Porous flow, filters

Chapter 6

ct4310 Bed, Bank and Shoreline protection
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**Faculty of Civil Engineering and Geosciences
Section Hydraulic Engineering**

TUDelft
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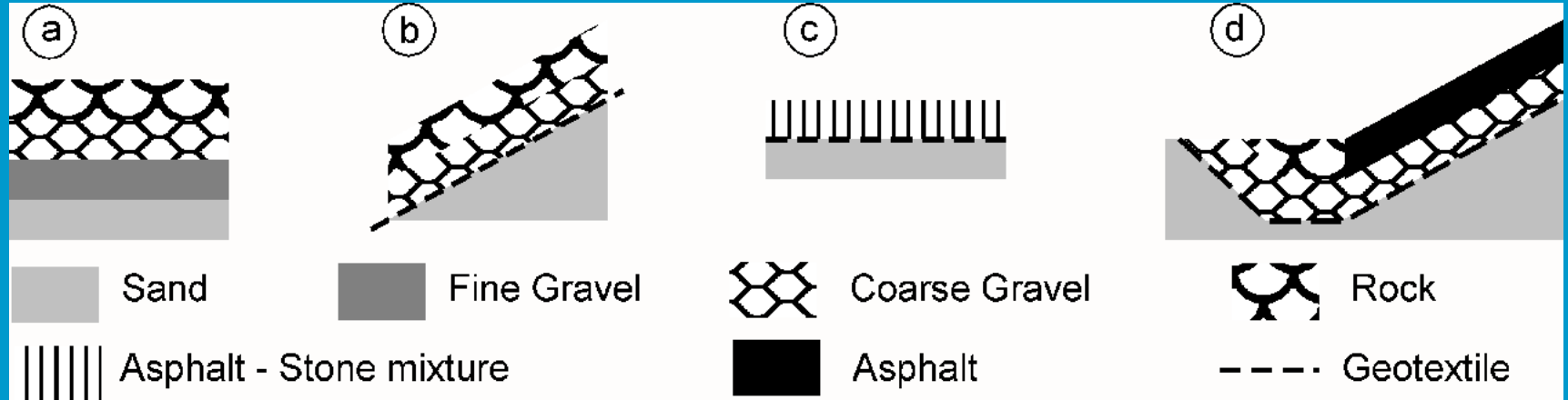
TUDelft
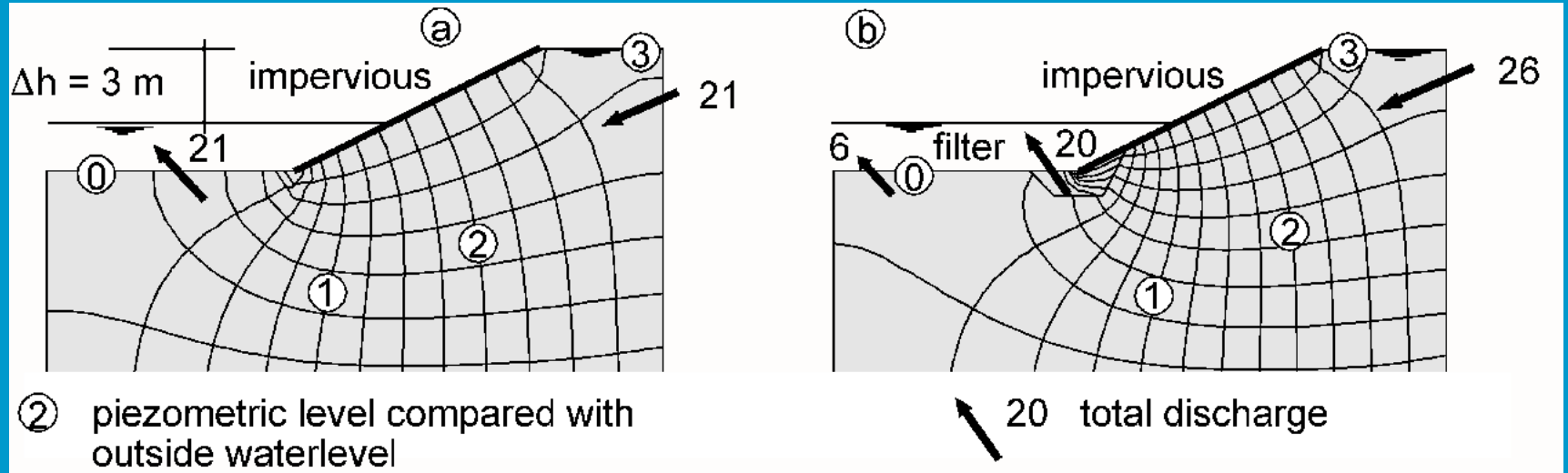
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Introduction

- On many places on should:
  - allow flow of water
  - prevent flow of sediment
- So structures are needed which are permeable and sandtight

