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Hydraulic structures. Dams and reservoirs

Embankment dam engineering-3

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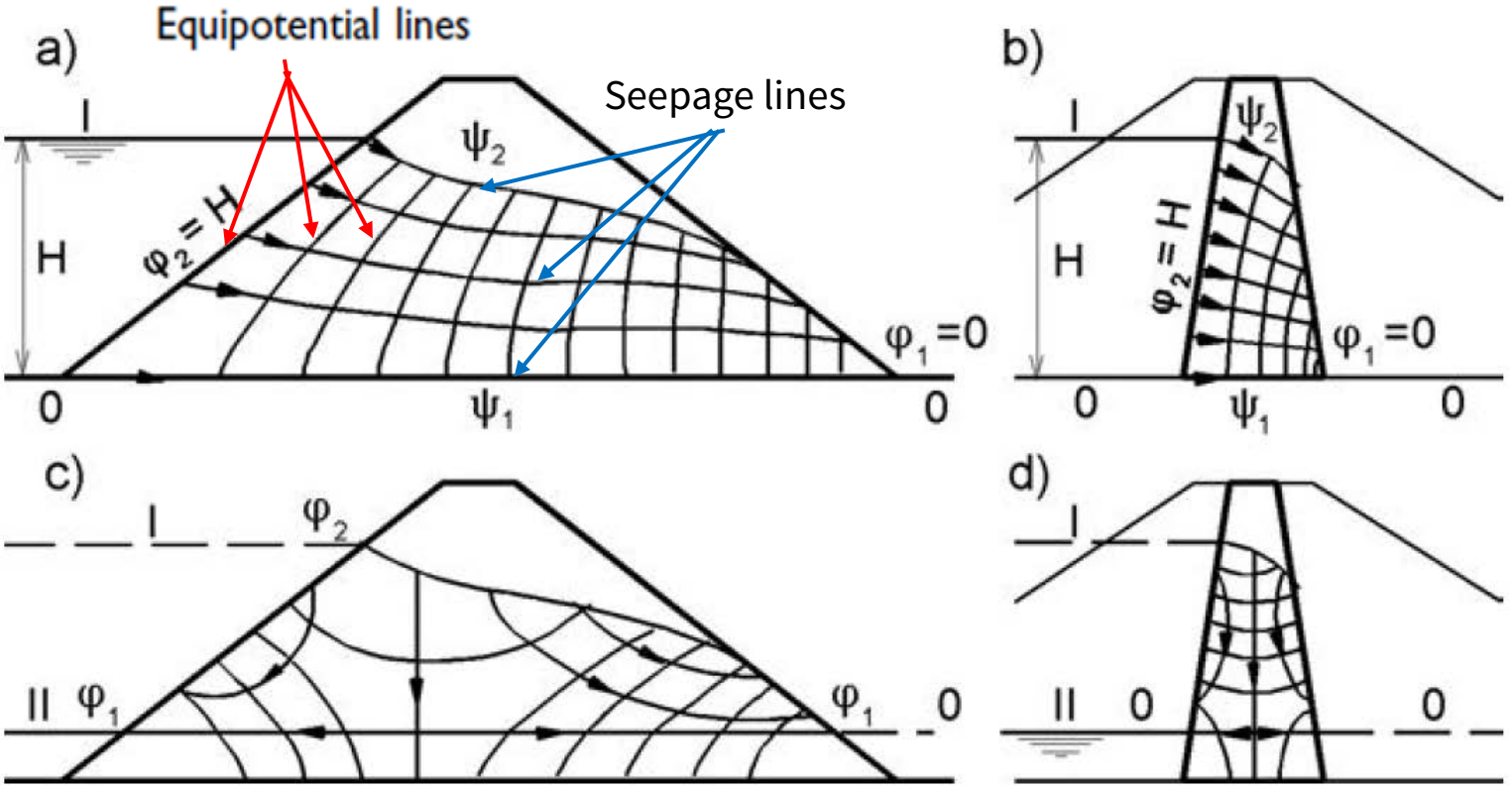
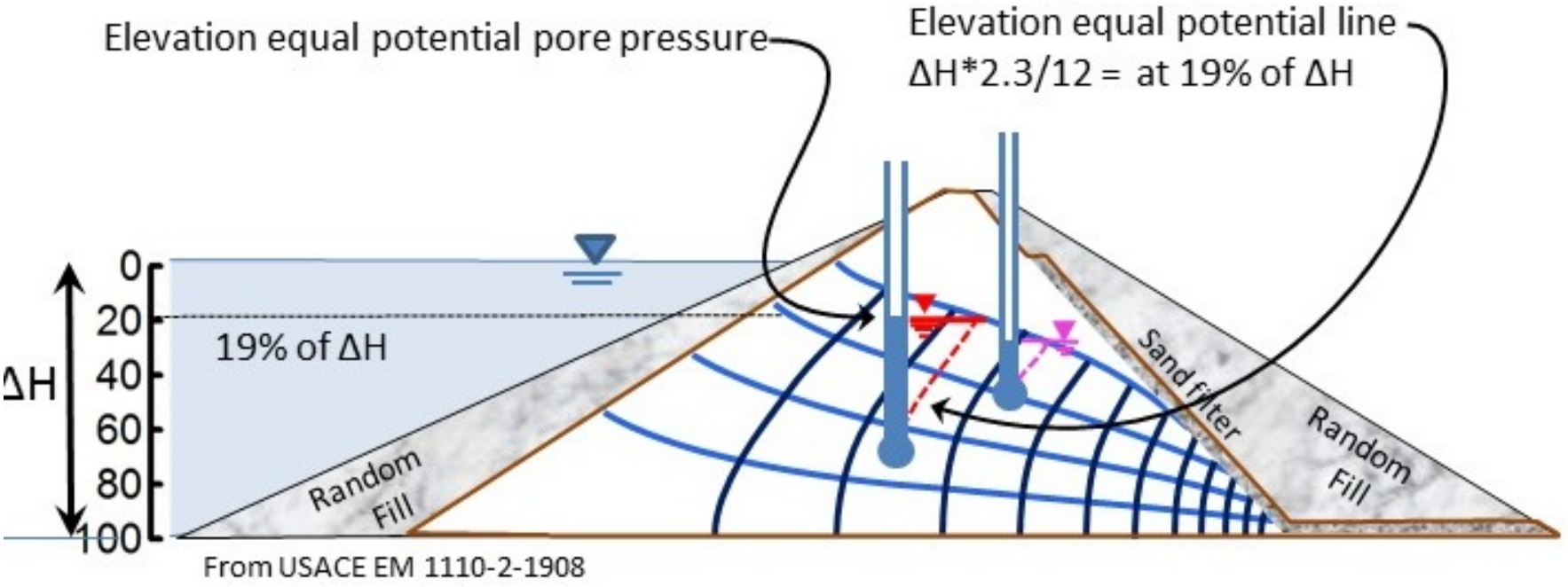
SEEPAGE LINE AND HYDRODYNAMIC NET IN EMBANKMENT DAMS

to determine the position of the top seepage line after the establishment of the stationary flow, which represents an upper boundary line of motion, there are a number of methods

