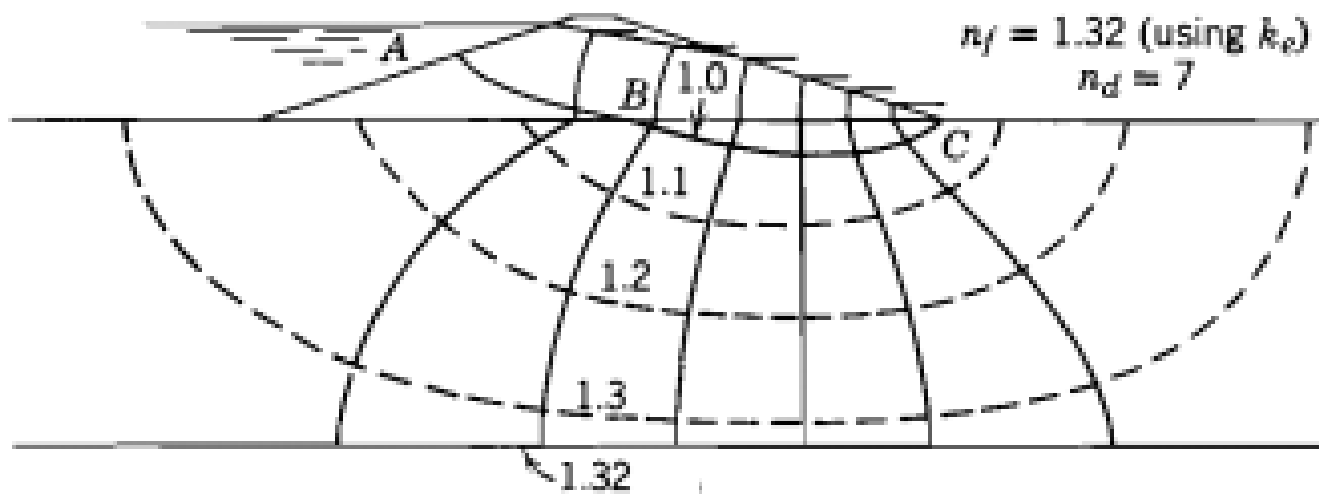
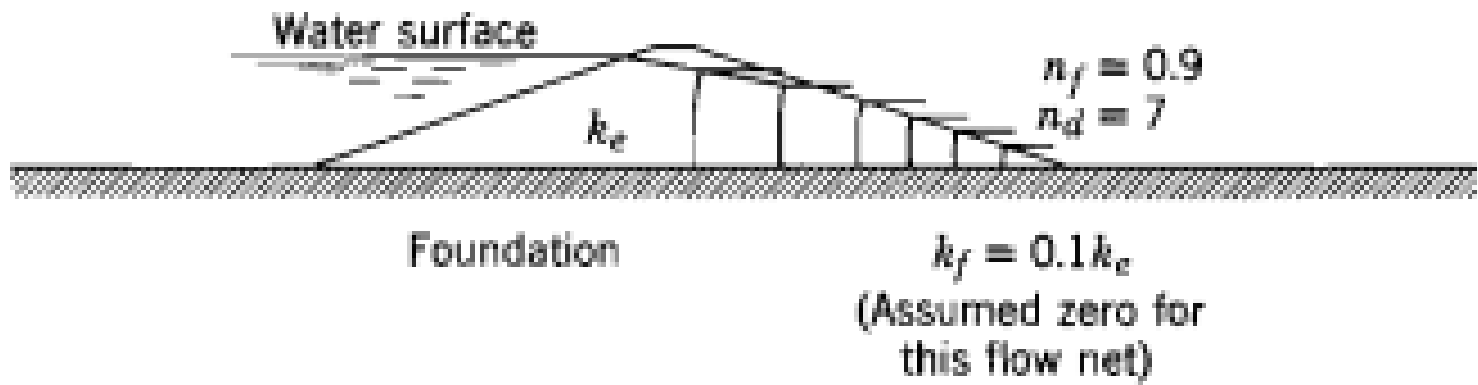
$$k_m = \frac{\sum (k_i d_i)}{\sum d_i}$$

