Irrigation and Drainage Engineering

(Soil Water Regime Management)

(ENV-549, A.Y. 2024/25)

4ETCS, Master option

Wrap-up and Exam Questions

Prof. Paolo Perona
Platform of Hydraulic Constructions

Oral Exam IDE 2024-2025

List of Exemplary questions

Lecture 1.1

- Worldwide water use and percentages
- Irrigation techniques and types (fundamental vs complement)
- Irrigation techniques and relative use

Lecture 1.2

- Explain the major forms of root tropism and their causes
- Explain different plant species (Xerophytes, Mesophytes, etc.)

Lecture 1.3

- Soil characteristics and moisture levels
- Water quality issues. Explain salinity and alkalinity and related indexes, classification diagram

Lecture 2.1

- Constitutive vs transpired water
- Water balance for irrigation needs (Crop water need) and computation of related terms
- Reference vs maximal evapotranspiration, link between ET0 and ETM (FAO method)?
- Crop factor, what is it and how to use it (sketch and explain)?
- Effective water needs for irrigation and related efficiency. Forecasting water need and return period

Lecture 2.2

- Effective water needs an irrigqtion efficiency
- Sketch a typical setup of gravity irrigation network (linear and punctual structures)
- Characteristic flow, handling flow, dose, frequency and duration
- Differences between distribution by rotation and on demand. Explain Clement's formula (not remember by heart)
- Energy lines for inversed siphons

Lecture 3.1

- Weirs and diverter. Explain
- Longitudinal profile design: velocity best practice criteria
- Infrastructures for water regulation: types and usage
- Upstream regulation (sketch types and explain adv vs dis)
- Downstream regulation (sketch types and explain adv vs dis)

Lecture 3.2

- Water regulation and partitioning structures: types and uses
- Rating curve of the mask module (single and multiple)
- Distribution chambers, proportional distribution

- Safety Infrastructure: concept and use. Explain
- Syphon: hydraulic functioning and grade lines

Lecture 4.1

- Practical realisations of canals
- Embankment technique for trapeizoidal canals
- Earthen made canals
- Advantages and disadvantages of different types of canal lining and drainage. Describe

Lecture 4.2

- Design of water canals. Main concepts, Manning-Strickler formula
- Longitudinal vs cross section profile design

Lecture 5.1

- Crossing infrastructures
- Water application methods and distribution
- Gutter, boards, basin irrigations
- Furrow irrigation
- Irrigation by submersion (and prolonged submersion)

Lecture 5.2

Irrigation model – NO QUESTIONS

Lecture 6.1*

- Pressurized irrigation: components and objectives
- List and sketch the components of a pressurized irrigation setup
- Water sprinklers. Types, selection, and displacement
- Practical calculation of friction losses in ramps

*Pipe hydraulics is considered to be known (e.g. Moody diagram)

Lecture 6.2

- Pumped systems: Hydraulic head schemes and functioning points
- Pumped systems: economic design of pumped pipeline
- Forces on anchoring systems. Explain
- Max overhead for rapid closures (water hammer)

Lecture 7.1

- Sprinkler systems and uniformity coefficient. Explain
- Practical organization of sprinkler systems
- Frost danger and related avoidance methods
- Criteria for frost fighting

Lecture 7.2

- Microirrigation. Explain concepts, adv vs disadvantages
- Dripping system classification, list and explain

- Sketch a typical microirrigation setup: components and related displacement
- Hydraulic design of drippers and desired characteristics

Lecture 8.1

- Pressure compensated drippers
- Mounting the drippers and moisture bulb
- Ramp Design, Darcy vs Hazen-Williams formulas

Lectures 8.2 and 9.1

- Irrigation impacts. List and describe possible negative impacts
- Salt water intrusion, derivation of the equilibrium condition (Ghiben-Herzberg model)
- Sanitary impacts: describe the main waterborne diseases, causes, effects on men and remedies (choose one and describe)

Lecture 9.2

- Water pound formation: causes and remedies through drainage
- List and explain the main drainage techniques methods (choose one to explain in detail)

Lecture 10.1

- Main hypotheses for the hydraulic draining space design
- Permissible submersion and characteristic draining rate: explain
- Explain the permanent vs the transitory regimes and the main working hypotheses

Lecture 10.2

- Calculation of drainage space gap in permanent regime and for pipes on an impermeable bed
- Calculation of drainage space gap in permanent regime and for channels on an impermeable bed
- Drains and pipes not lying on an impermeable layer. Houghoudt analogy method: explain

Lecture 11.1

- Draining trenches. Derivation of the flow equation
- Variable regime: derivation of the space gap for drains located on an impermeable bed.
- Drainage by wells: derivation of the pumping rate and superposition principle
- Types of draining networks

Lecture 11.2

- Guest lecture (not to learn)

Lecture 12.1

- Draining pipes: materials and selecting criteria
- Type of clogging: primary vs secondary
- Causes of pipe filling: list and explain
- Filters for risk of filling and calculation (using the tables provided)

Lecture 12.2

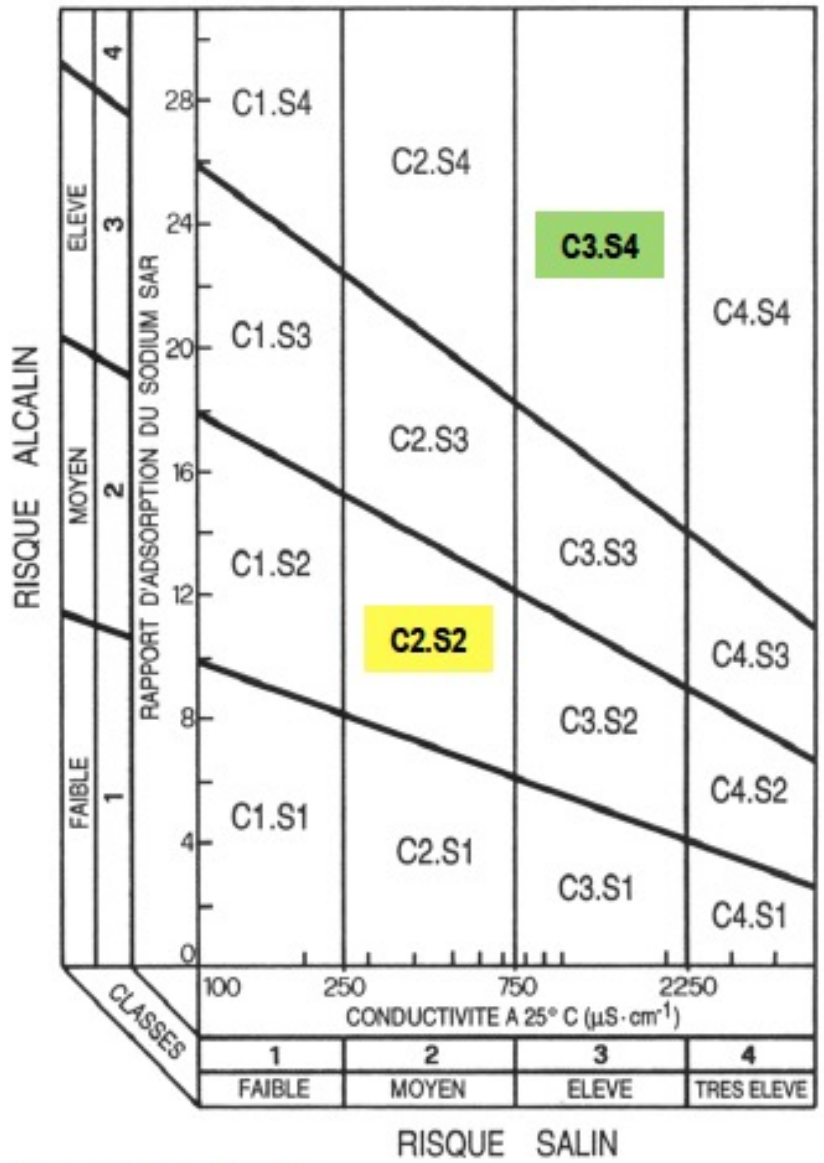
- Materials used for drainage conduits. Why old earthenware pipes are not being used anymore?
- Drain execution techniques: list and explain
- Impact of drainage: advantages and disadvantages

Lecture 13.1

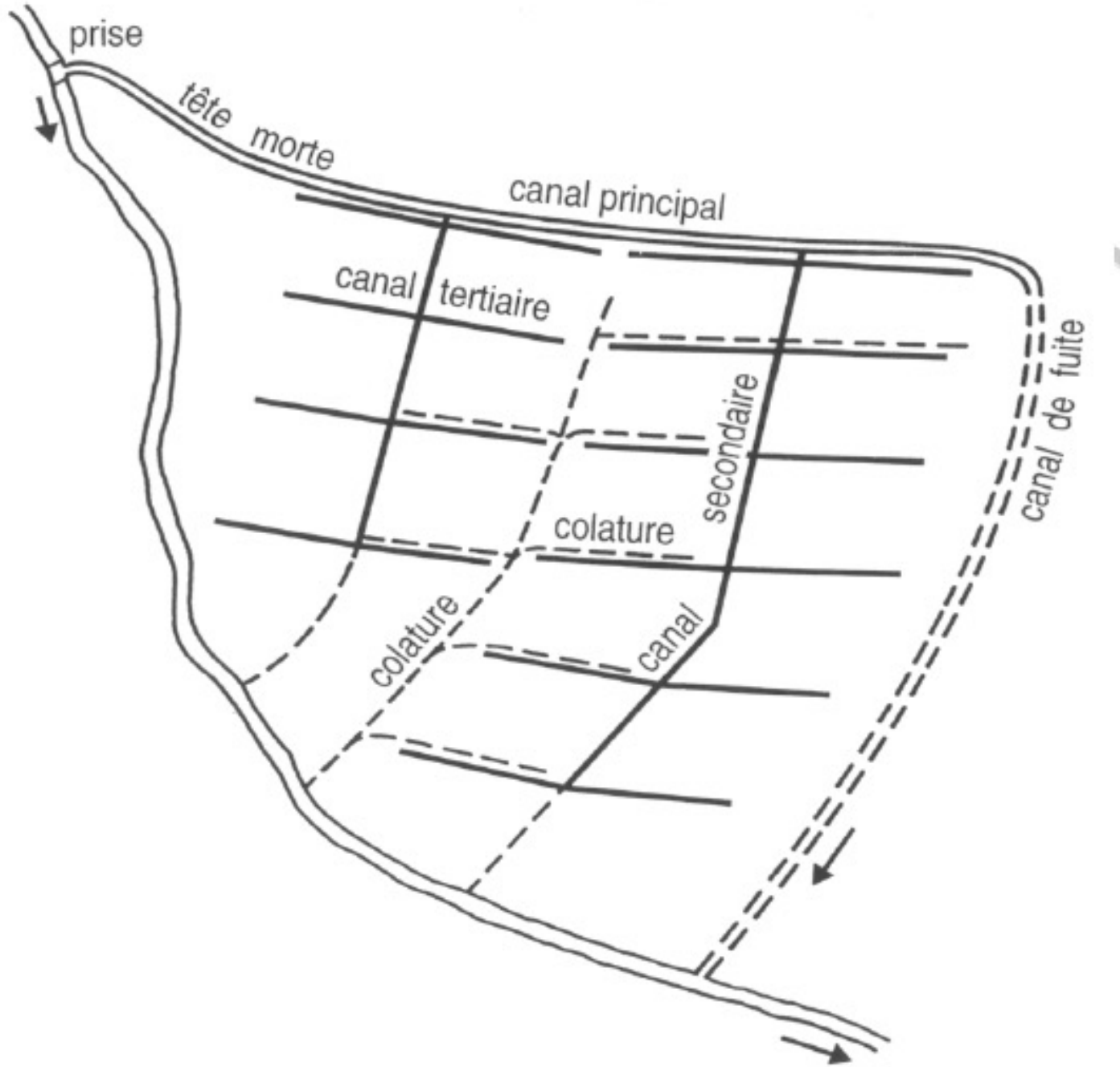
- Impact of drainage: direct vs indirect environmnental impacts
- Subsidence of soil and causes
- Buffer zones design criteria (formula not to remember)