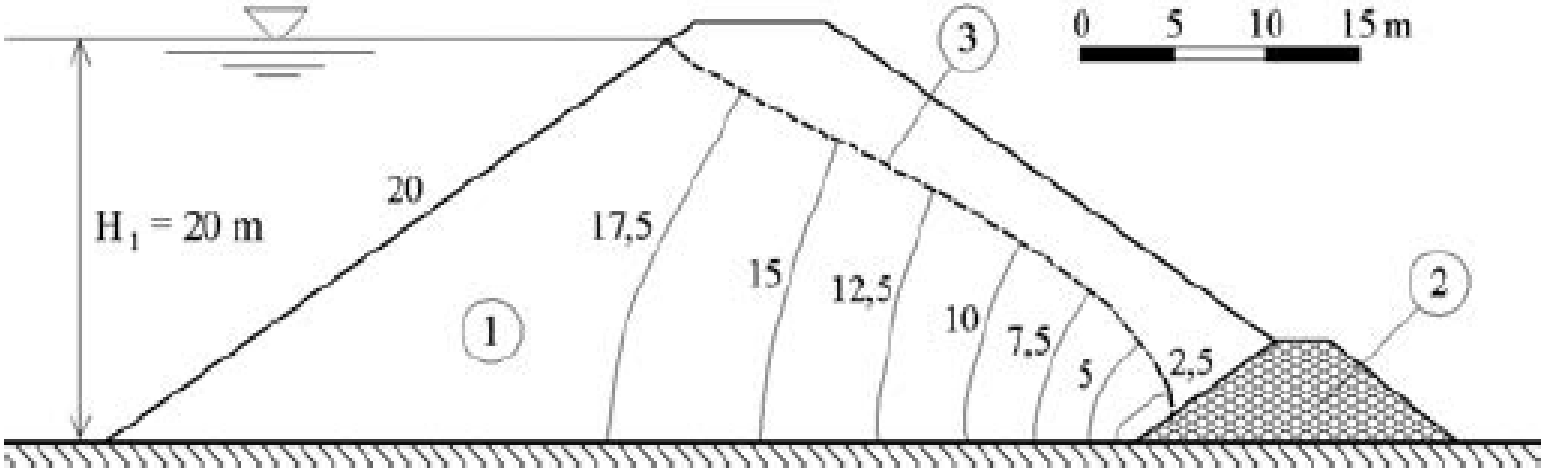


3 Hydrodynamic net through a homogeneous dam and through the core of an earth–rock dam.



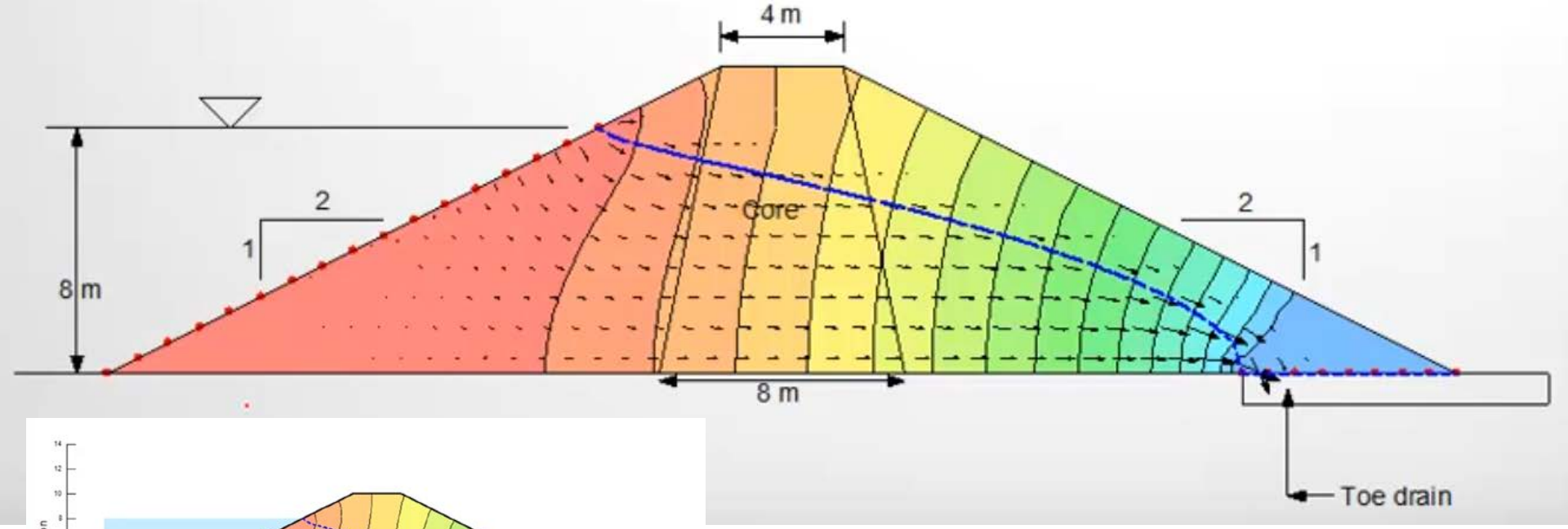
From USACE EM 1110-2-1908

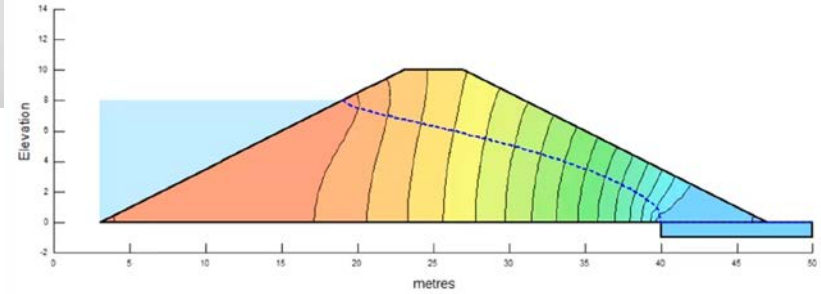
in the example of a homogeneous earthfill dam Casagrande approximates the seepage line with a parabola



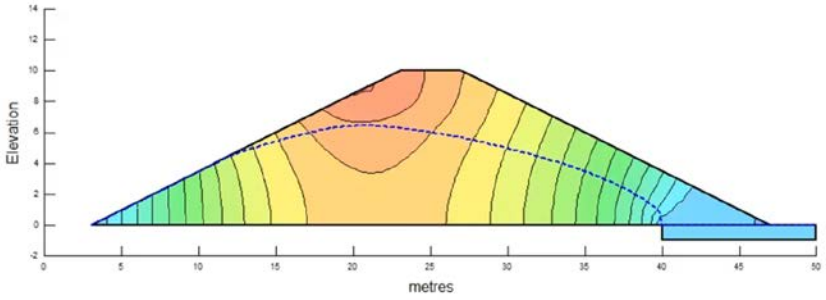
Equipotential lines (in metres) for a homogeneous dam on an impervious foundation for a stationary seepage flow, obtained by means of the finite element method using SEEP/W. (1) Dam's body of poorly permeable earth material; (2) drainage prism; (3) seepage line.

