Basic Equation for Fluid Flow in Soil

Chapter 5 - B

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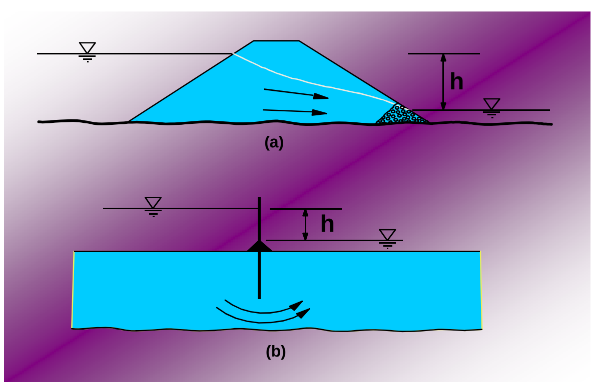
TWO DIMENSIONAL FLOW
FLOW NETS

Two dimensional flow: fluid parameters are the same in parallel planes.



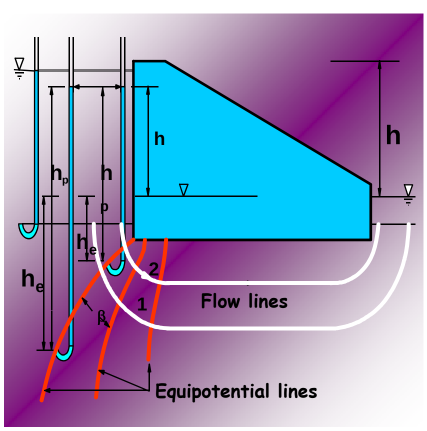
Flownet

Assumptions

1. Isotropic, saturated, homogeneous aquifer
2. Soil and water are incompressible
3. Darcy's law is valid
4. Boundary conditions are known

Solution

- Solutions to Laplace's equation for two-dimensional seepage can be presented as flow nets.
- Two orthogonal sets of curves form a flow net:
    1. equipotentials connecting points of equal total head h
    2. flow lines indicating the direction of seepage down a hydraulic gradient



Flow line:

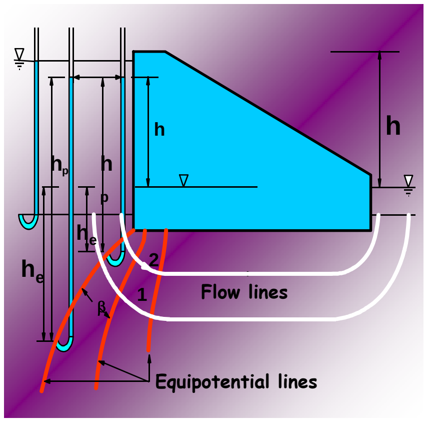
Average flow path of a particle of water flowing from the upstream reservoir down to the tailwater,

i.e. points of high heads to points of low heads

Equipotential line:

Line of equal energy,

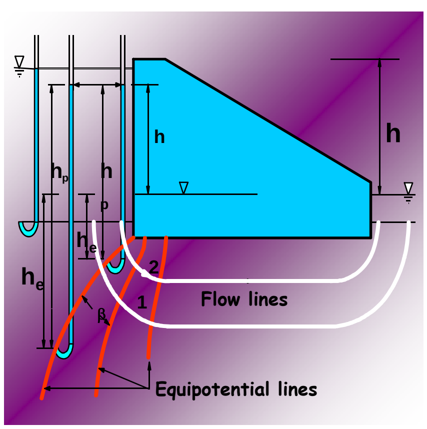
the energy available to cause flow is the same all along that line.



The network of flow lines and equipotential lines is called a ***flow net***.

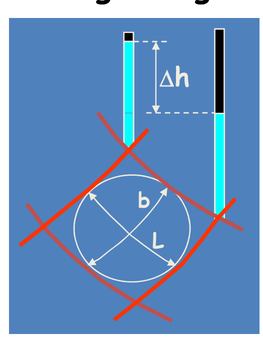
Flow net: concept that illustrates graphically how the head or energy is lost as water flows through a porous medium.

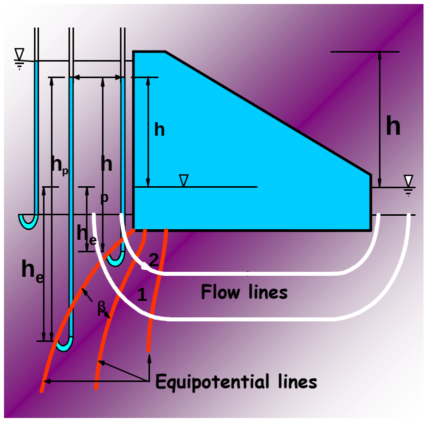
In an isotropic soil the flow must follow paths of the largest gradient.



K=1.0 m/day

The flow lines have to cross the equipotential lines at right angles.



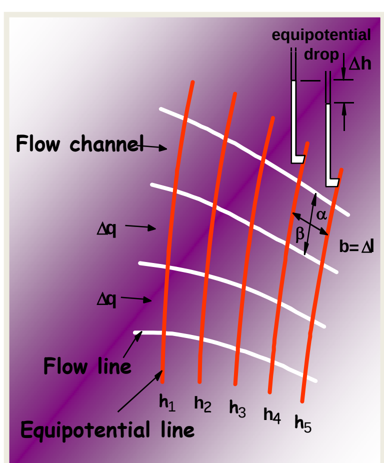


Not all the squares in a flow net have to be the same size

A flow line cannot intersect an impervious boundary.

An impervious boundary is a flow line.

Equipotential lines must meet impervious boundaries at right angles.



Consider the square with dimensions a x b.

$$i = \Delta h / \beta$$

β is length of flow path in one square.

Δh is the equipotential drop between two flow lines.

If there are N_e equi. drop along each of the channel. Then:

$$h = N_e \, \Delta h$$

$$i = (h/N_e) / \beta$$

h total head lost in the system

N_e total number of potential drops