$$Q = k_m \cdot \left(\frac{H}{L}\right) \cdot \sum d_i$$

Perda de água pela fundação



$$Q_f = k_f \frac{H}{B + 0,88D} D \quad (\text{Dachler})$$

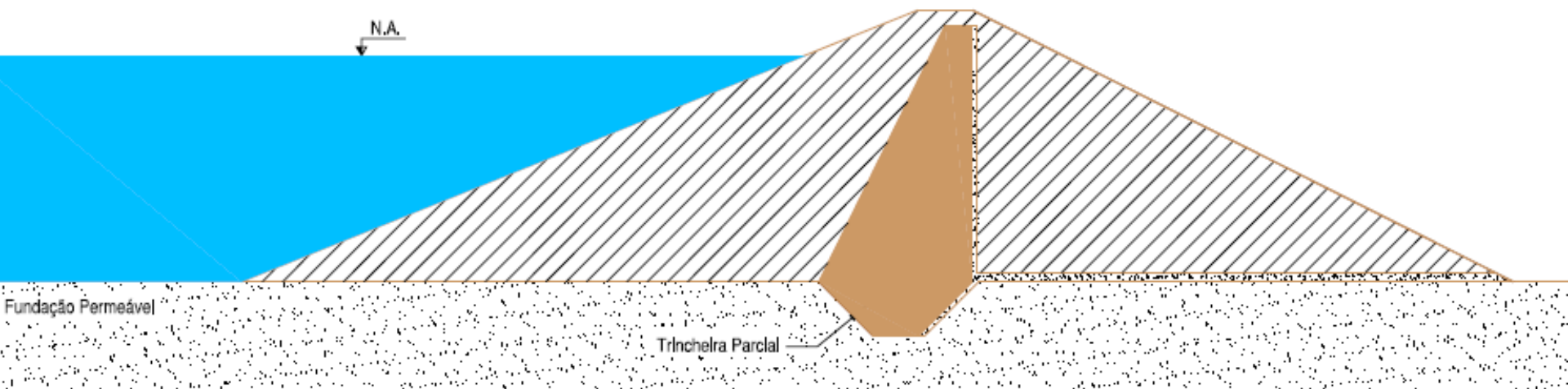
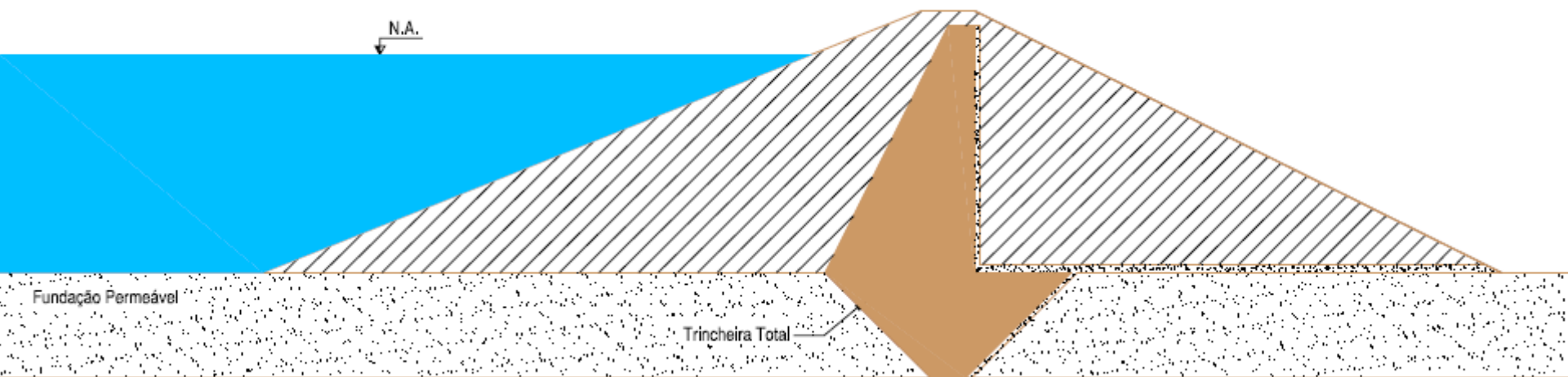