Equipotential lines, steady state case NWL





1 day



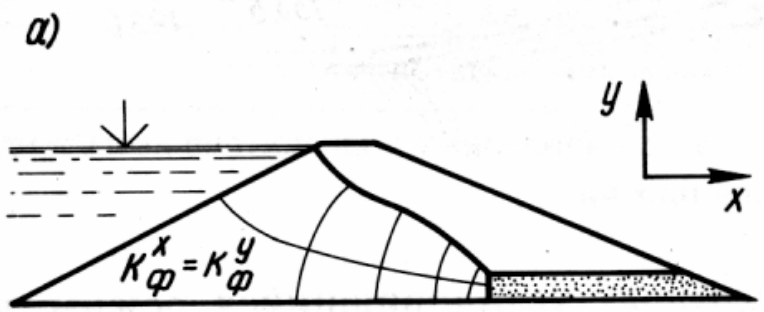
12 day

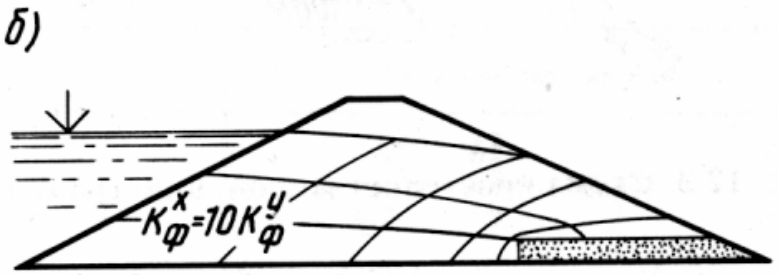
Equipotential lines, rapid drawdown

Control of seepage

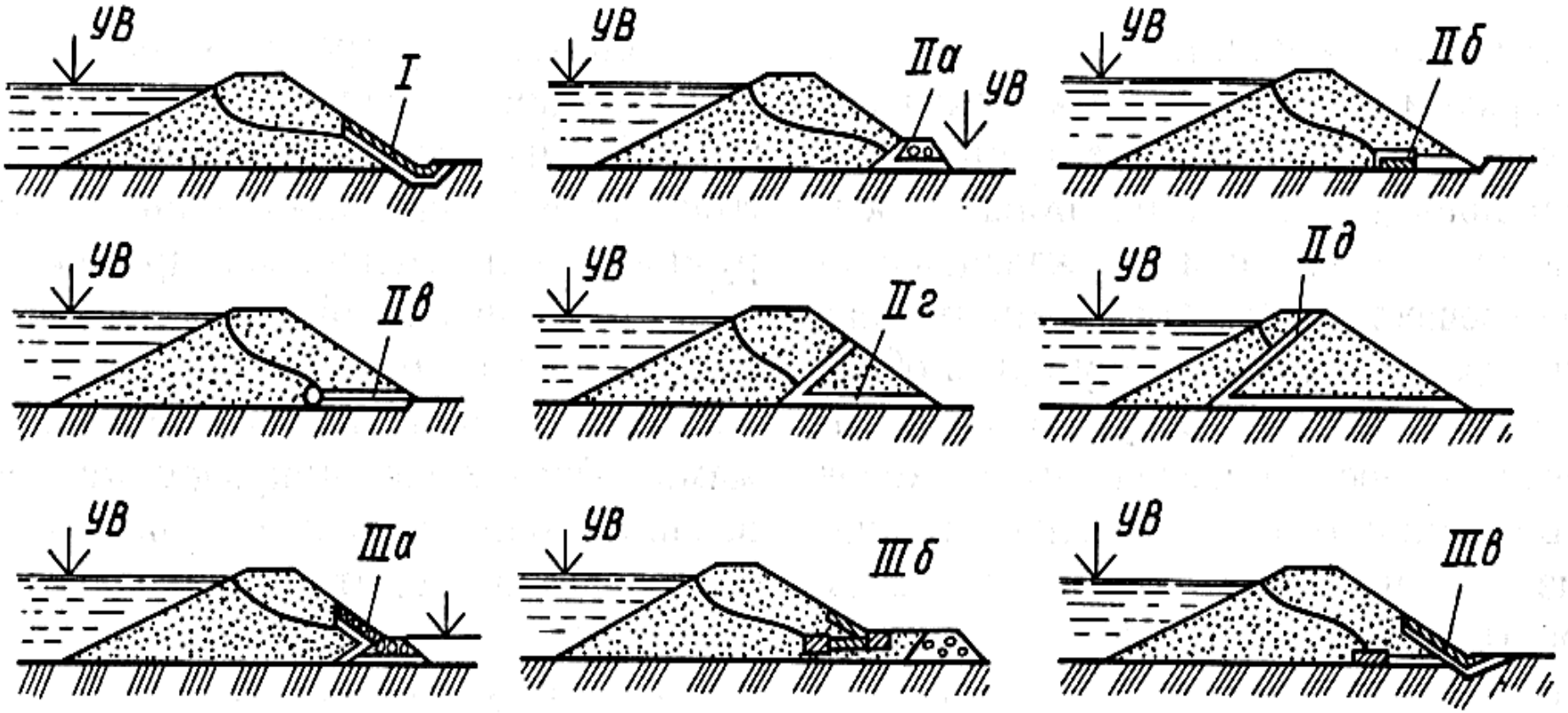
Seepage within and under the embankment must be controlled to prevent internal erosion and migration of fine materials (from the core), or external erosion