Lecture 13.2 (Guest lecture on regenerative agriculture)

- Regenerative Agriculture (RA): Name three fundamental approaches to water management in RA and explain how they contribute to reducing the net irrigation water need. Where do you recognize the RA strategies “Multi-functionality” and “Functional redundancy”?
- RA: Name and explain three positive effects that agroforestry systems (AFS) have on the hydrologic budget of neighboring crops as well as two further benefits that AFS can provide
- RA: Which two basic principles characterize a Keyline pattern? What are its advantages in terms of water management (at the farmscale) compared to a) Contour farming and b) Conventional linear farming?



Laboratoire de salinité des sols des USA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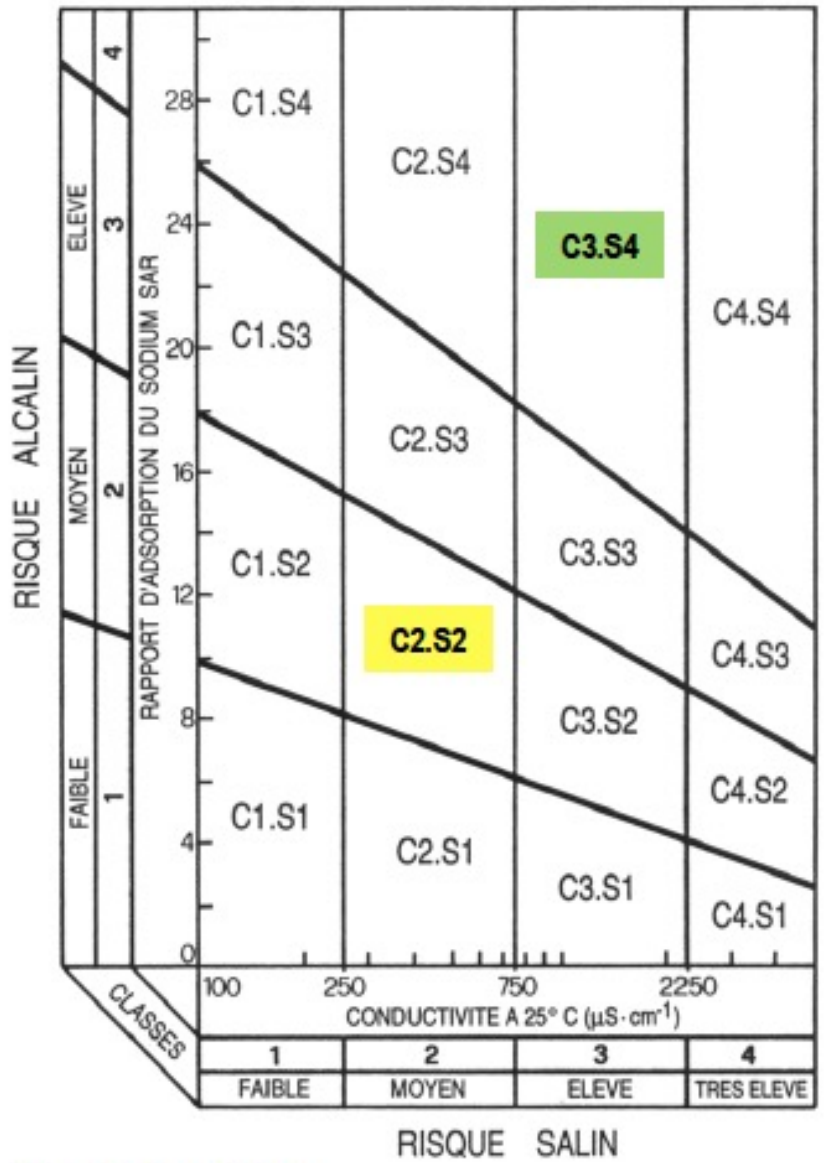

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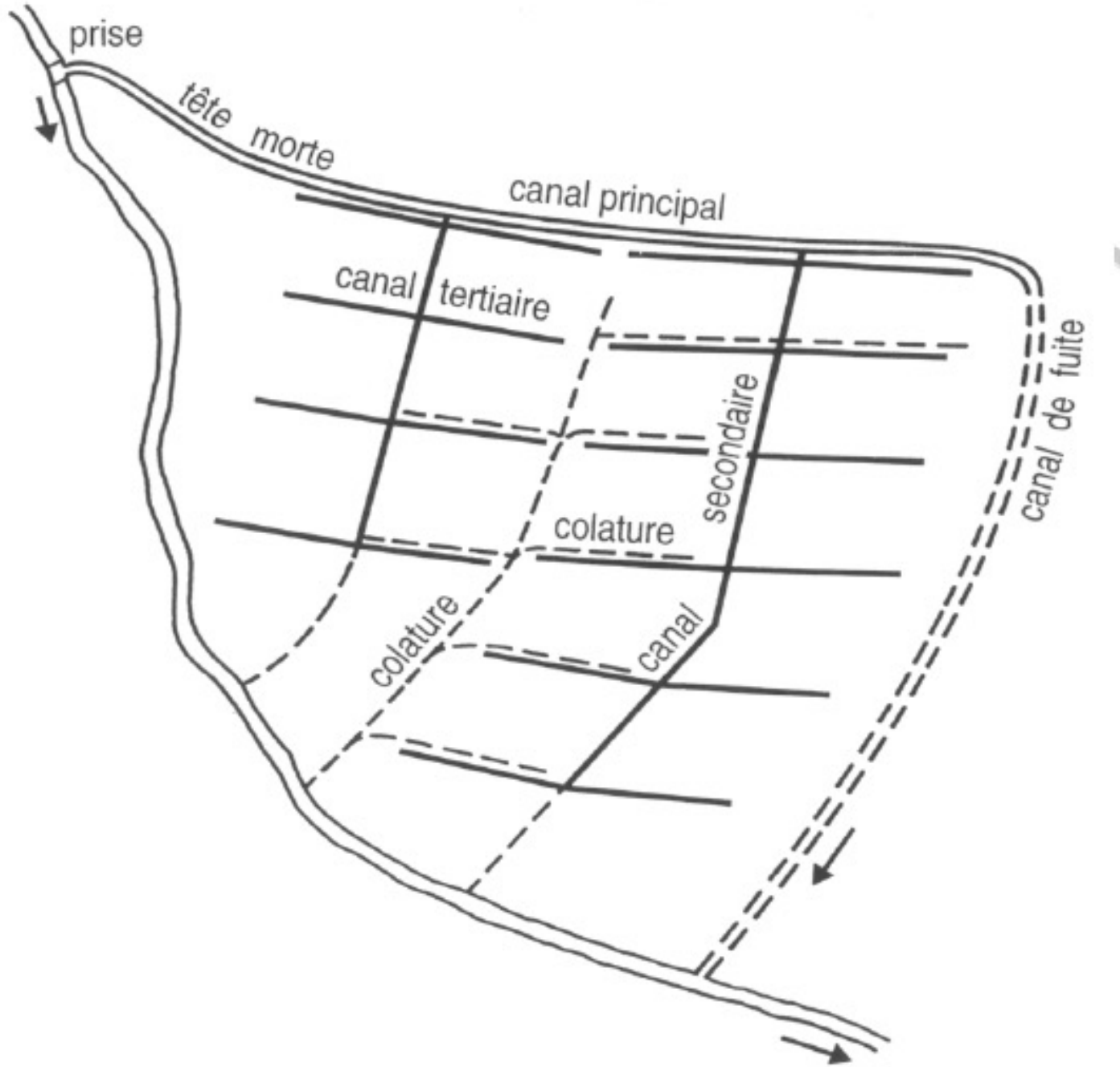
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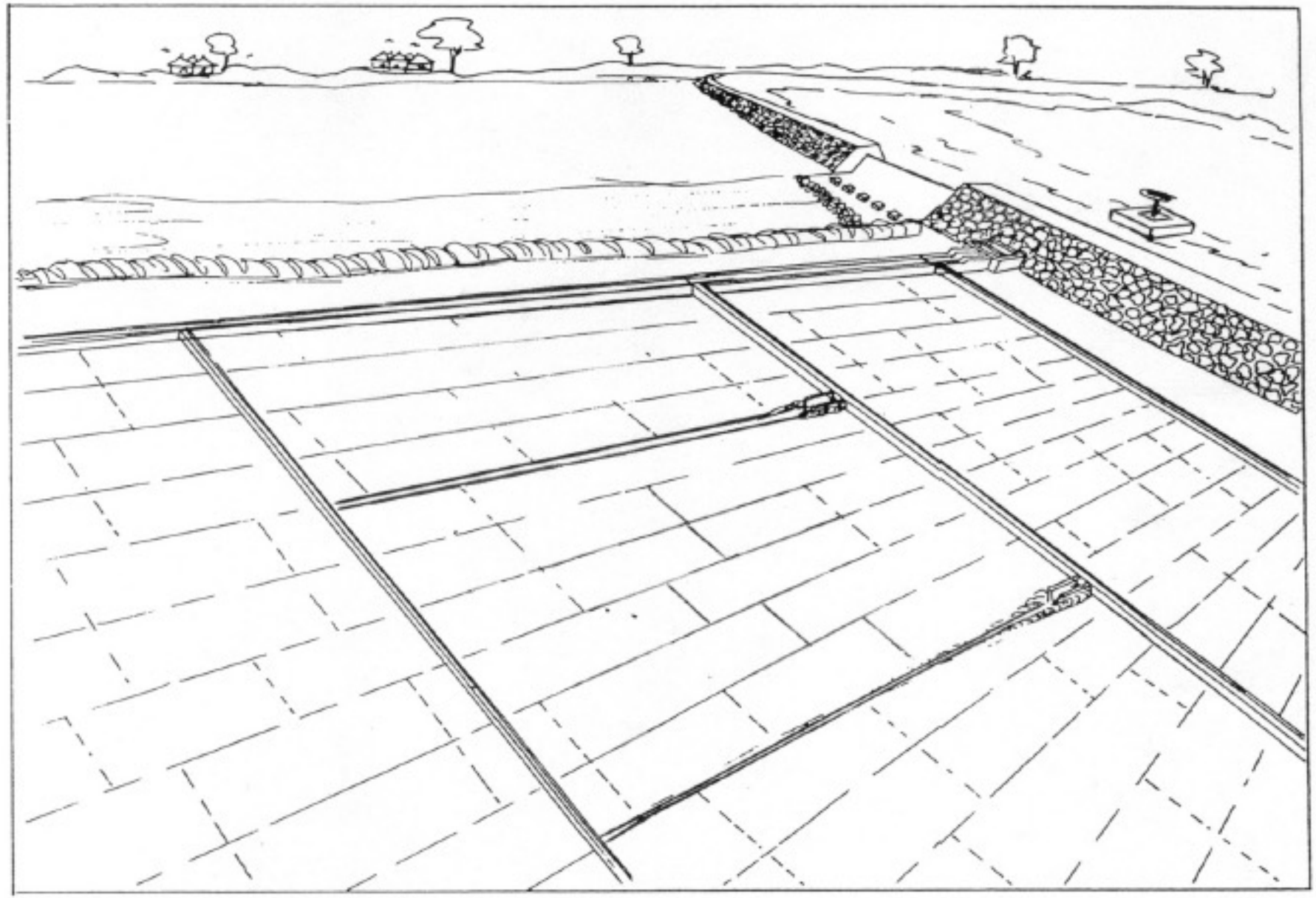