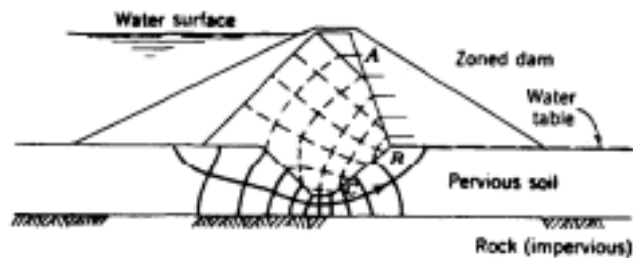
Eficiência do tratamento

$$E = 1 - \frac{Q_f}{Q_{f0}}$$

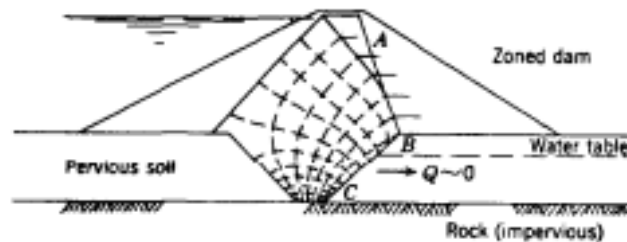
Trincheiras de vedação (*cut off*)



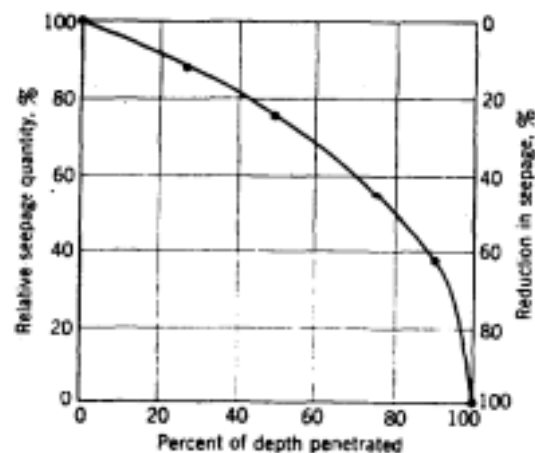




a. Partial cutoff



b. Complete cutoff



c. Relationship between quantity of seepage and depth of penetration of partial cutoff

Figure 9-3. Efficiency of a compacted backfill trench partial cutoff in reducing the quantity of underseepage (courtesy of John Wiley and Sons¹⁵⁵)