- Filters can be build up from:
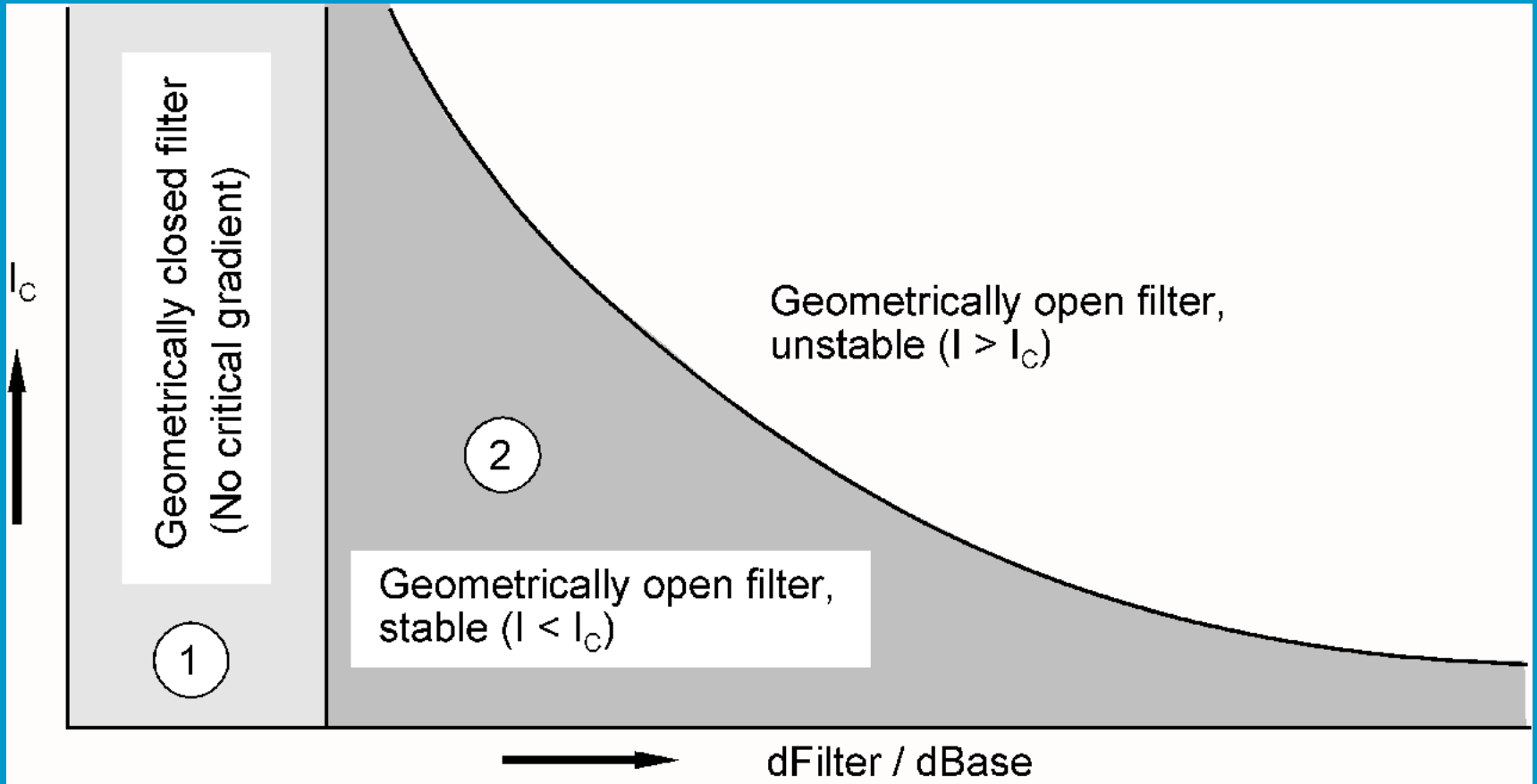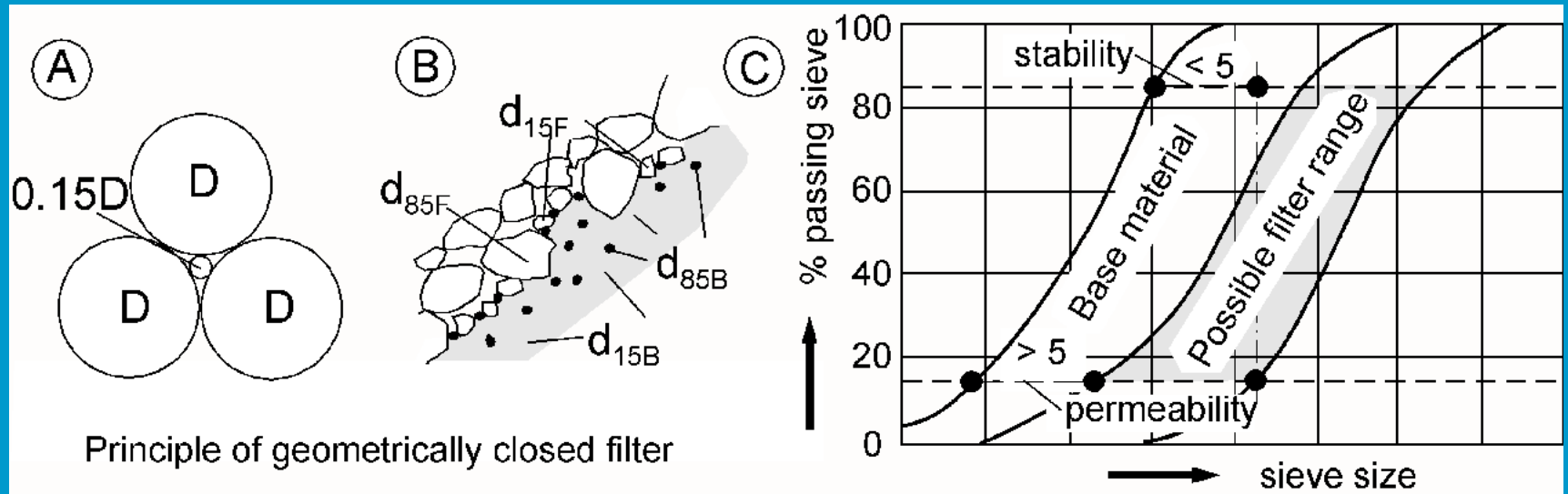 - granular material
  - geotextiles

examples of filters

influence of filter on flow under impervious revetment

(a)

$\Delta h = 3$ m   impervious   ③   21

21   ⓪   ②   ①

(b)