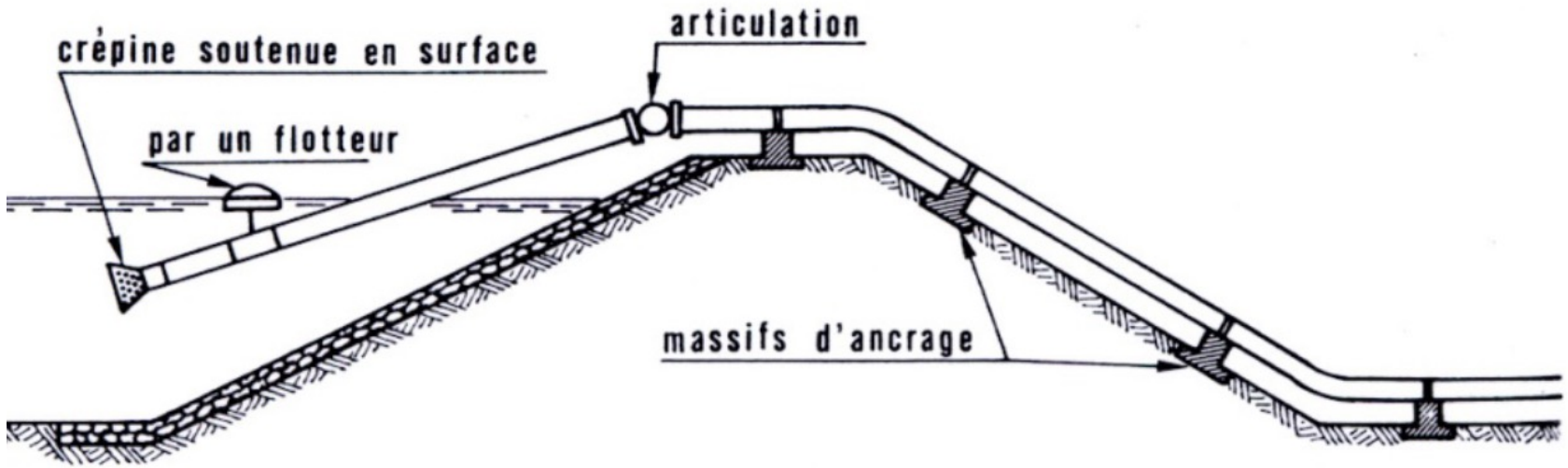
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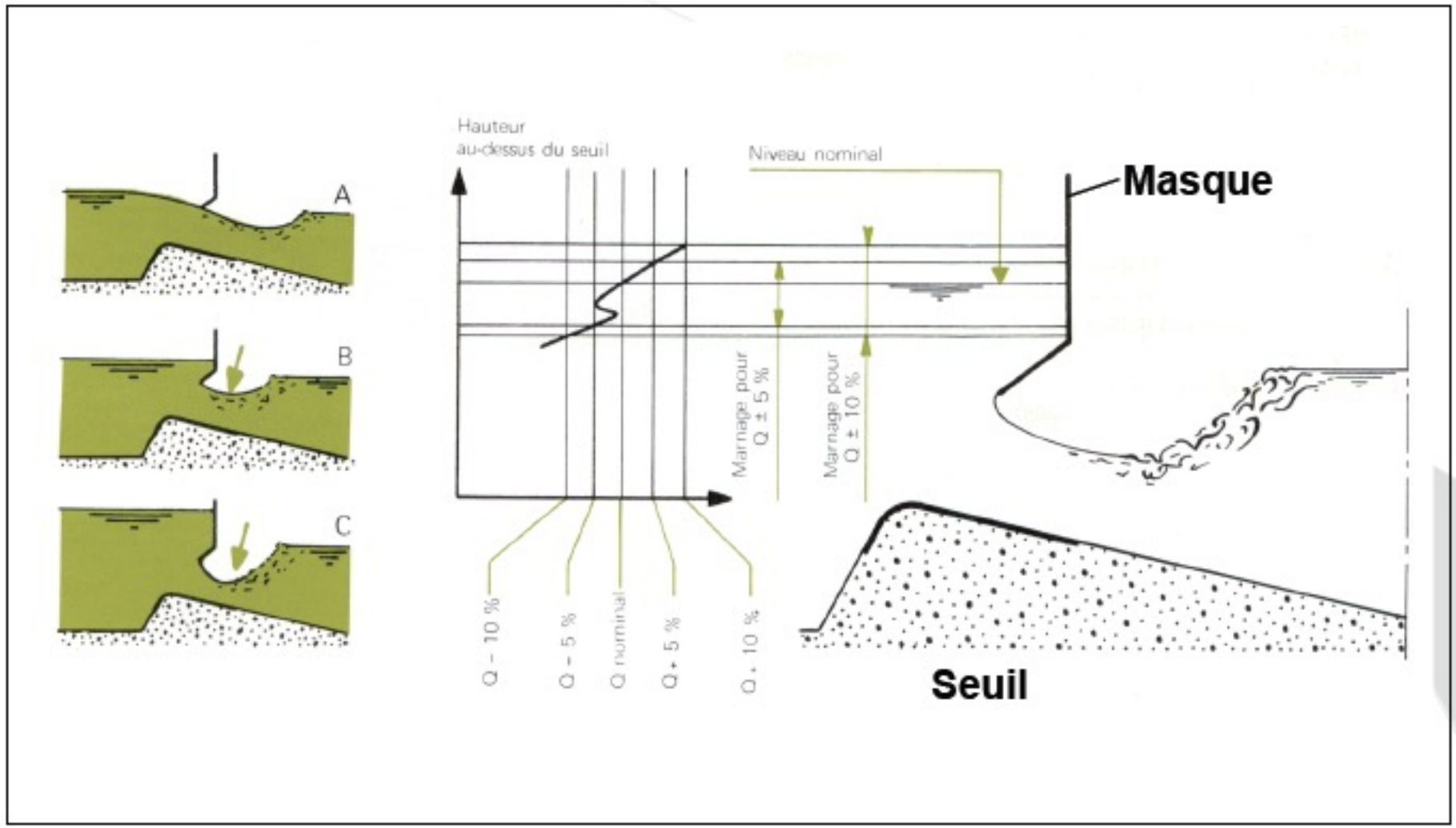
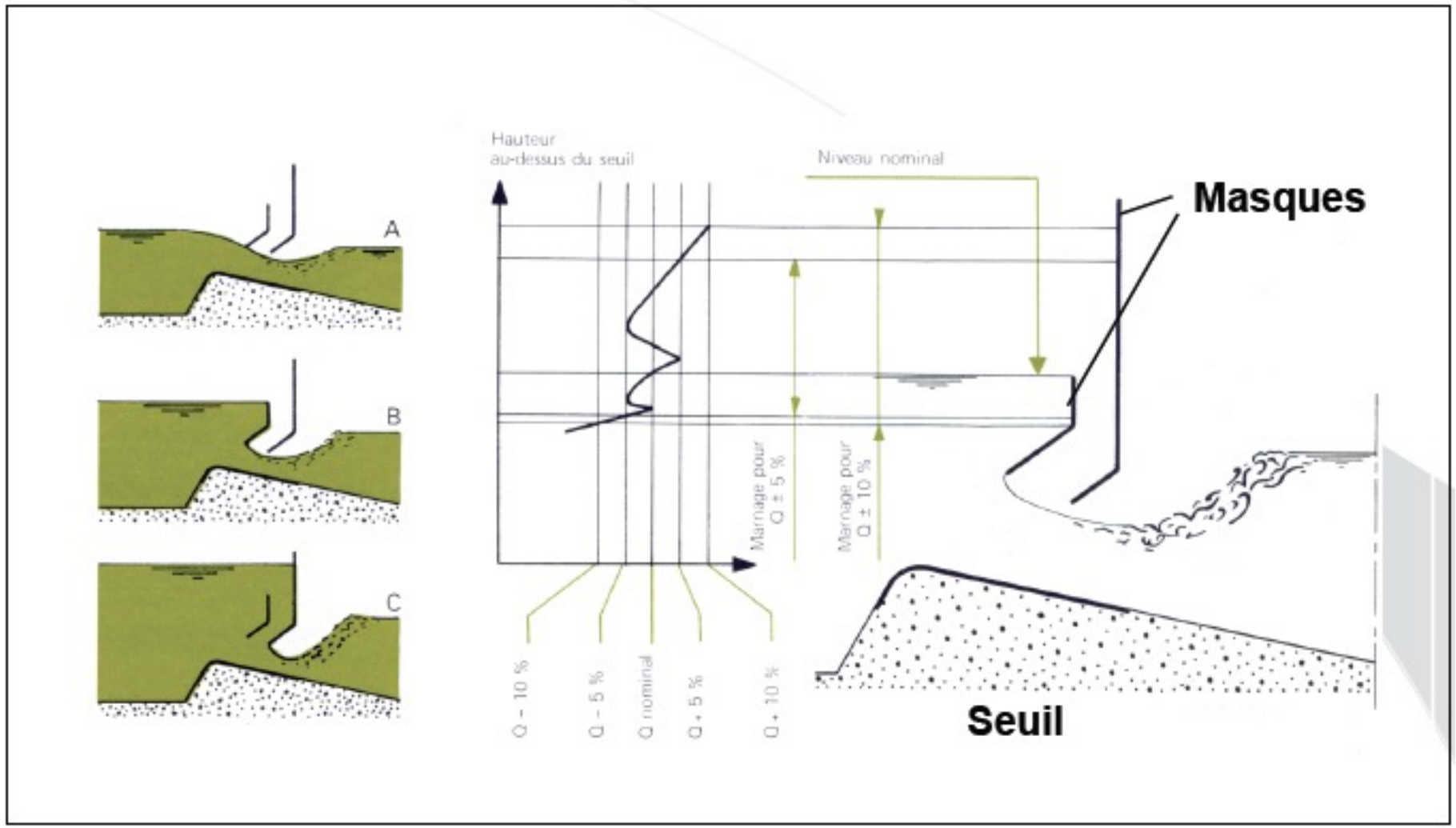
par un flotteur
articulation
massifs d'ancrage