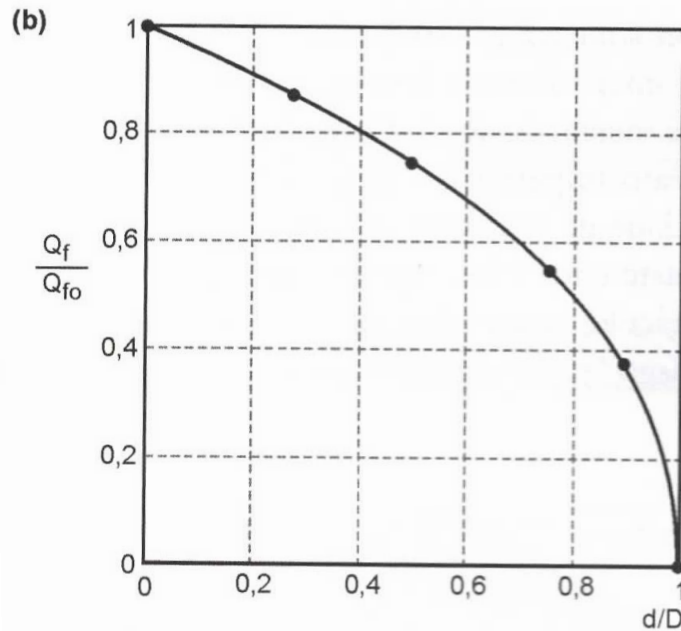
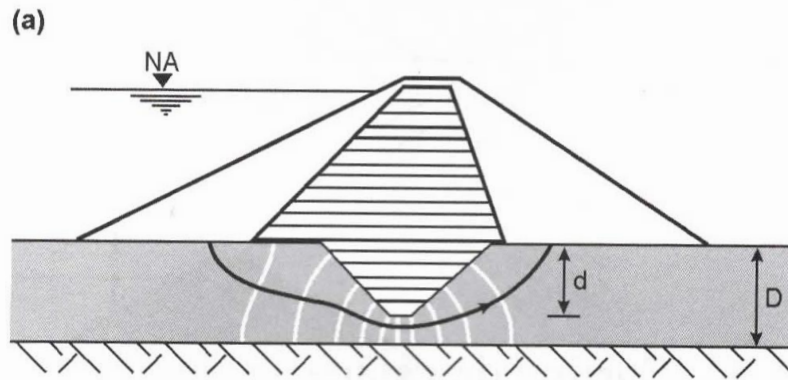
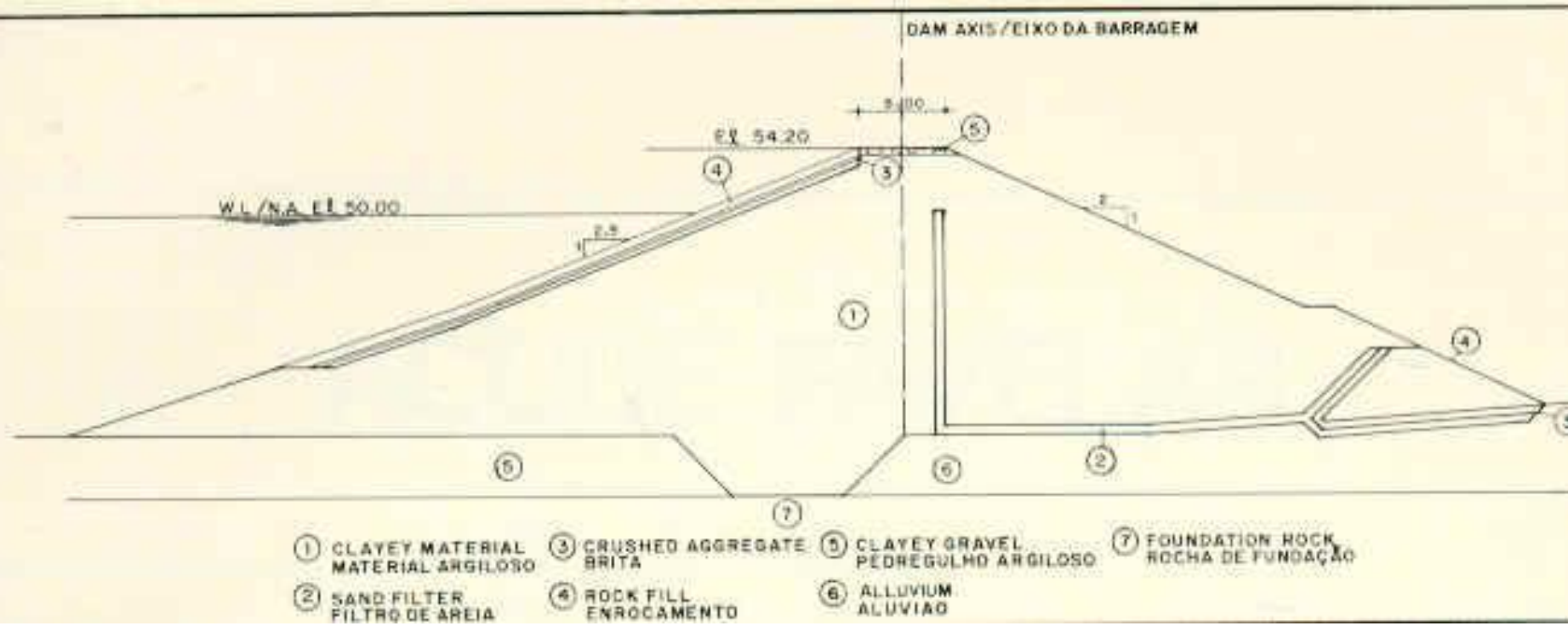
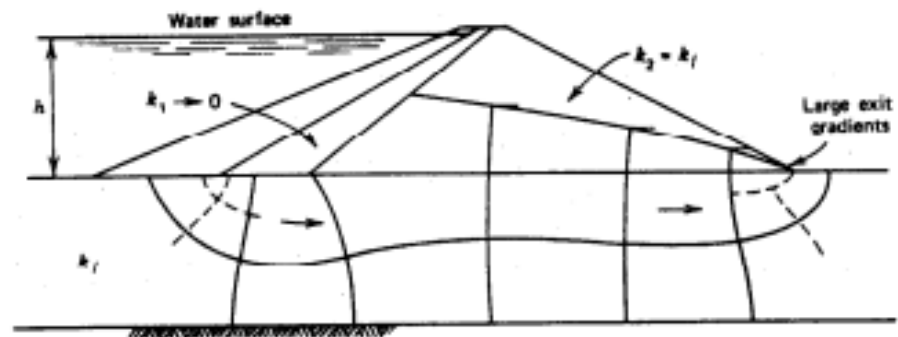