impervious   ③   26

6   filter   20   ⓪   ②   ①

②   piezometric level compared with outside waterlevel

20   total discharge

possible design criteria for granular filters

geometrically closed filters

Principle of geometrically closed filter

filter rules

stability: $$\frac{d_{15F}}{d_{85B}} < 5$$

internal stability $$\frac{d_{60}}{d_{10}} < 10$$

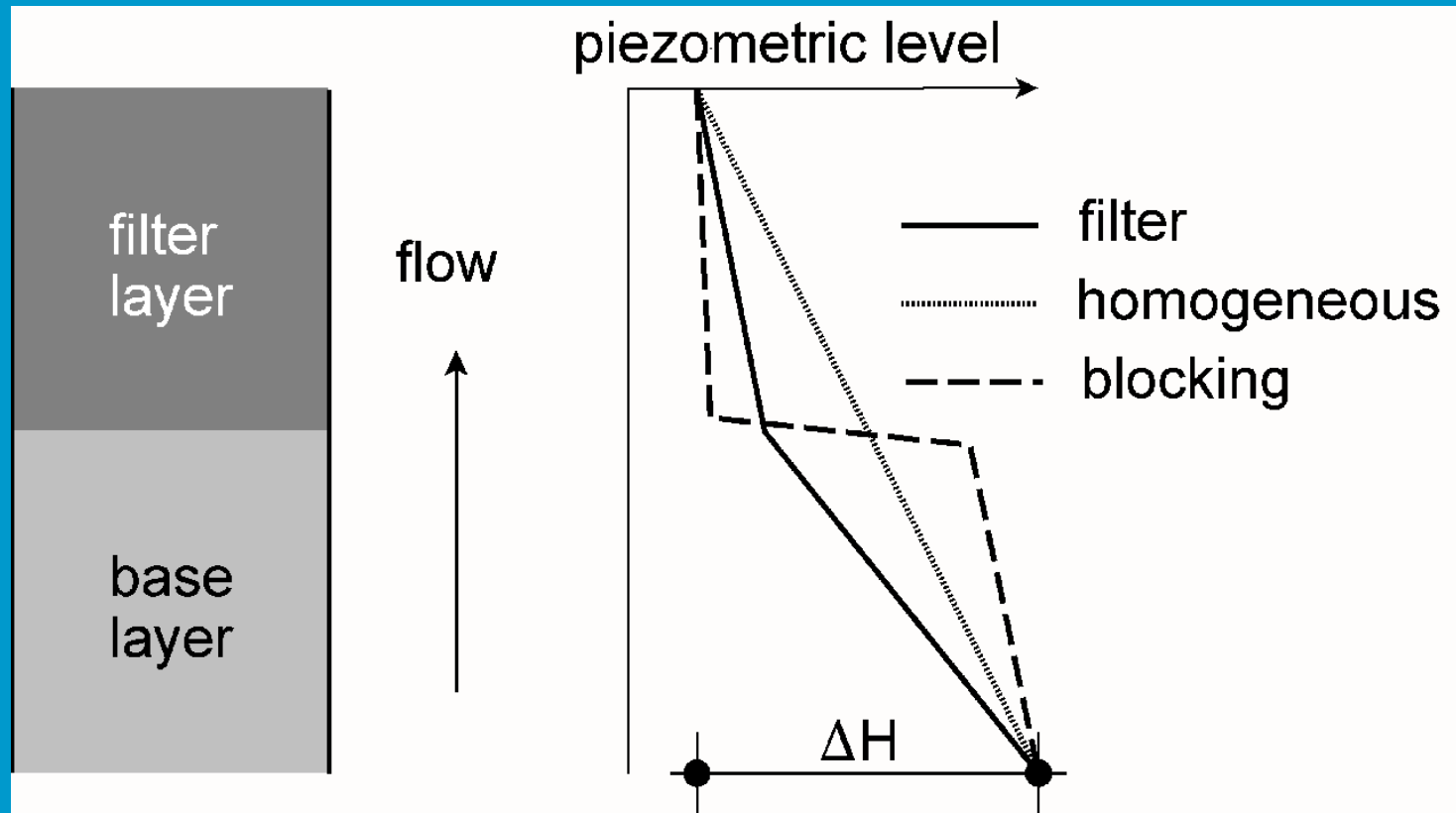permeability $$\frac{d_{15F}}{d_{15B}} > 5$$

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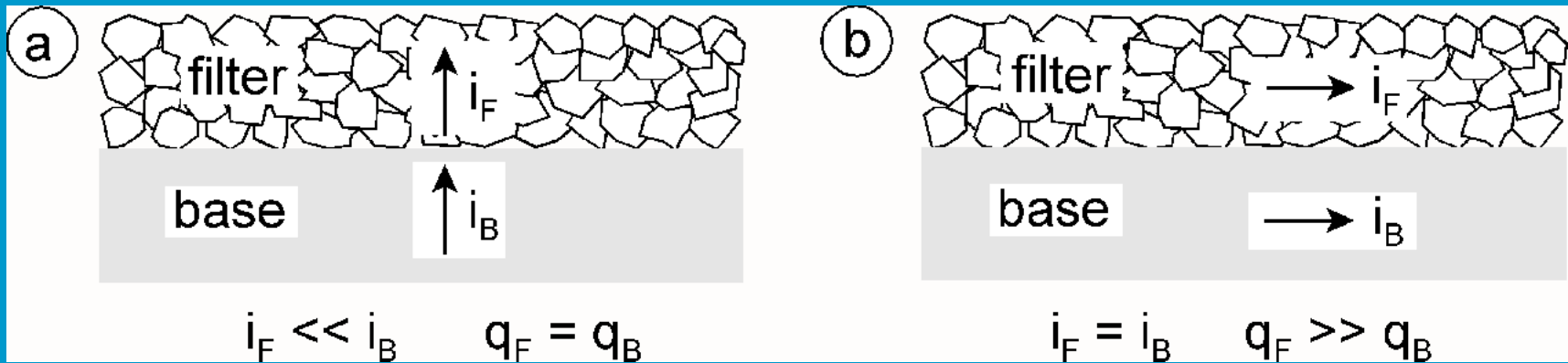# application of filter rules
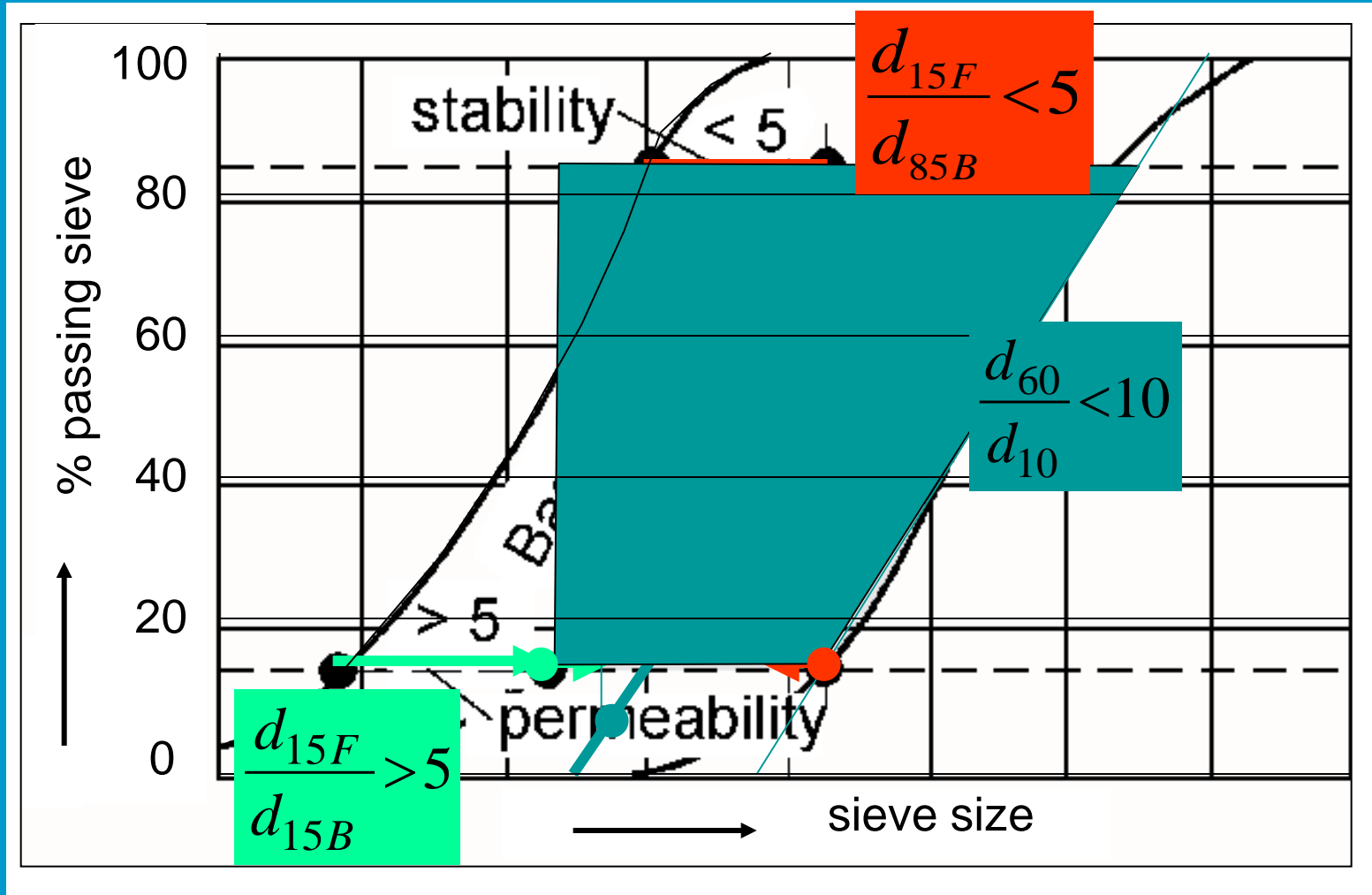
effect of blocking