A
B
C
Hauteur
au-dessus du seuil
Niveau nominal
Masque
Marnage pour
Q ± 5 %
Marnage pour
Q ± 10 %
Q - 10 %
Q - 5 %
Q nominal
Q + 5 %
Q + 10 %
Seuil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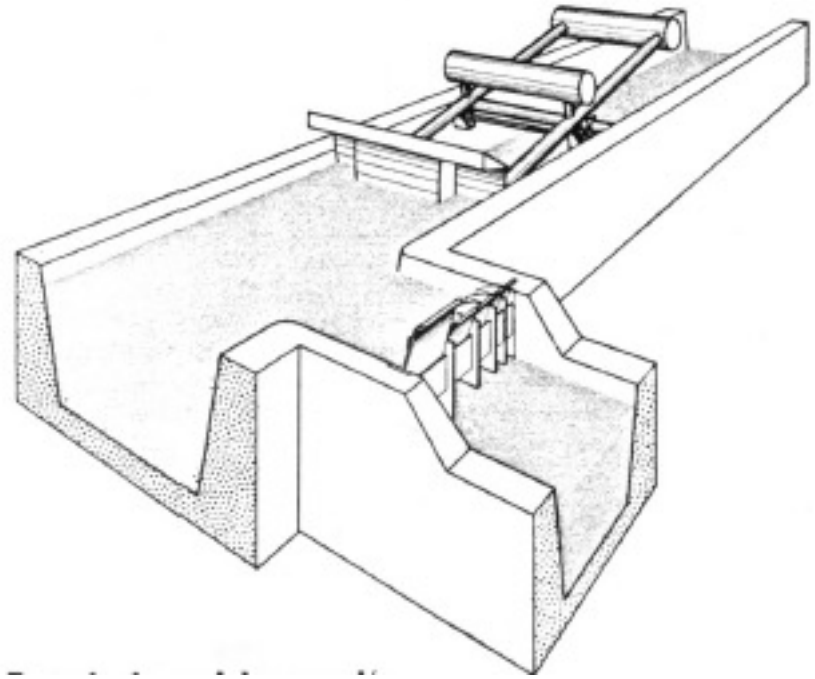
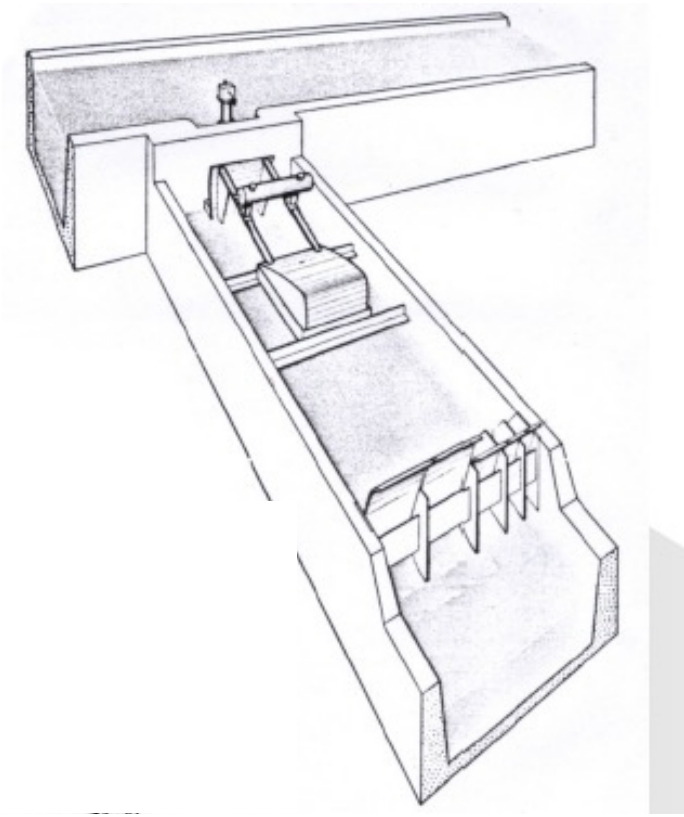
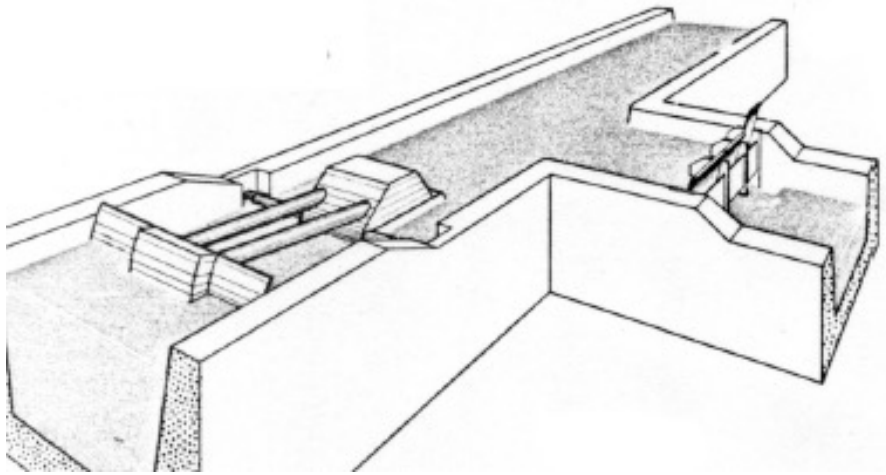
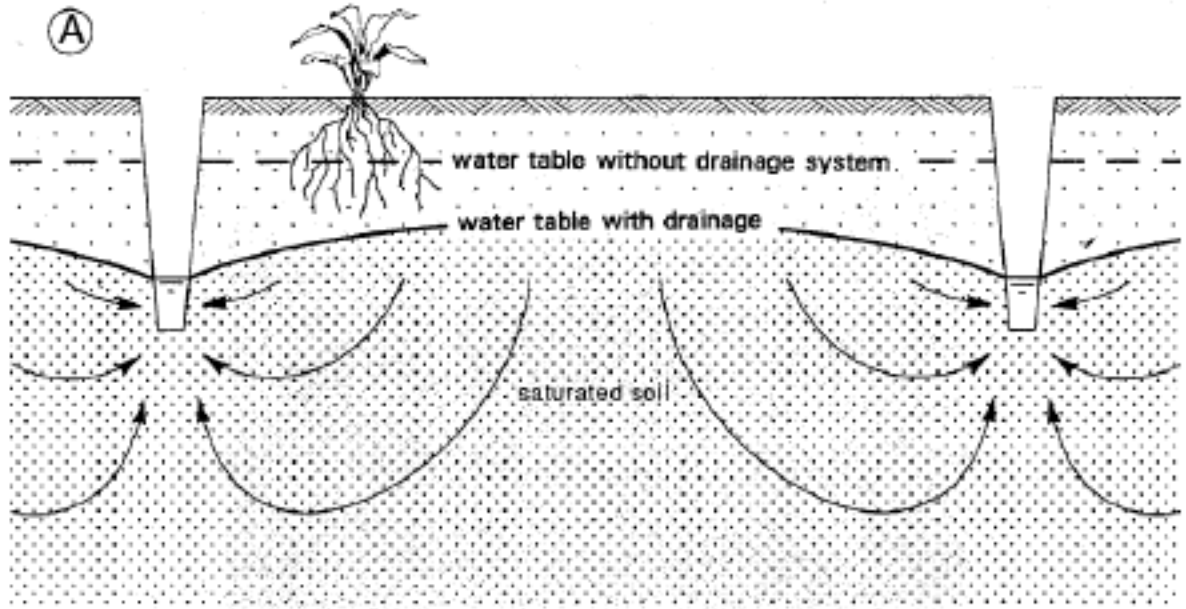
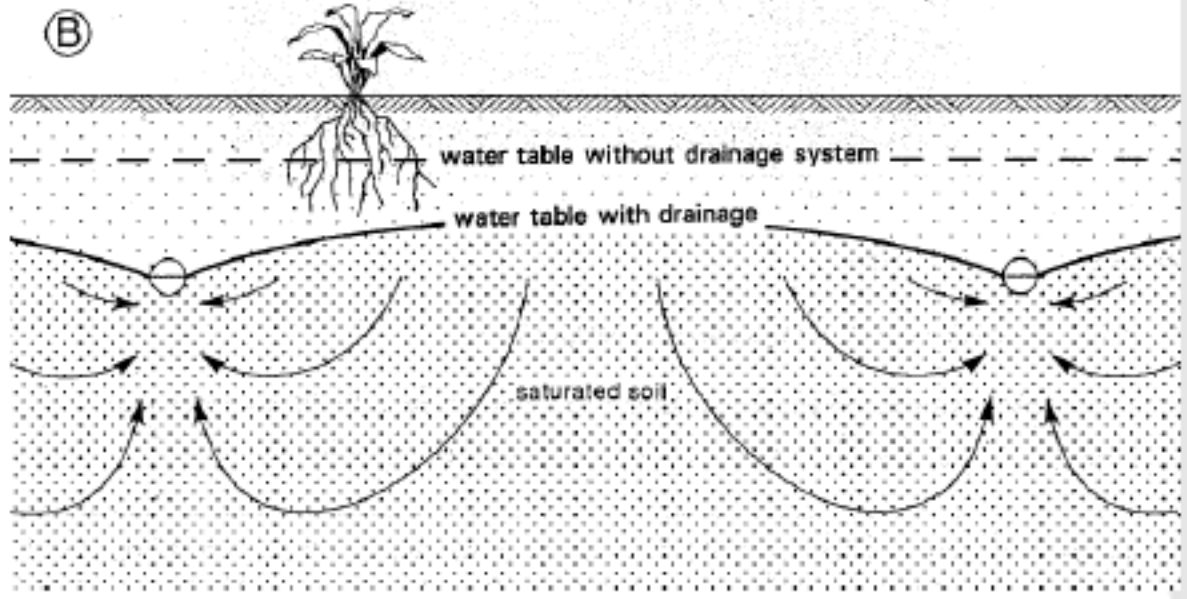
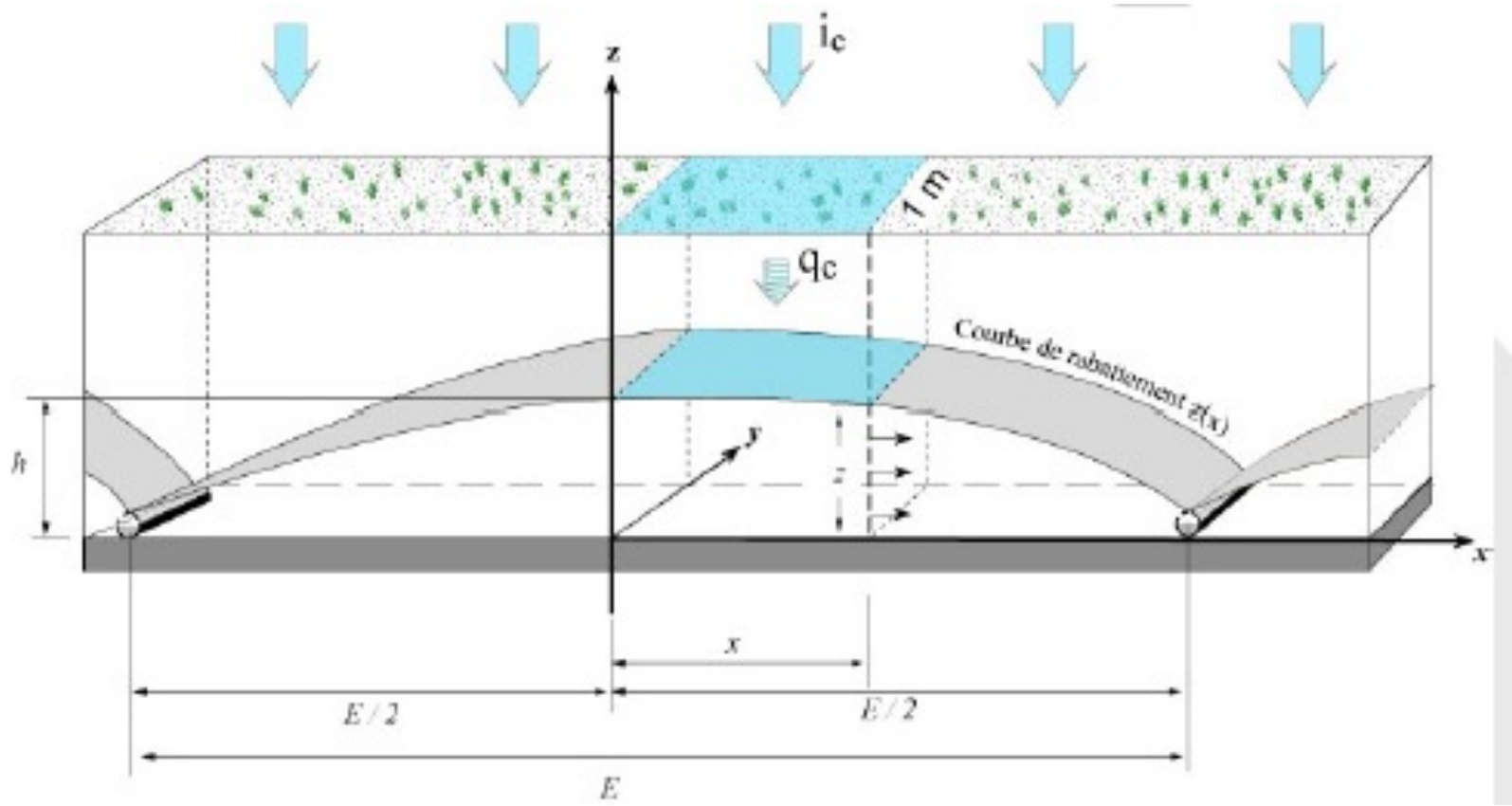