Seepage

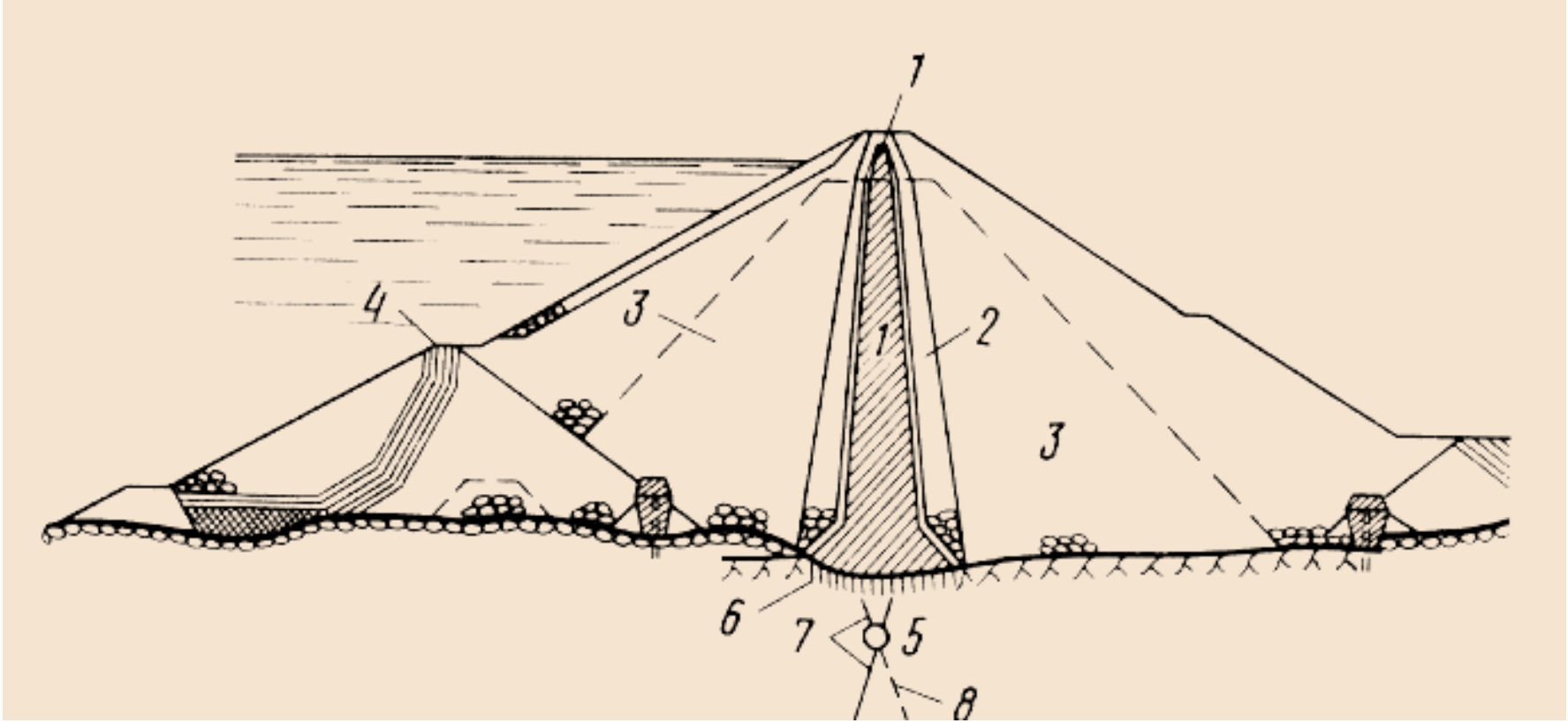




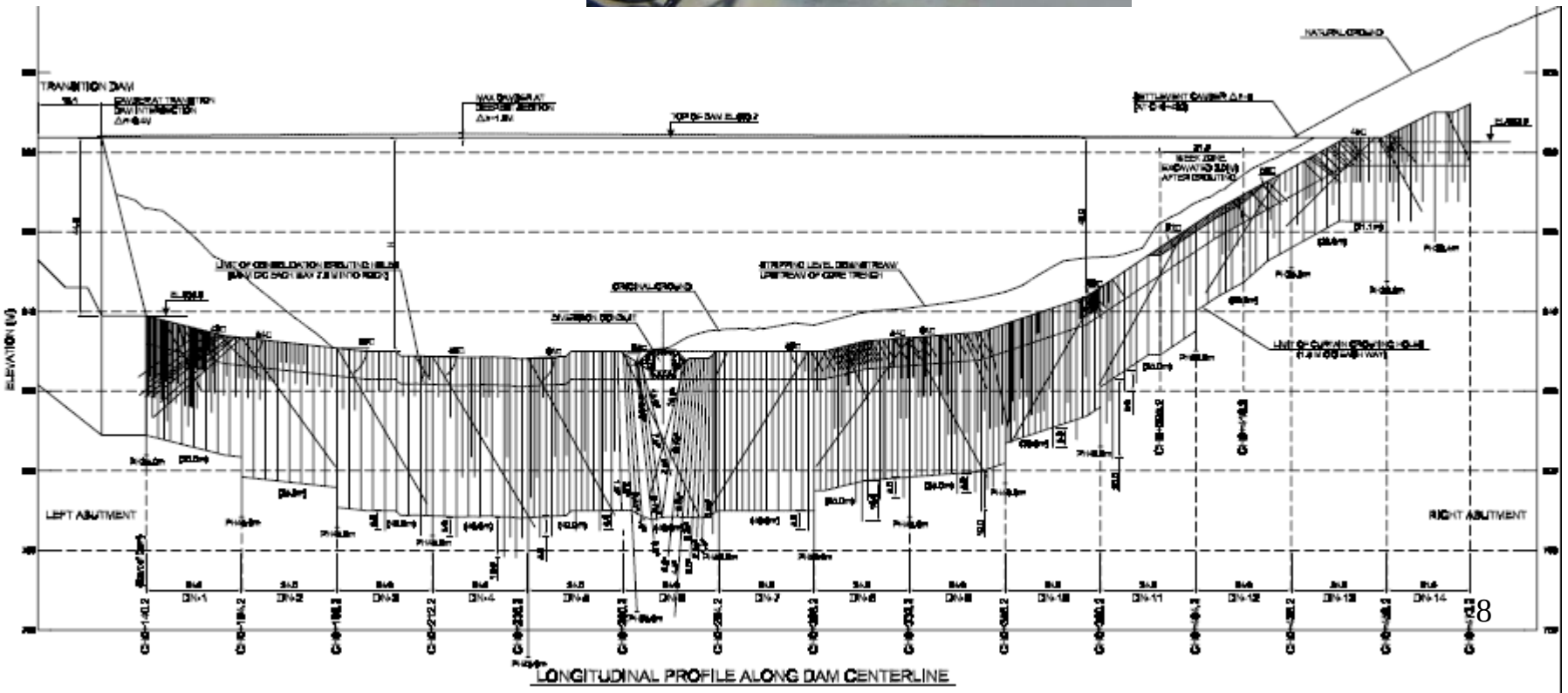
Drainage



Seepage control in dam body and foundation

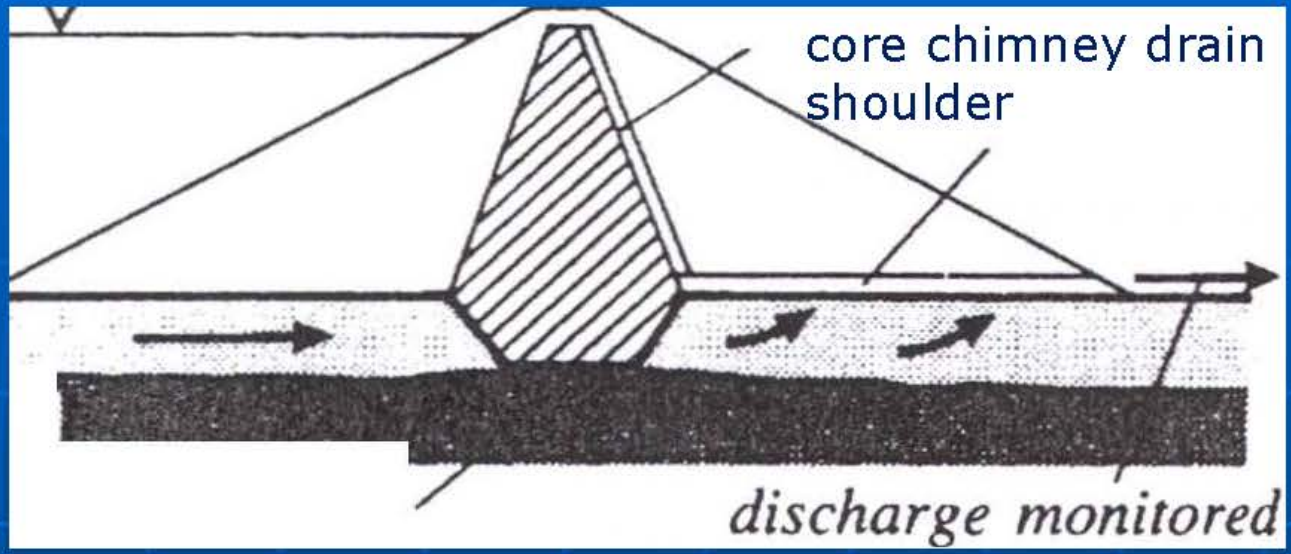


GROUT CURTAIN