geometrically open filters

- Grains are much smaller than gaps
- Velocity in filter is always below critical velocity
- Movement of base material cannot be initiated

perpendicular and parallel flow

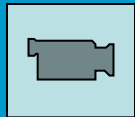a — filter, base, i_F, i_B, $i_F << i_B$, $q_F = q_B$

b — filter, base, i_F, i_B, $i_F = i_B$, $q_F >> q_B$

Example of a dynamic load

Threshold of sediment motion:

	grain size	filter 20 mm
		bed 0.82 mm
	Porosity Filter	41 %
	Wave period	2 sec

1	16 mm/s	0.05
2	22 mm/s	0.07
3	28 mm/s	0.10
4	32 mm/s	0.13 threshold
5	35 mm/s	0.13 threshold
6	40 mm/s	0.15
7	42 mm/s	0.18

bb 4310/6 GeoOpenFilter

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Flow in a void

Tracerzugabe

Zuleitung zum
Druckaufnehmer

Lichtleiter

Kies

Fliess-
richtung

Endoskope

Messvolumen
(Stereovolumen)

Tracer-Partikel
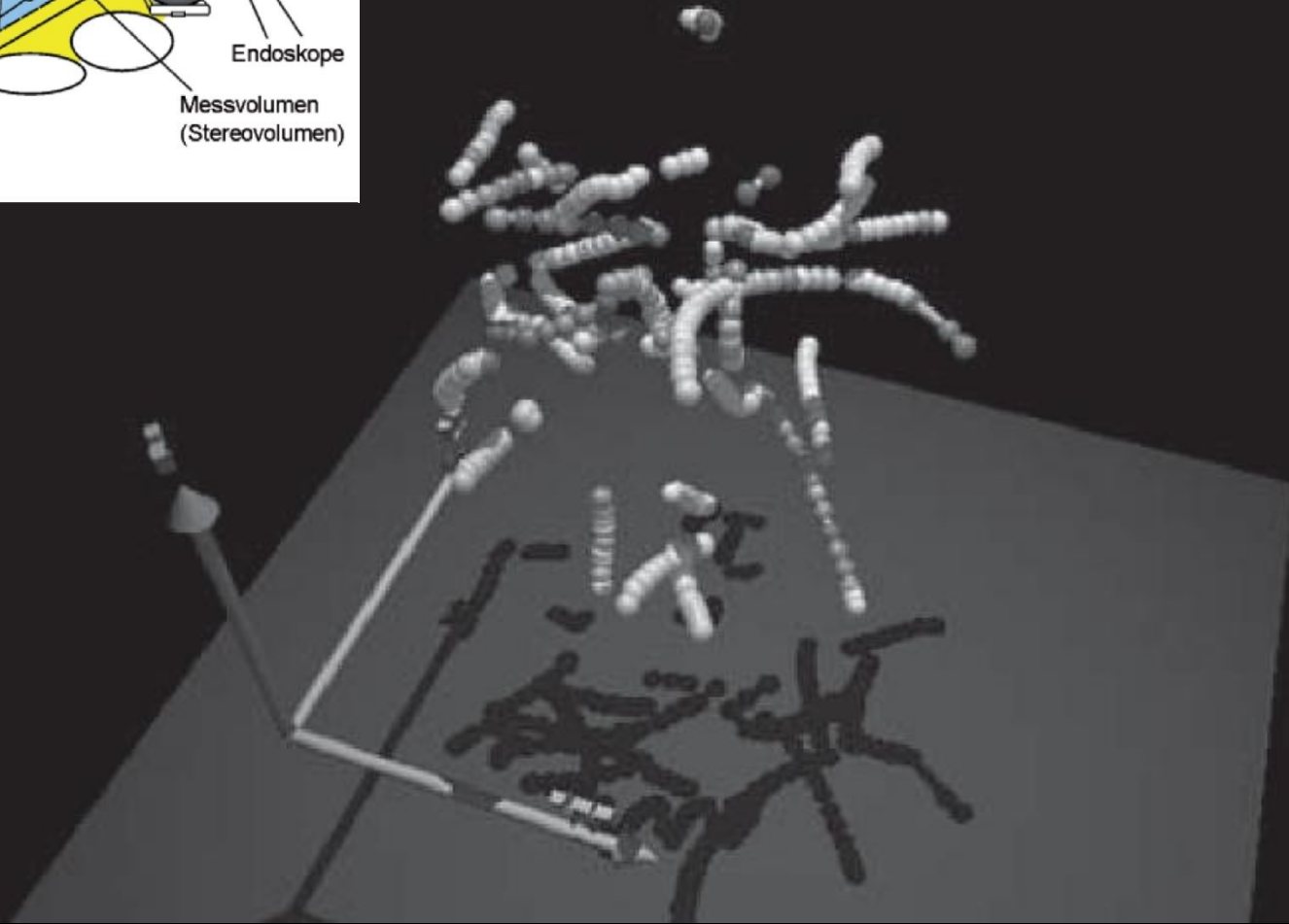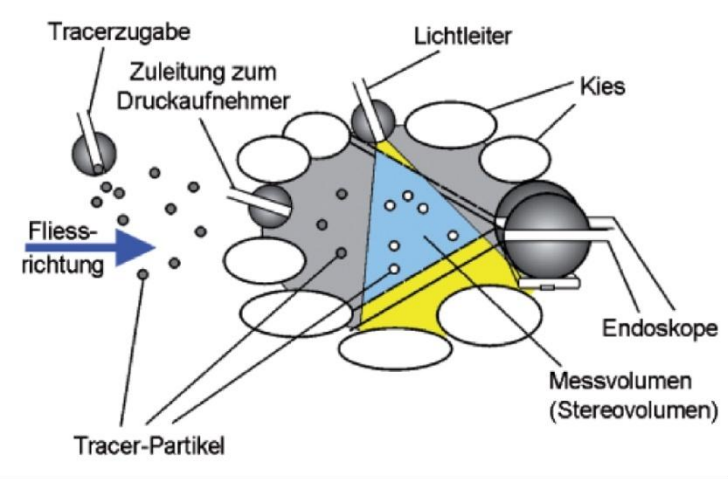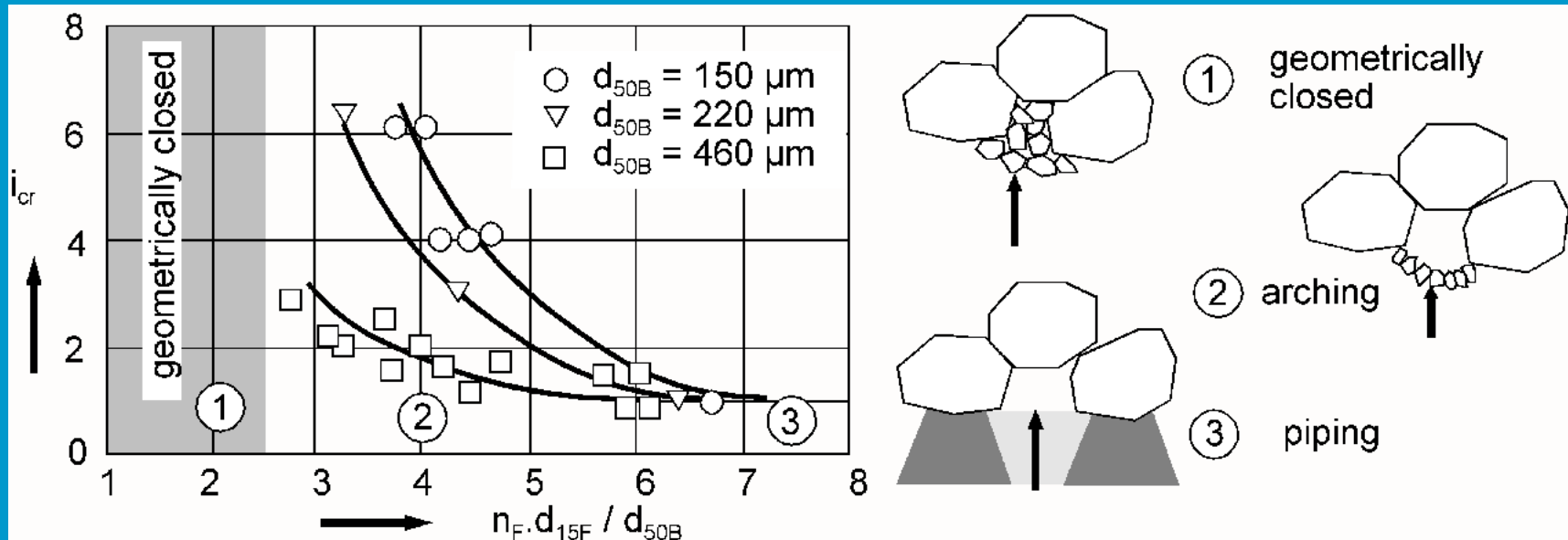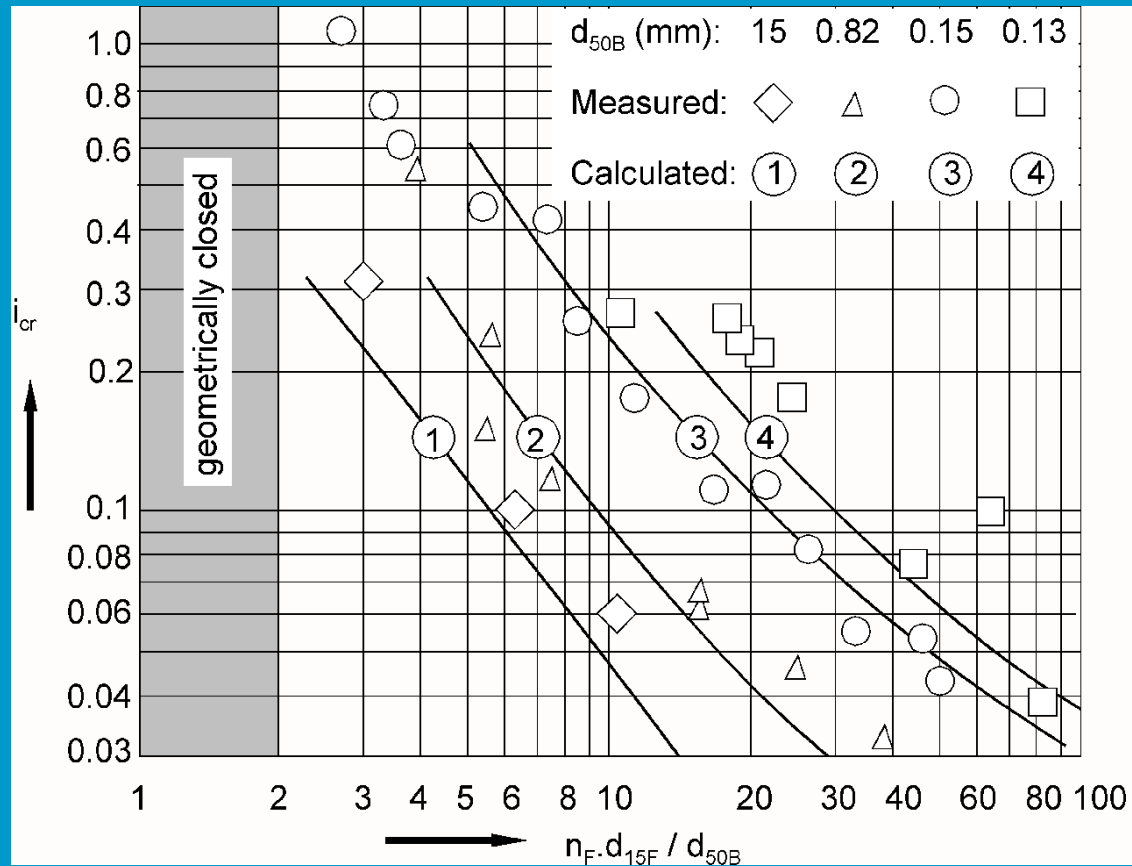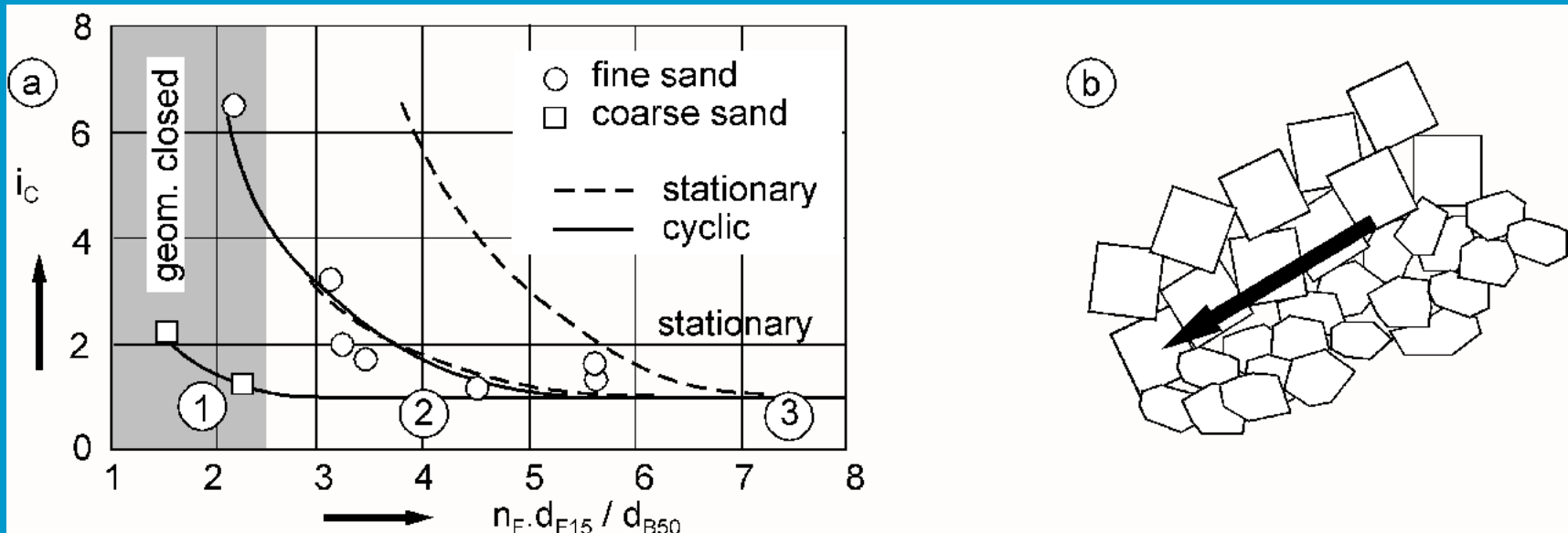
Wenka & Köhler
BAW 2007