A
water table without drainage system
water table with drainage
saturated soil


B
water table without drainage system
water table with drainage
saturated soil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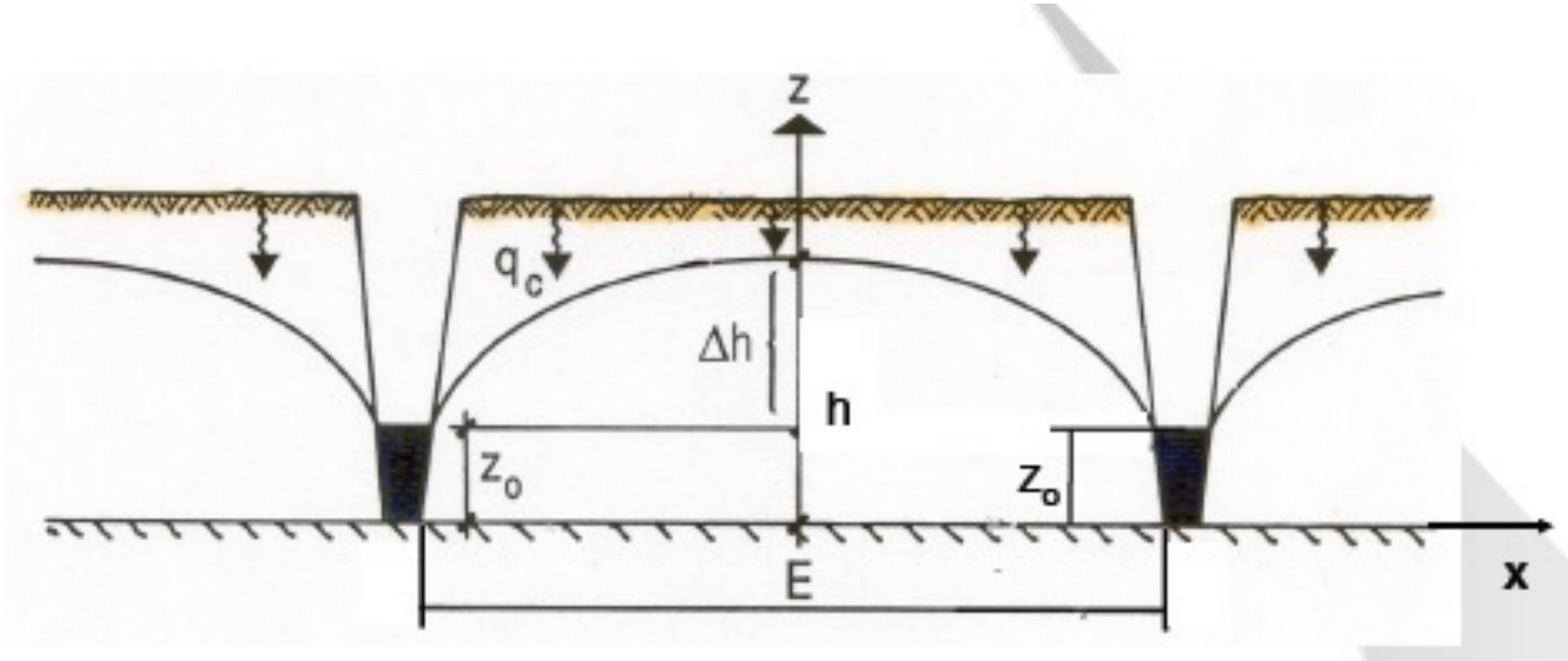
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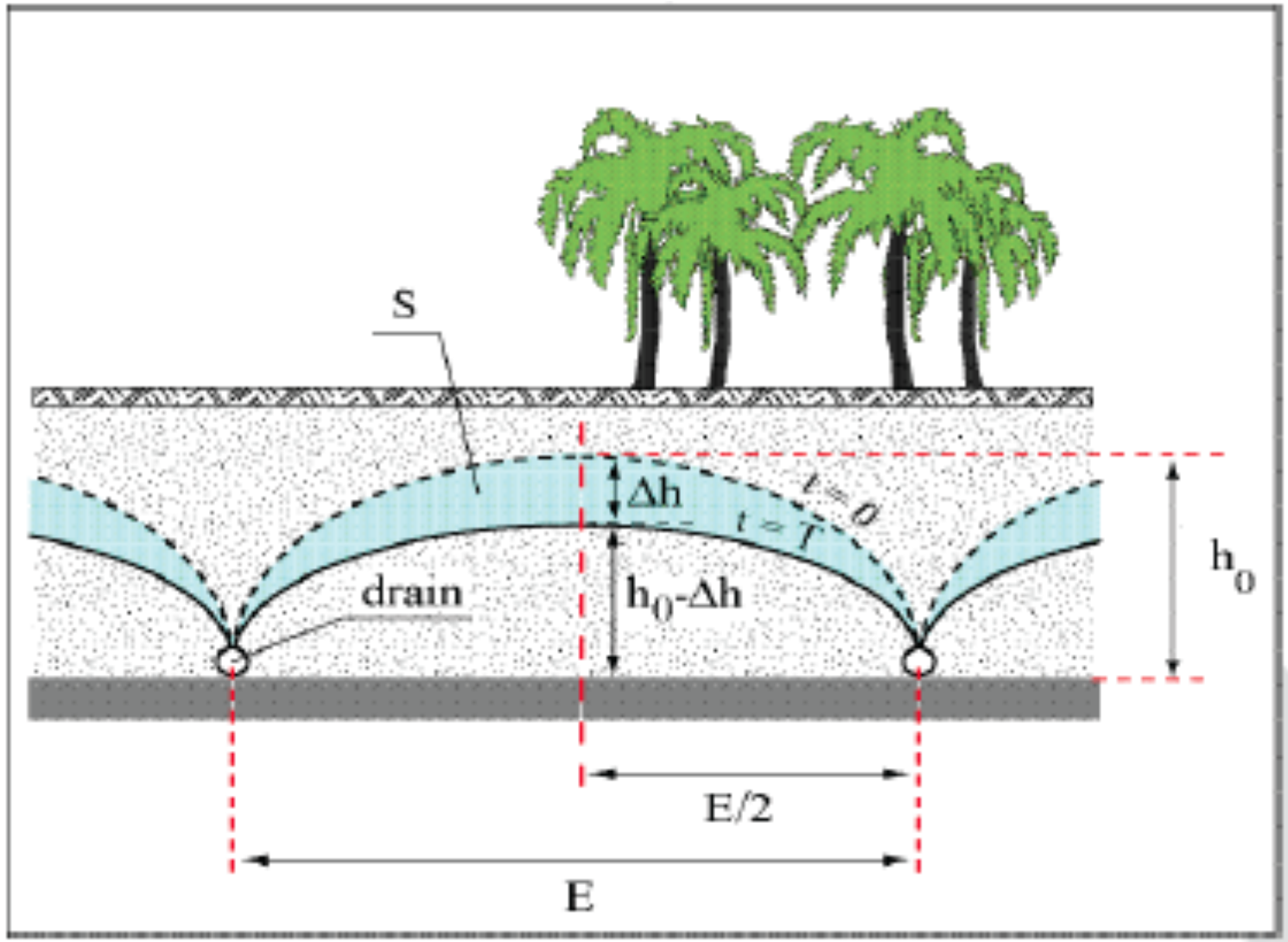
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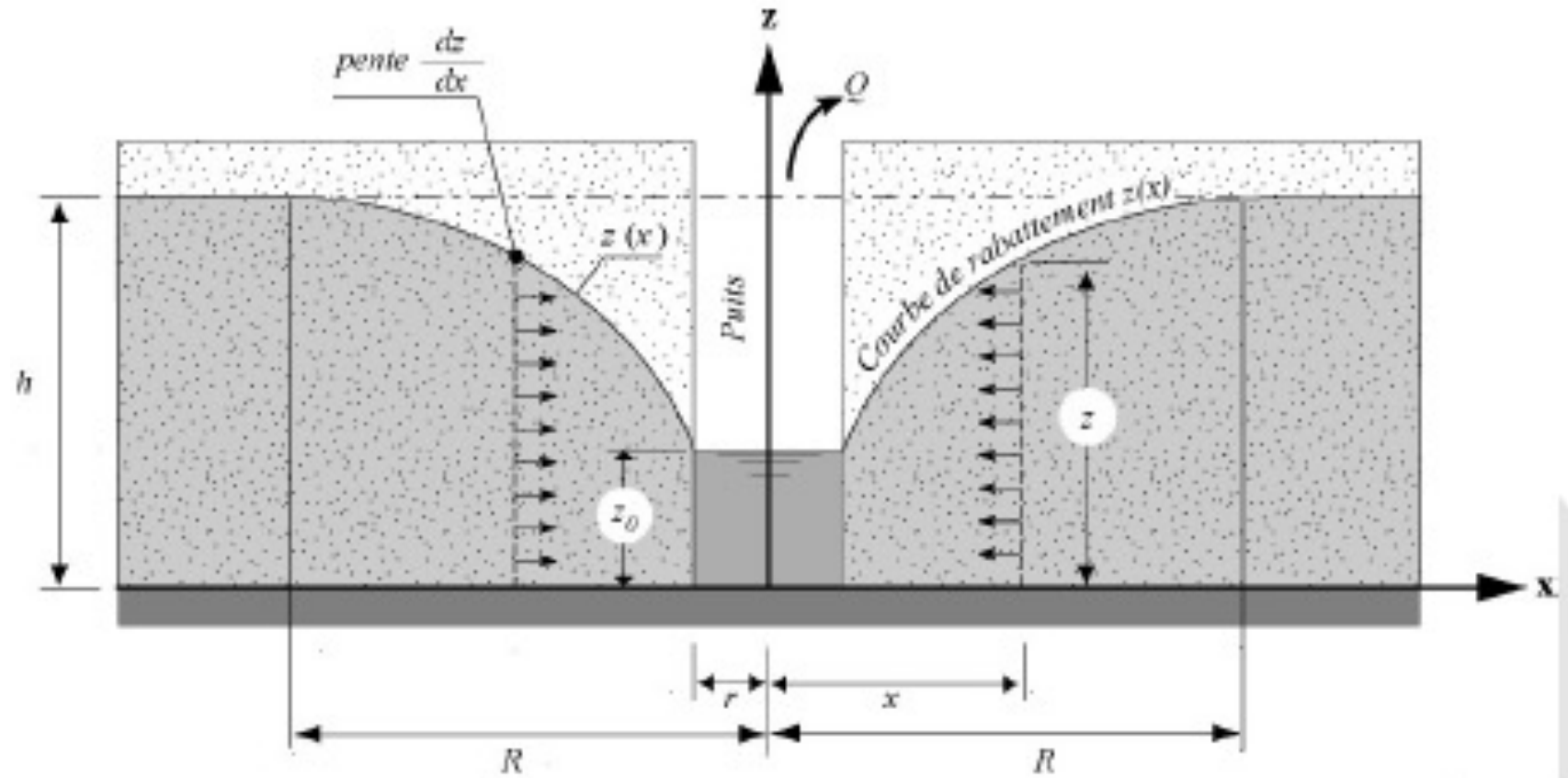
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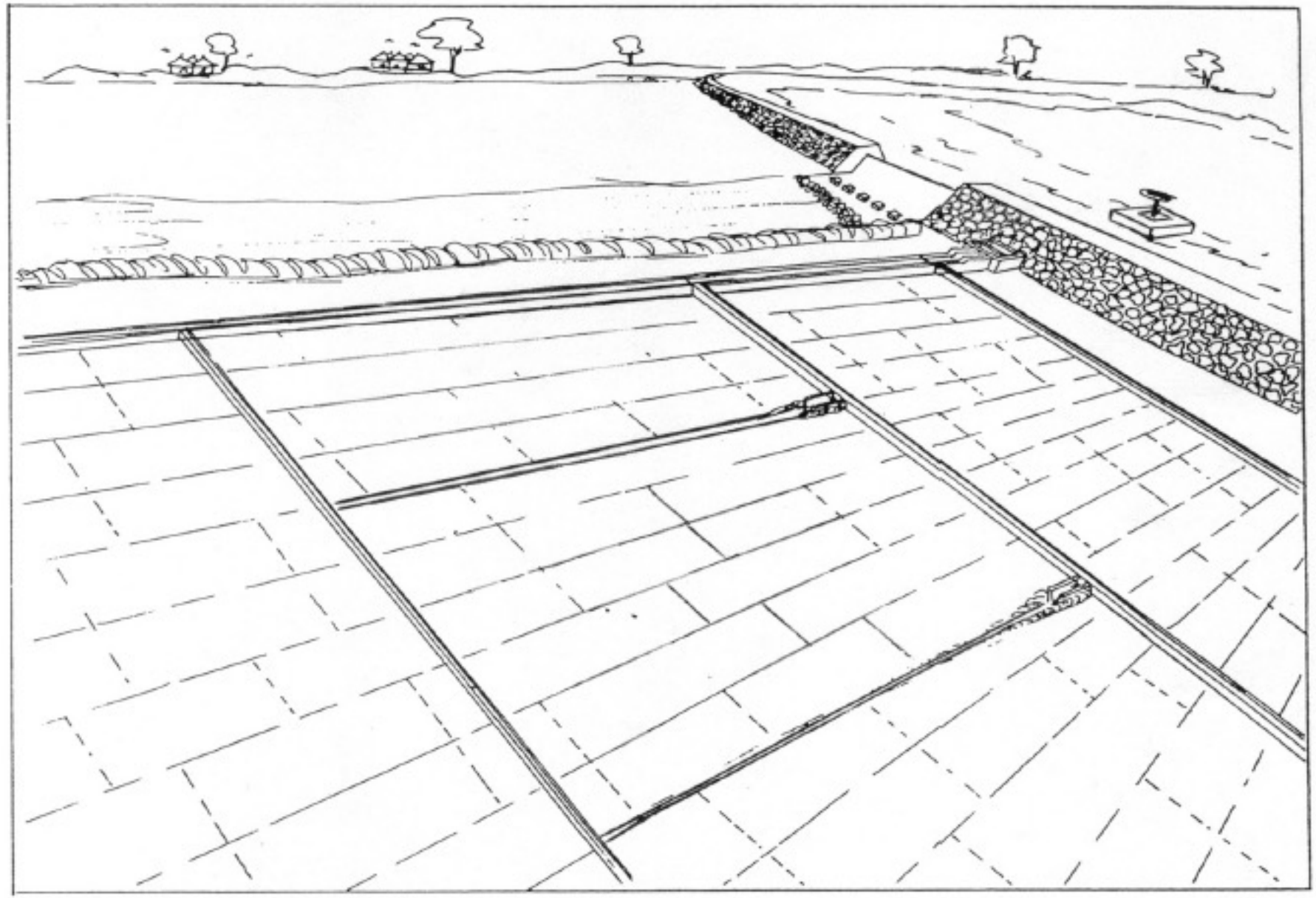