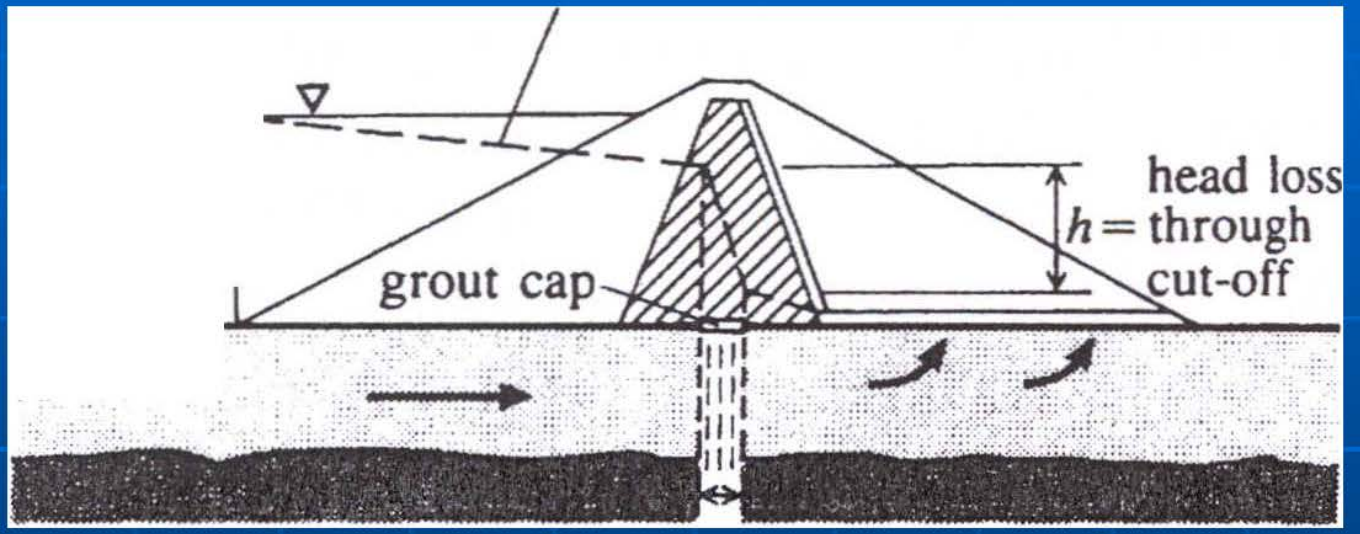
LONGITUDINAL PROFILE ALONG DAM CENTERLINE

Foundation seepage control



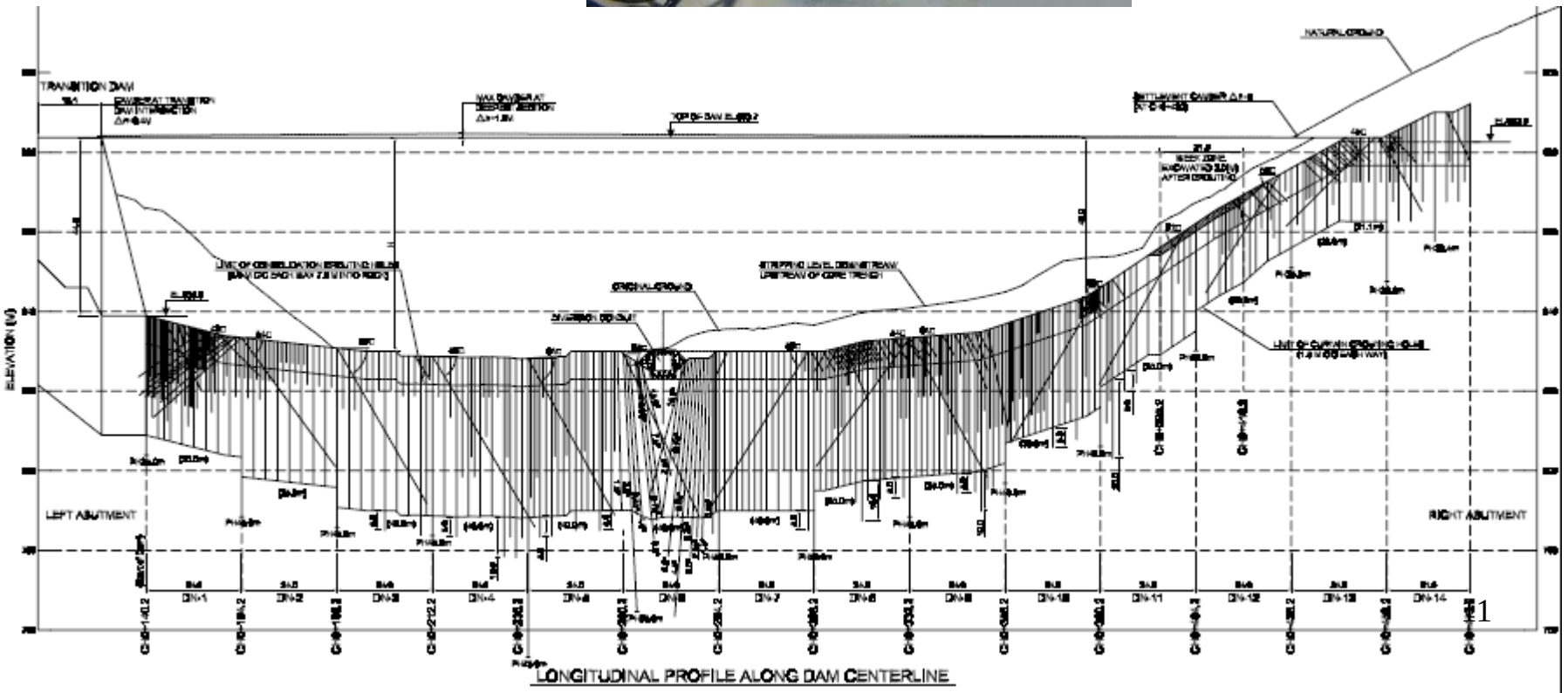
(a) Open trench cut-off (to moderate depth only)