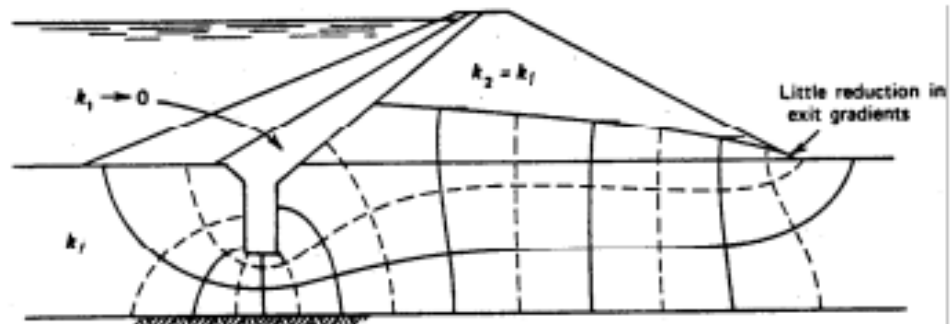
Fig. 8.2

(a) Barragem de terra com trincheira de vedação ou cut off;
(b) variação das perdas d'água em função da penetração do cut off (Cedergren, 1967)

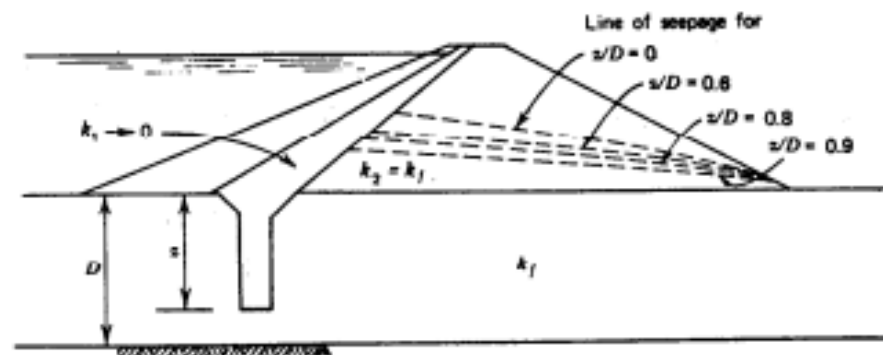




a. Flow net for no cutoff

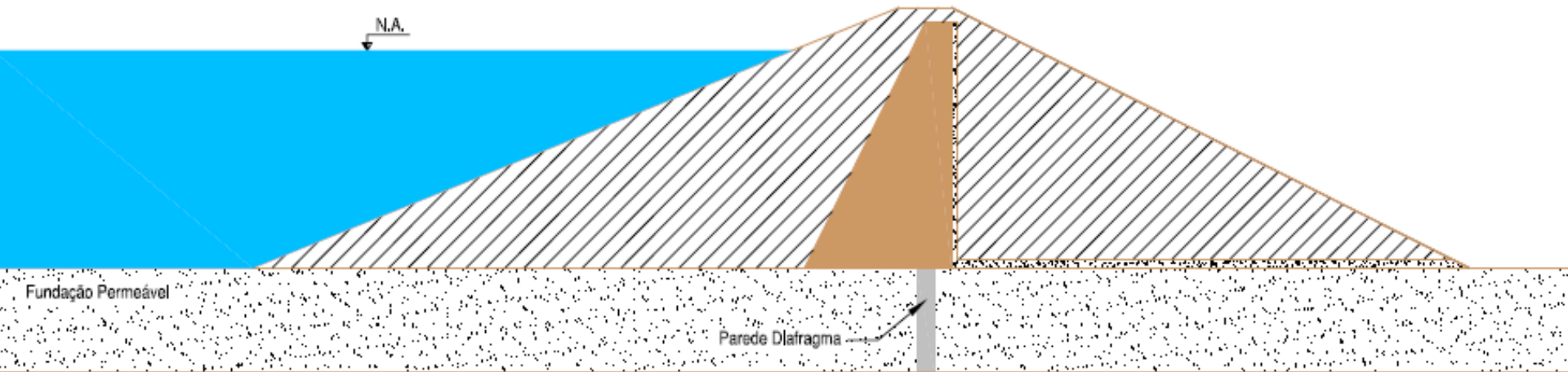


b. Flow net for partial cutoff



c. Position of line of seepage for various values of penetration

Parede diafragma



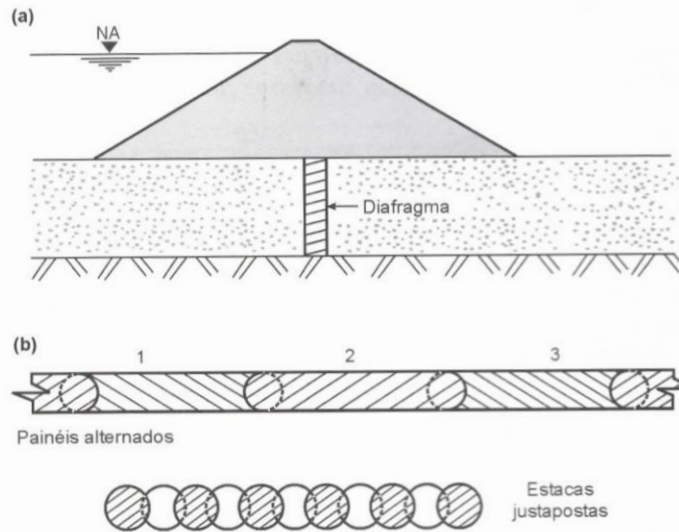


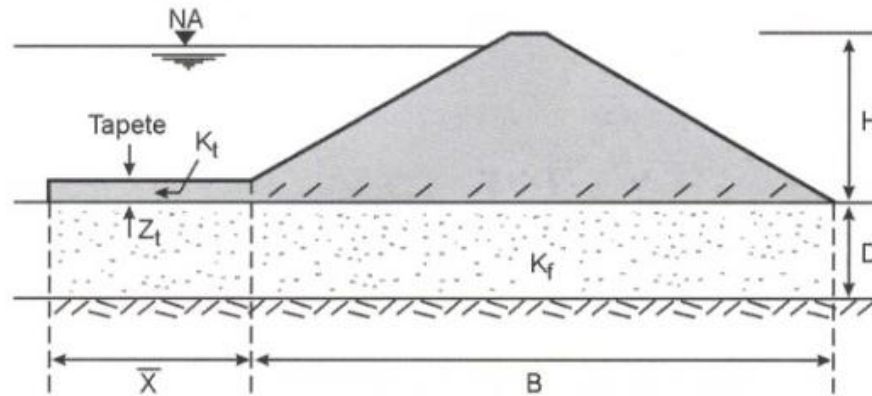
Fig. 8.5
Diafragmas para
interceptar o fluxo de
água pelas fundações

$$k_m = \frac{B}{\frac{B-b}{k_f} + \frac{b}{k_d}}$$

$$Q_f = k_m \frac{H}{B} D$$

$$Q_f = \frac{k_f H}{0,88D + B + b \left(\frac{k_f}{k_d} - 1 \right)} D$$

Tapete impermeável de montante



$$Q_f = k_f \frac{H}{0,88D + B + x_r} D$$

x_r = comprimento do tapete se ele for totalmente impermeável

Se não for totalmente impermeável, x_r é o comprimento equivalente impermeável

$$x_r = 0,63 \bar{x} \quad \bar{x} = \frac{\sqrt{2}}{a} \quad a = \sqrt{\frac{k_t}{k_f z_t z_f}}$$