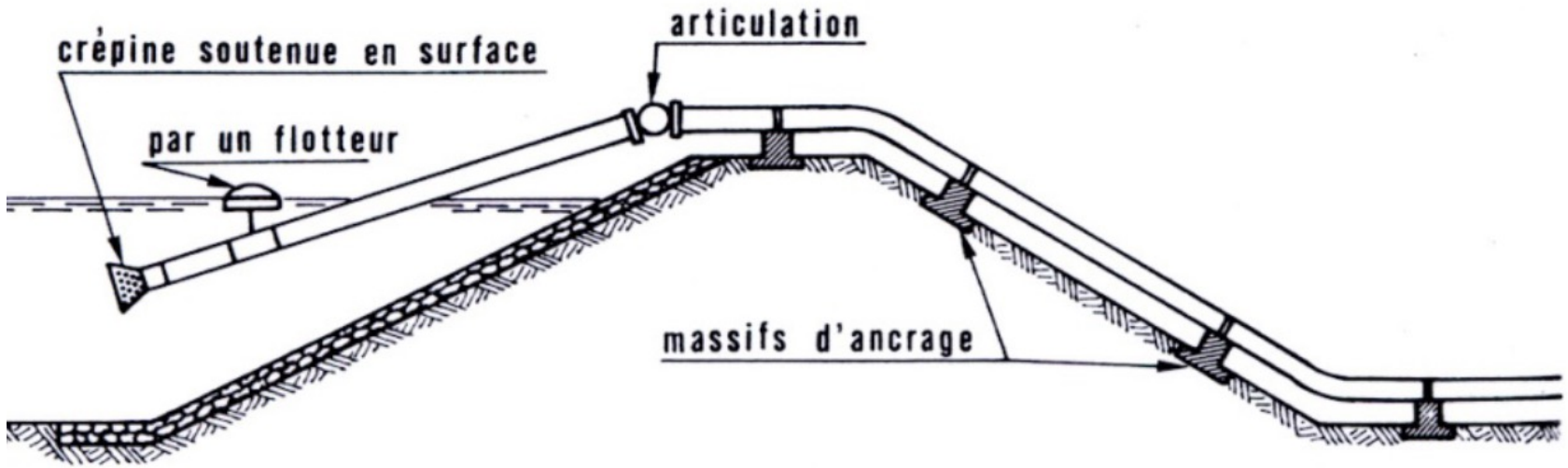
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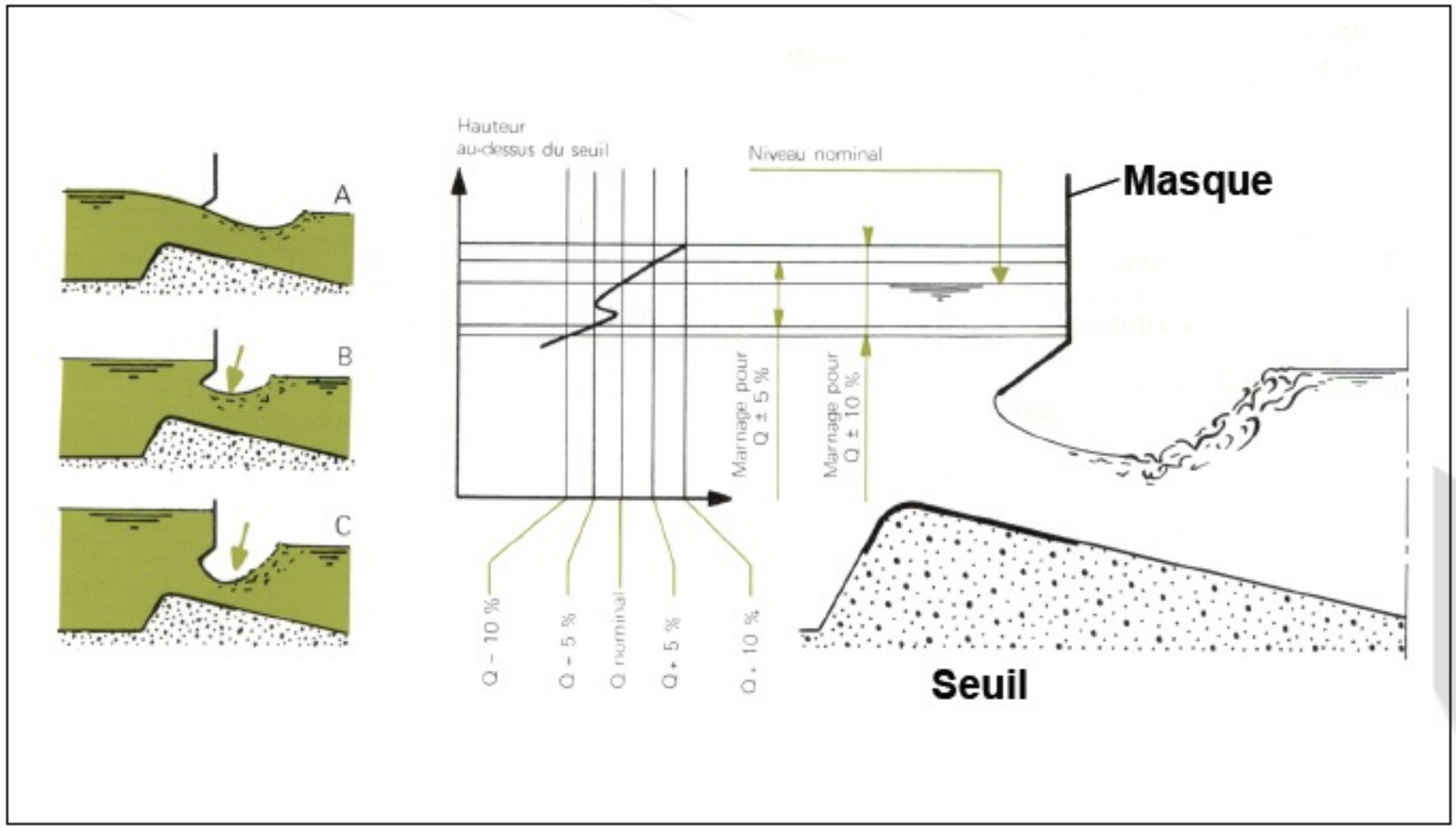
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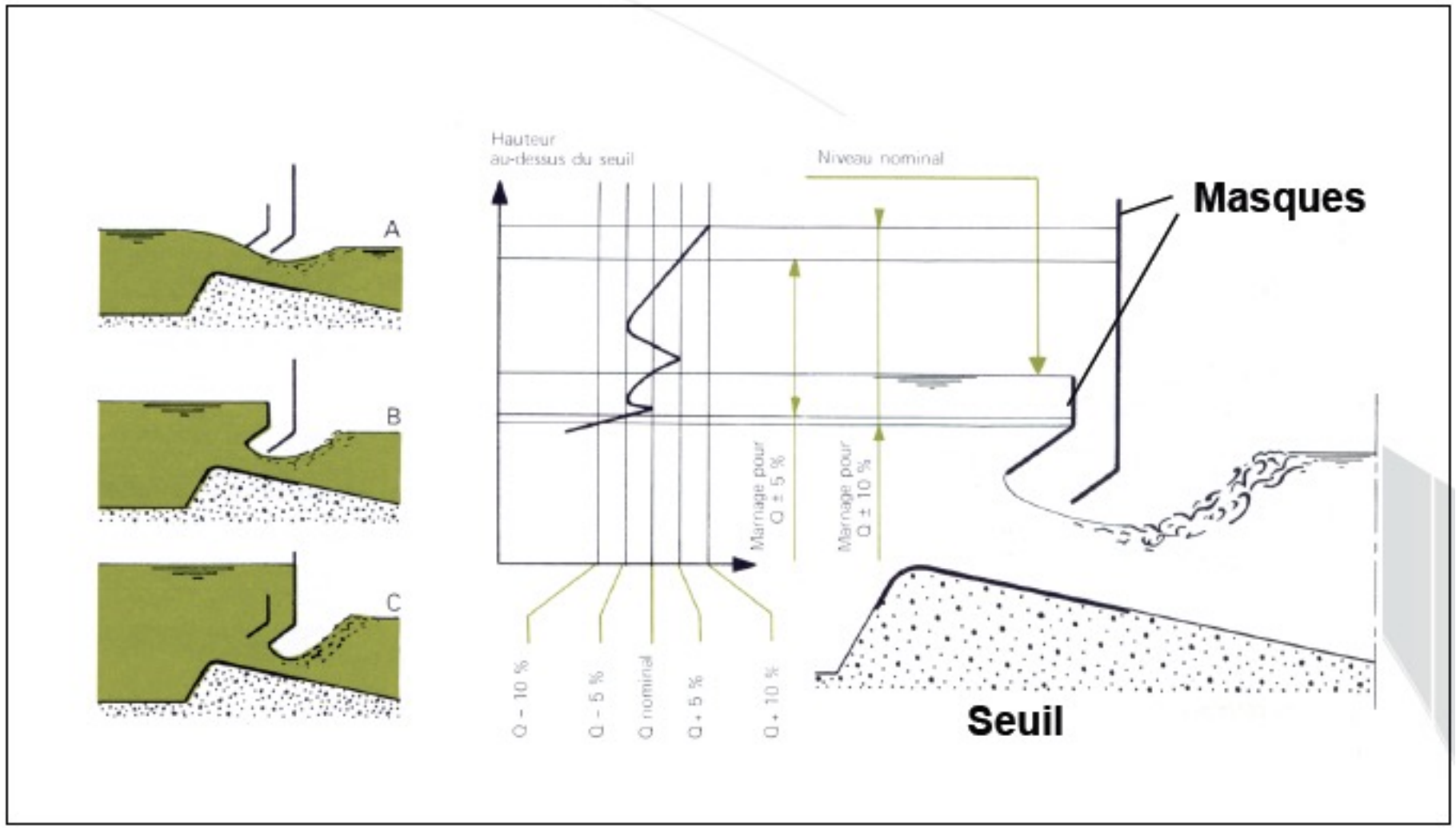
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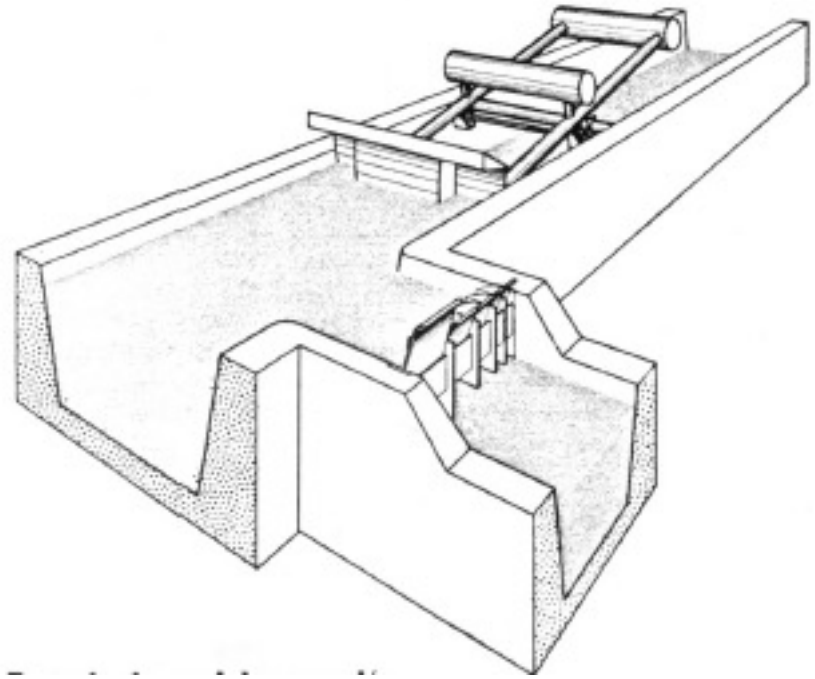
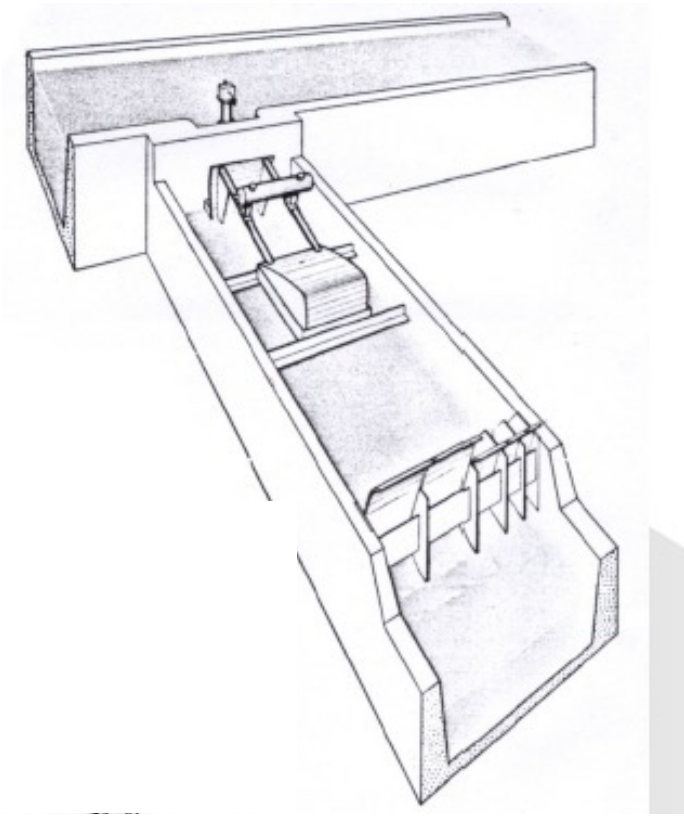
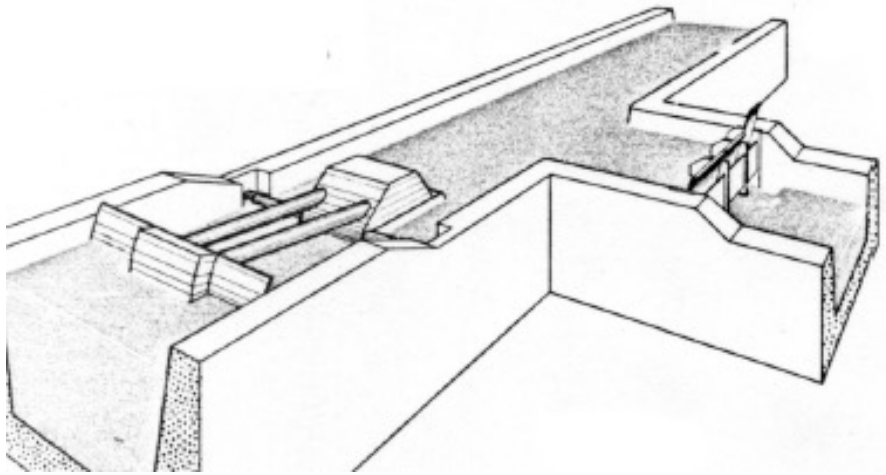
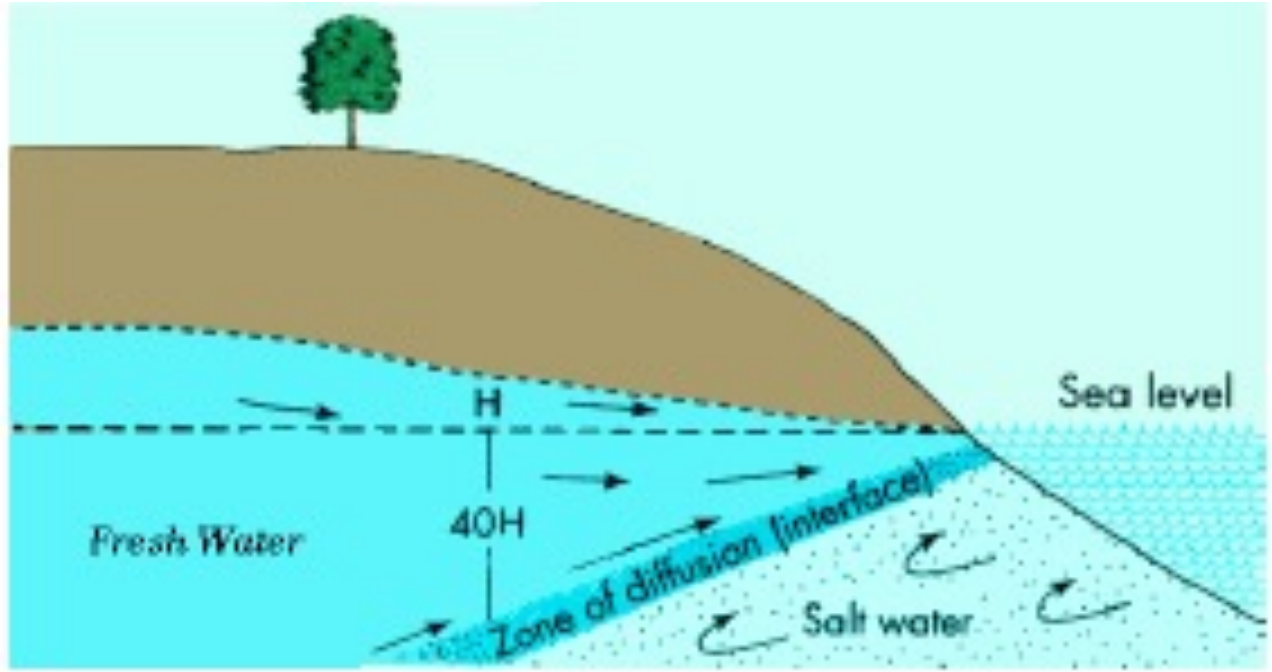
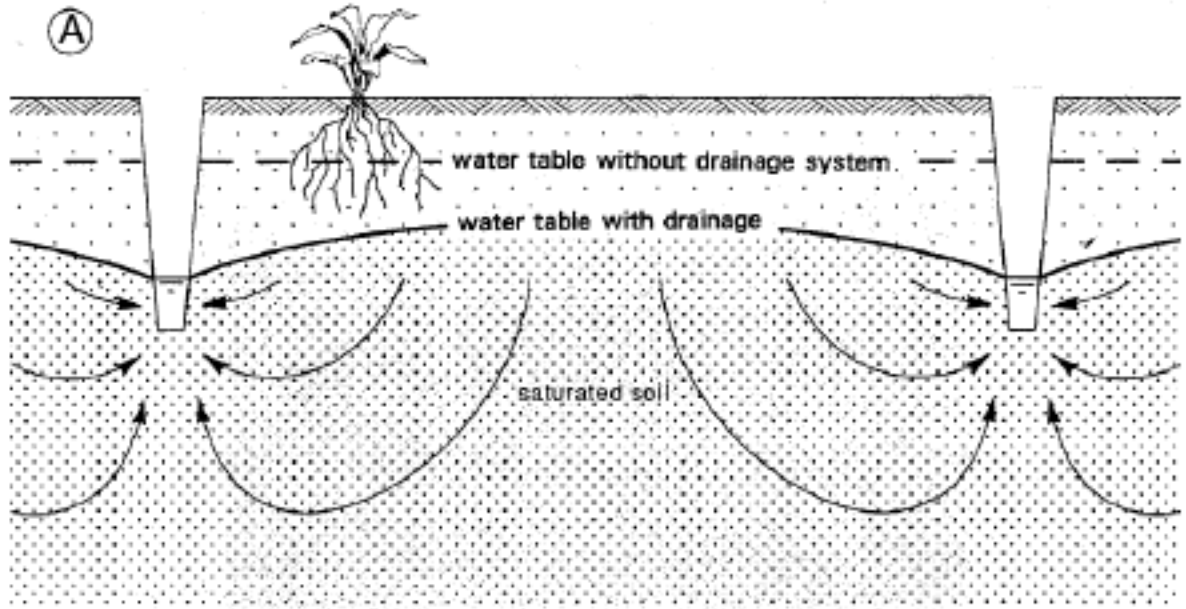