Foundation seepage control

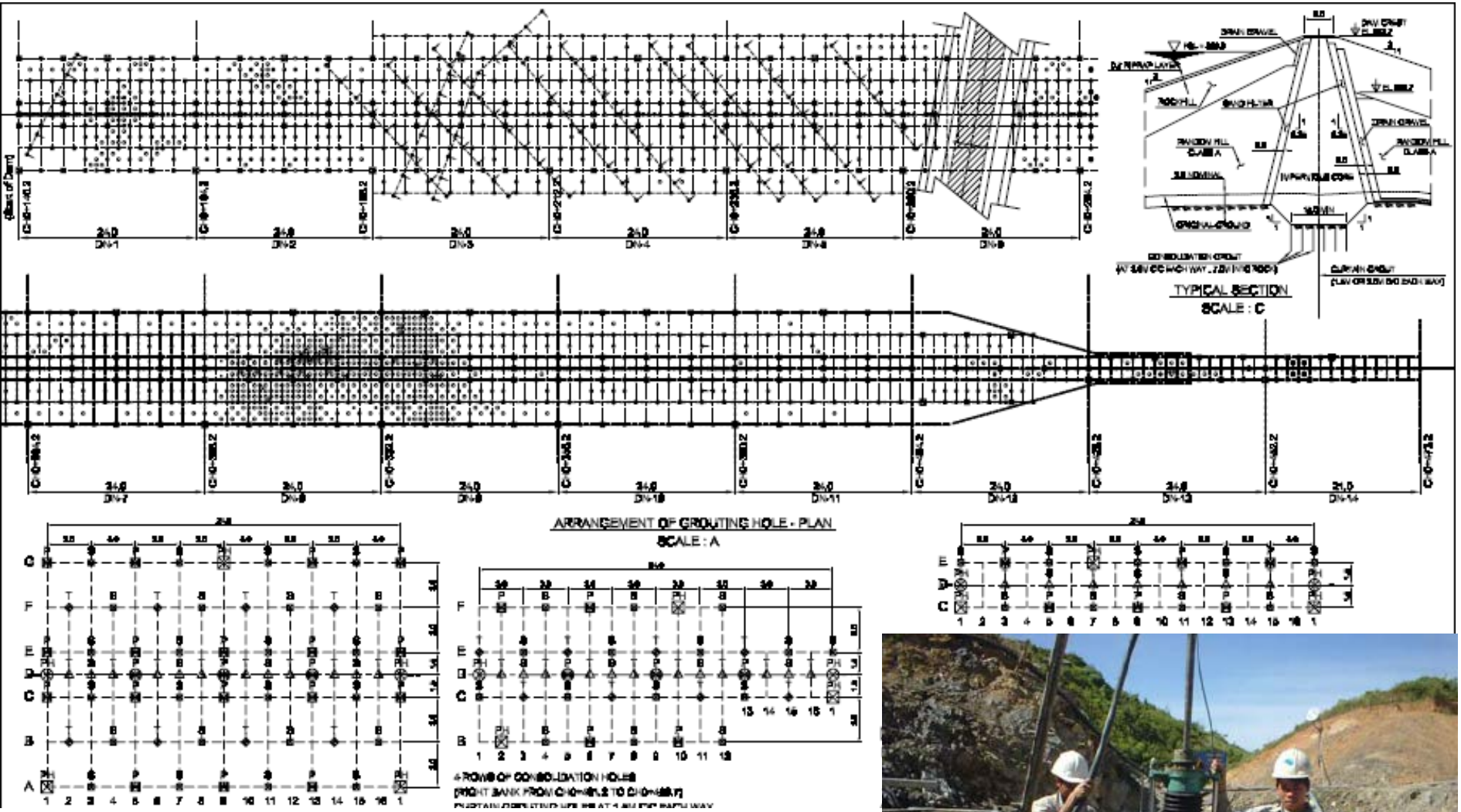


(b) Grouted cut-off
(need not penetrate to impervious horizons)