Poços de alívio

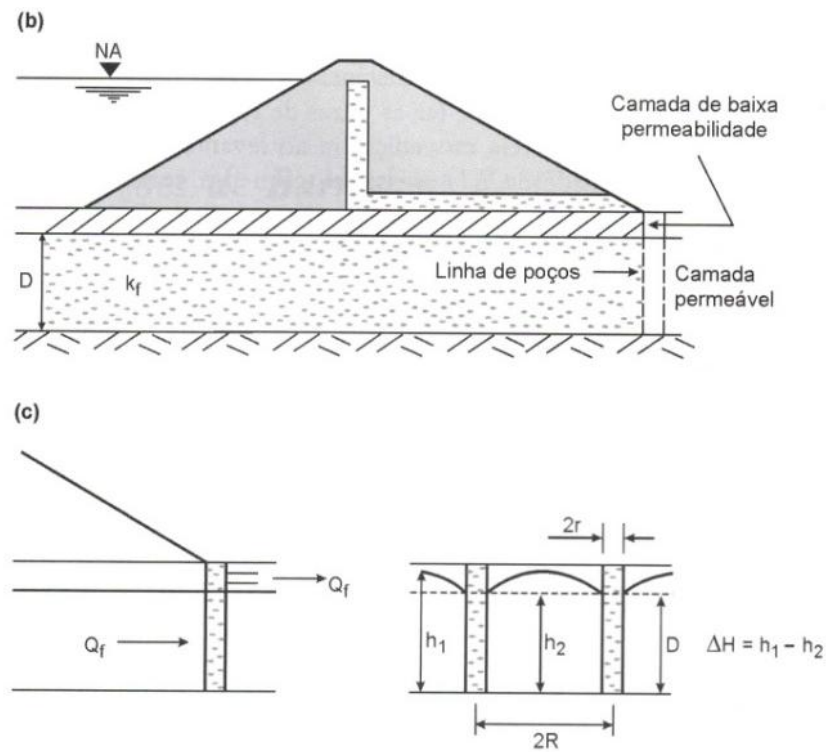


Fig. 8.9

Poços de alívio para o controle da saída d'água, a jusante

Filtro invertido

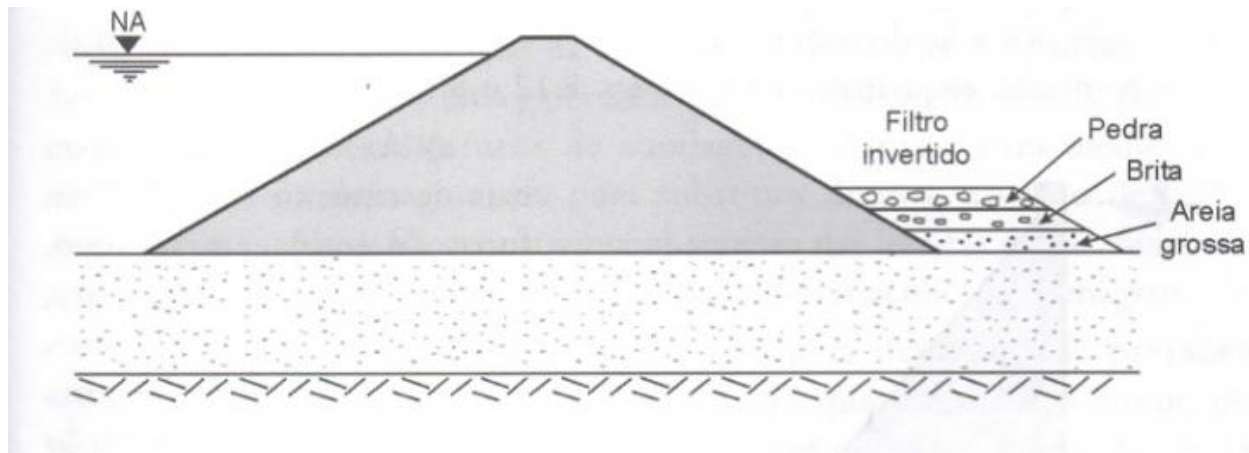


Fig. 8.10

***Filtro invertido
para controle de
gradientes de
saída.***