H
Sea level
40H
Fresh Water
Zone of diffusion (interface)
Salt water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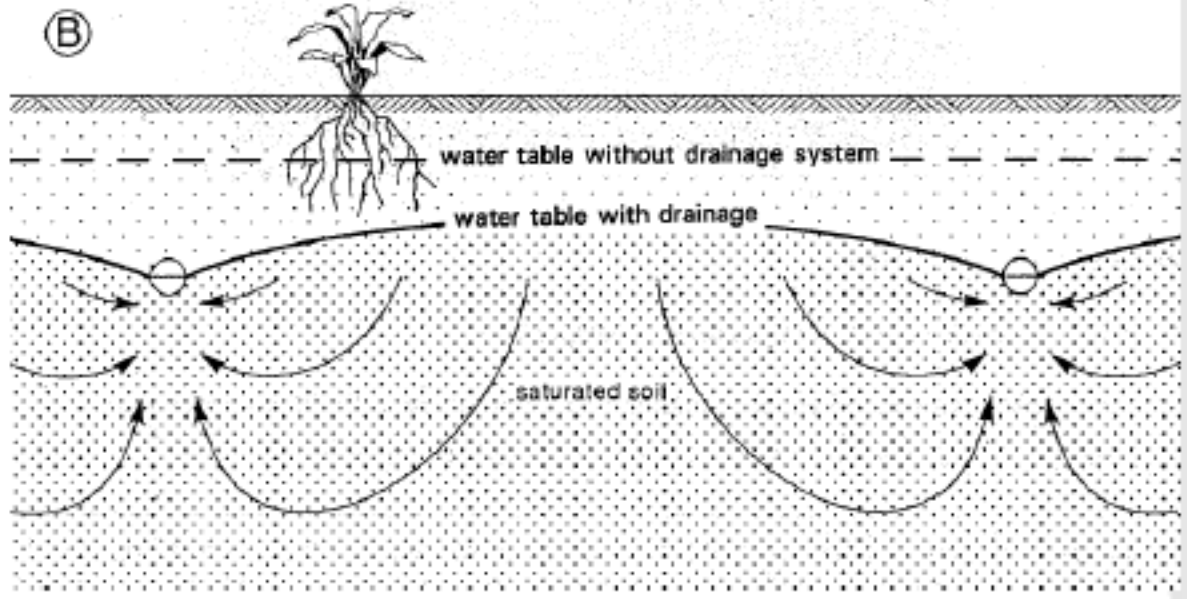
water table without drainage system
water table with drainage
saturated soil