GRAUTED CUT-OFF

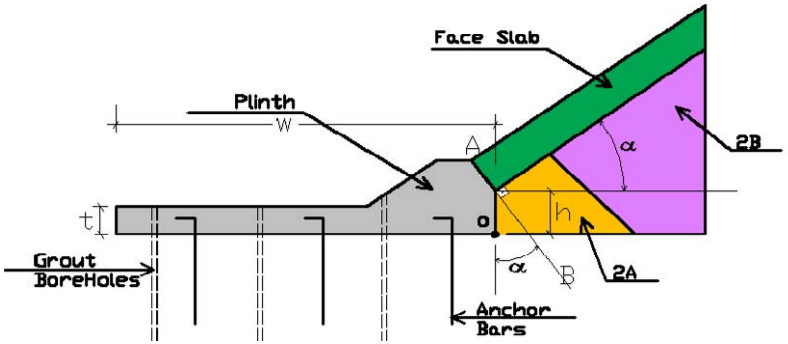


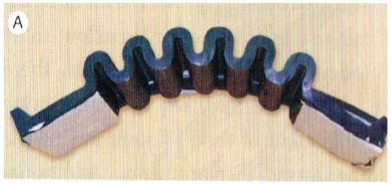
LONGITUDINAL PROFILE ALONG DAM CENTERLINE

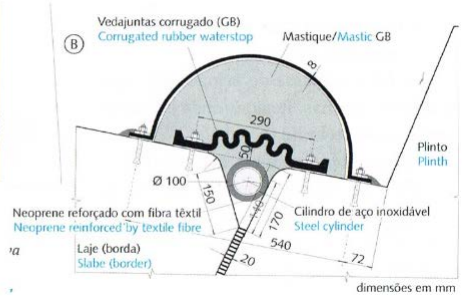

TYPICAL SECTION
SCALE : C
ARRANGEMENT OF GROUTING HOLE - PLAN
SCALE : A

drilling ⟶

P, Mpa → z of the plate

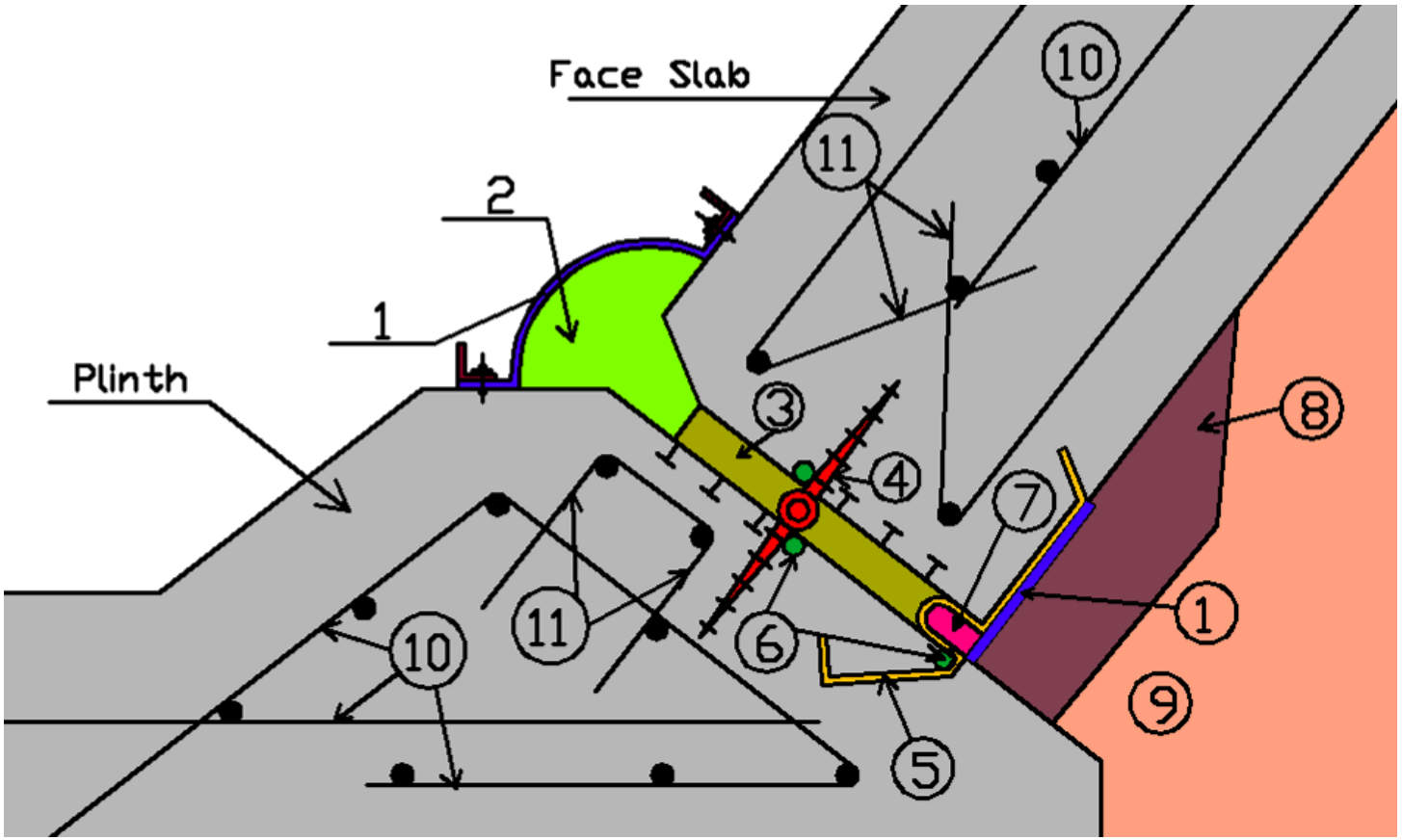




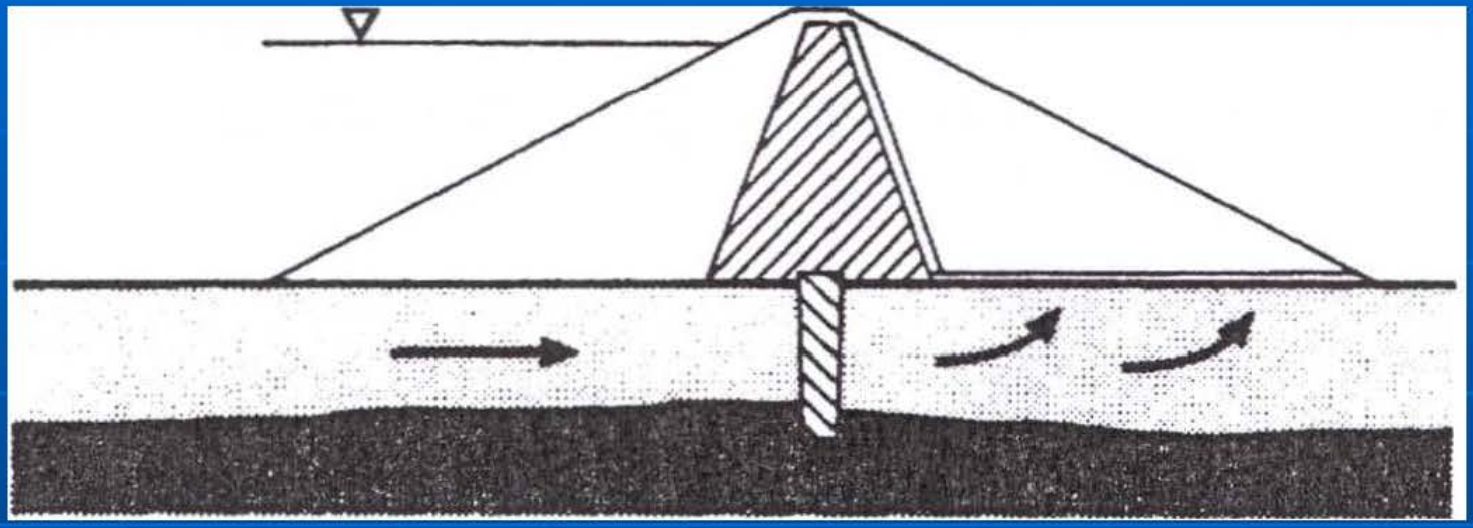


$$z = \frac{10^3 p}{n\gamma_b} m,\ p[MPa]$$