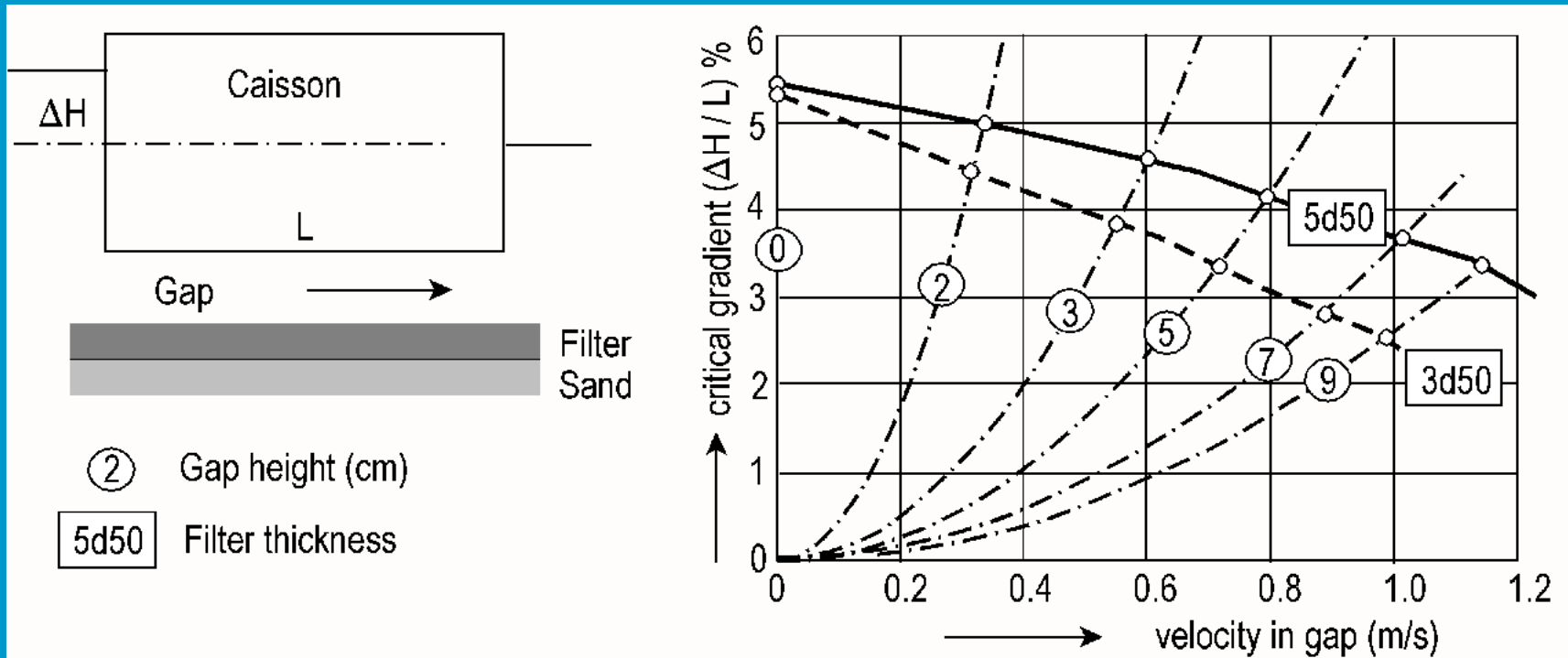# perpendicular flow through geometrically open filter

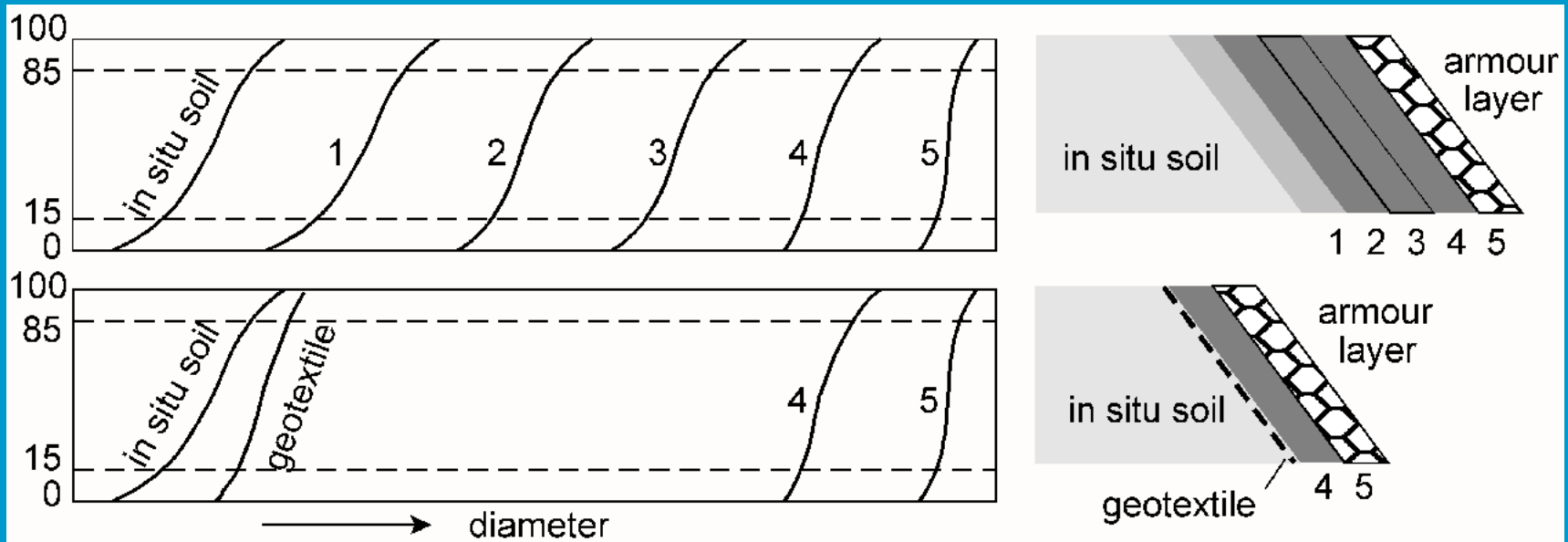# critical parallel gradient for geometrically open filters
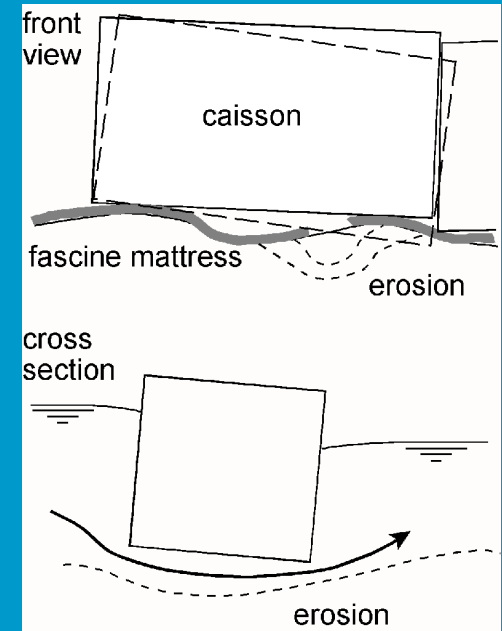
filters in unstationary flow