waterstops



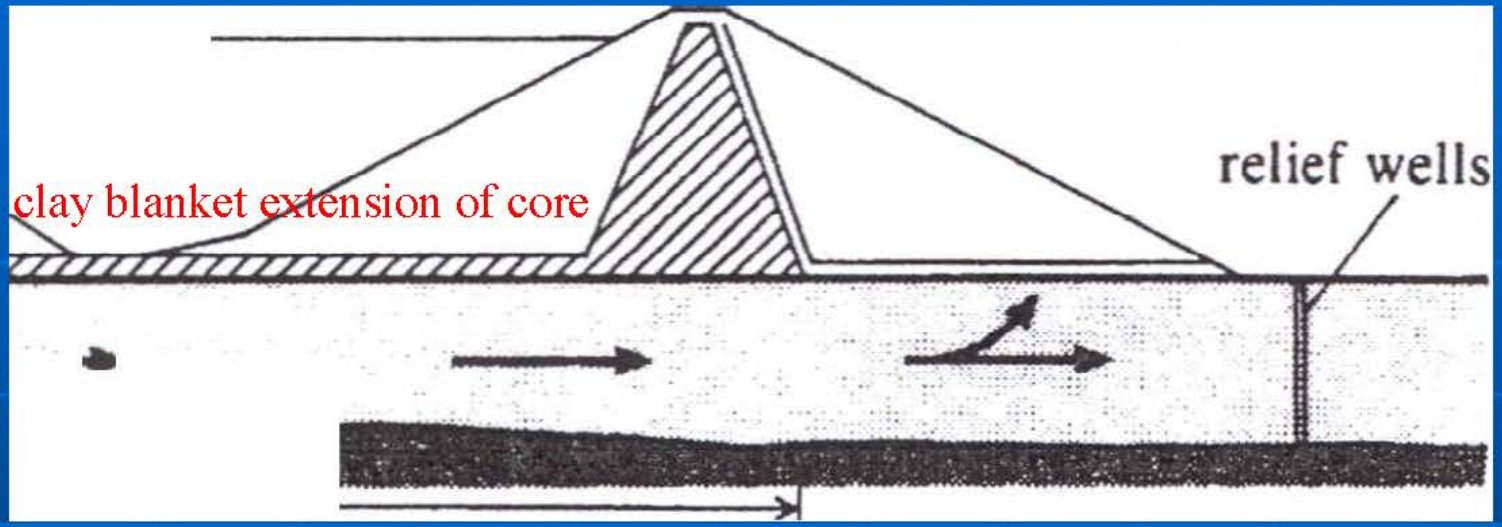
Foundation seepage control

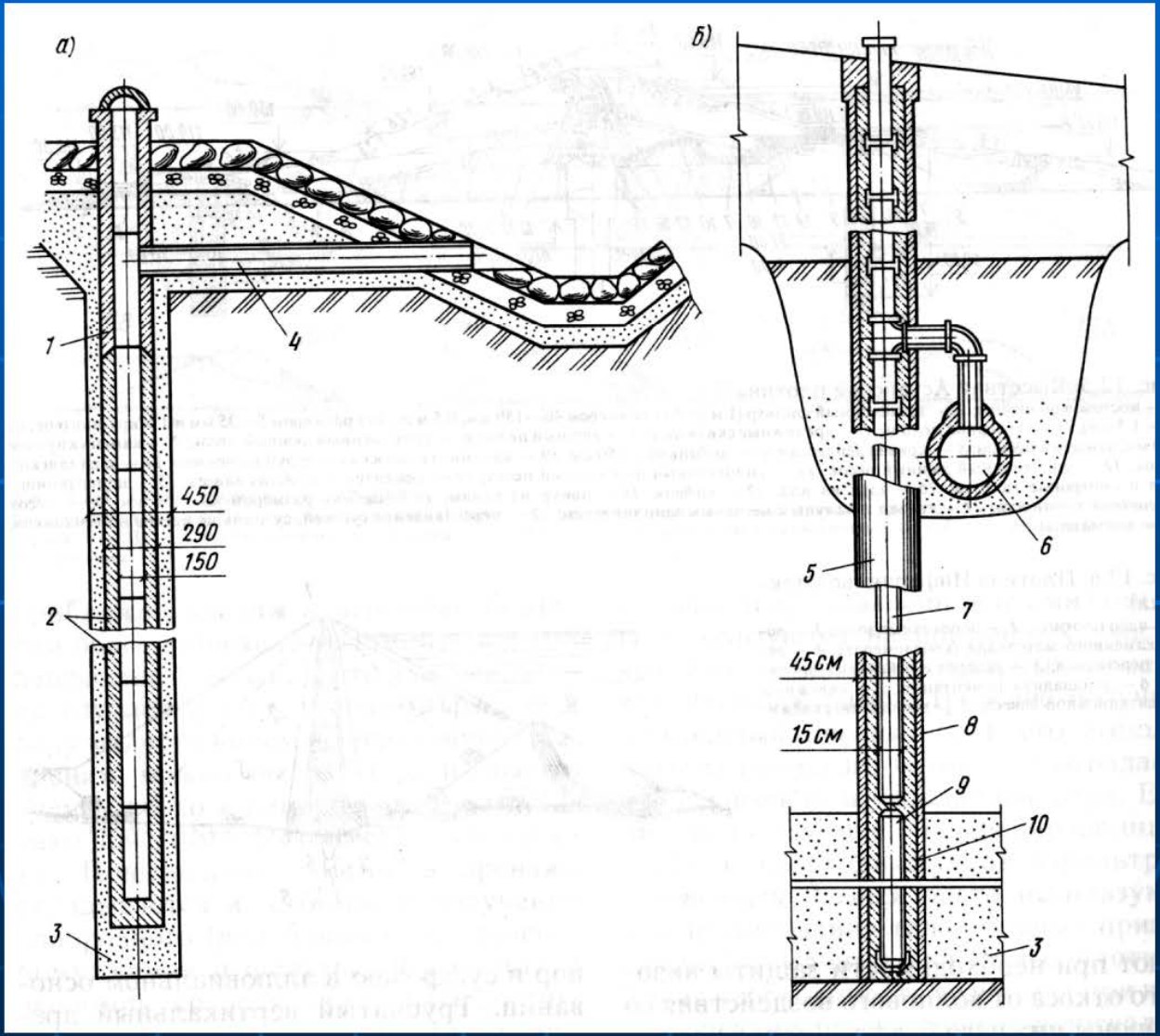


(c) Diaphragm cut-off (need not penetrate to impervious horizons)

https://www.youtube.com/watch?v=w3XeovI93M0
https://www.youtube.com/watch?v=_NHhapkoUYk

Foundation seepage control



(d) Upstream blanket
(may employ underdrain with relief wells)

relief wells