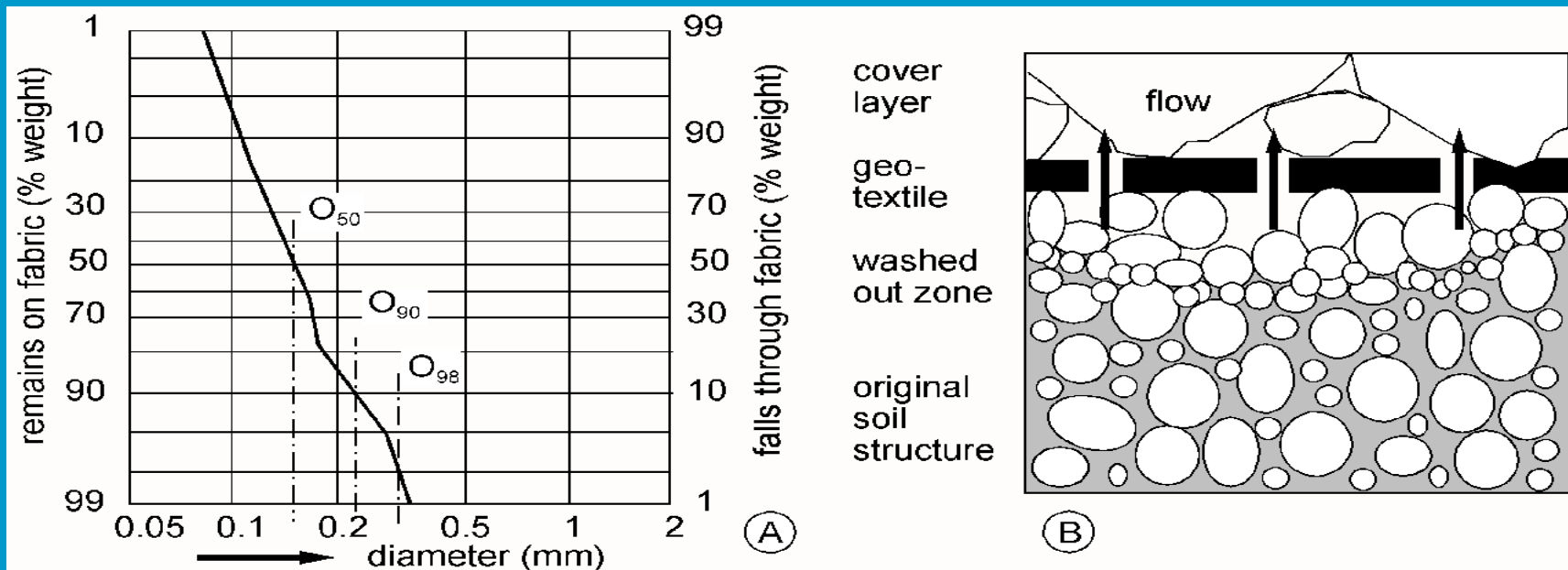# tests with flow over bed protection with filter

granular filters or geotextile

improvisation

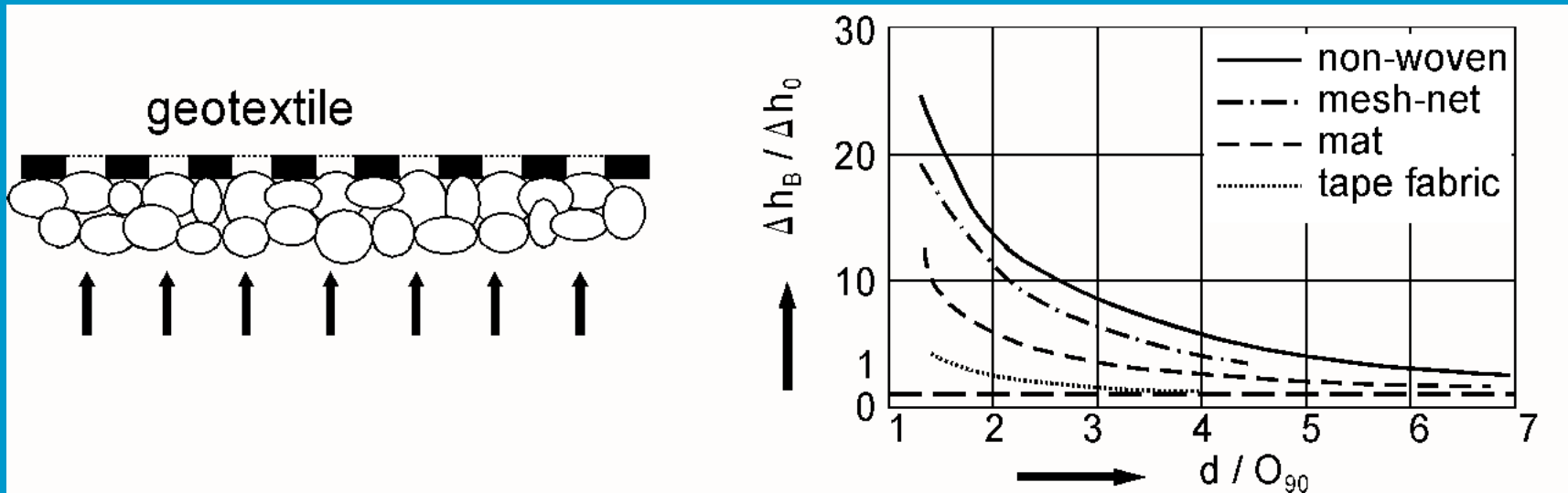# definitions apertures geotextile and migration of fine particles

permeability

$$P = \frac{u_f}{\Delta h} = \frac{k}{e}$$

Δh head difference
e   thickness geotextile
k   'normal' permeability coefficient

Type	O_{90} (mm)	P (1/s)
Mesh net	0.1 - 1	1 - 5
Tape fabric	0.05 - 0.6	0.1 - 1
Mat	0.2 - 1	0.05 – 0.5
Non-woven	0.02 - 0.2	0.01 – 2

blocking of geotextile

overall stability of filter with geotextile