B
water table without drainage system
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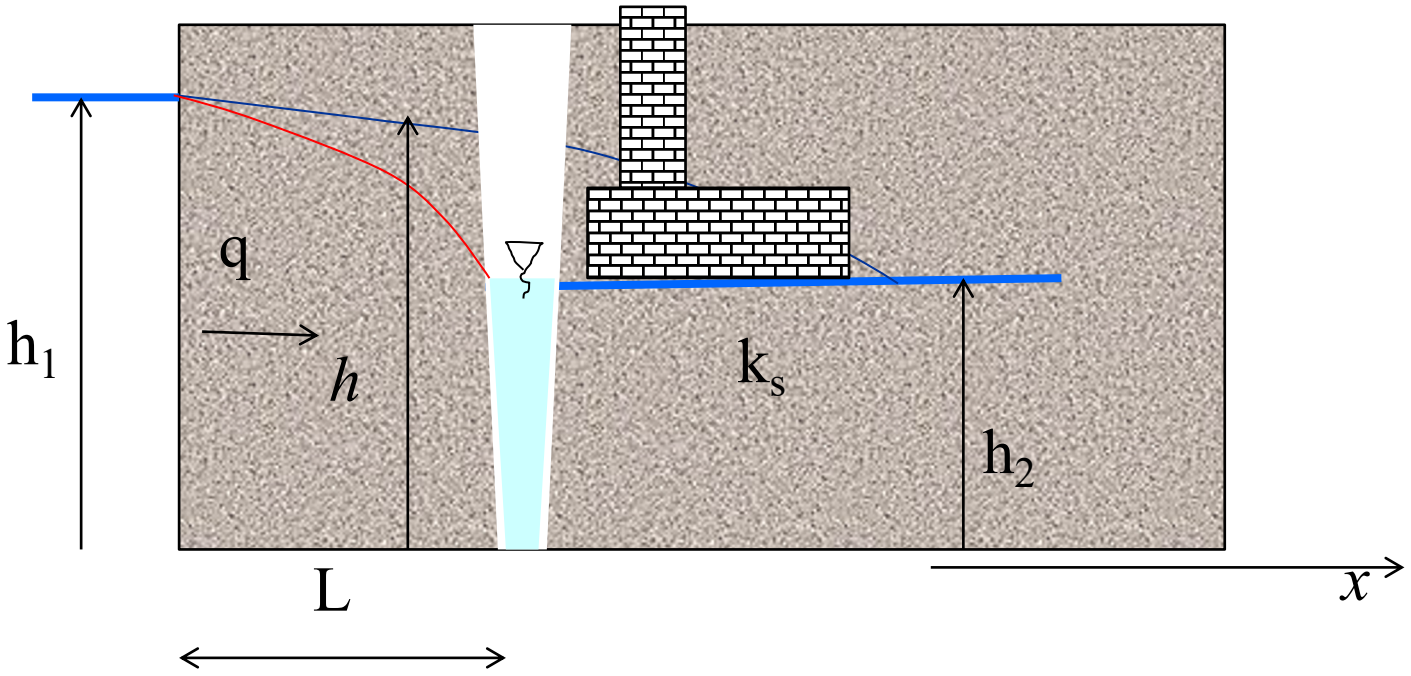
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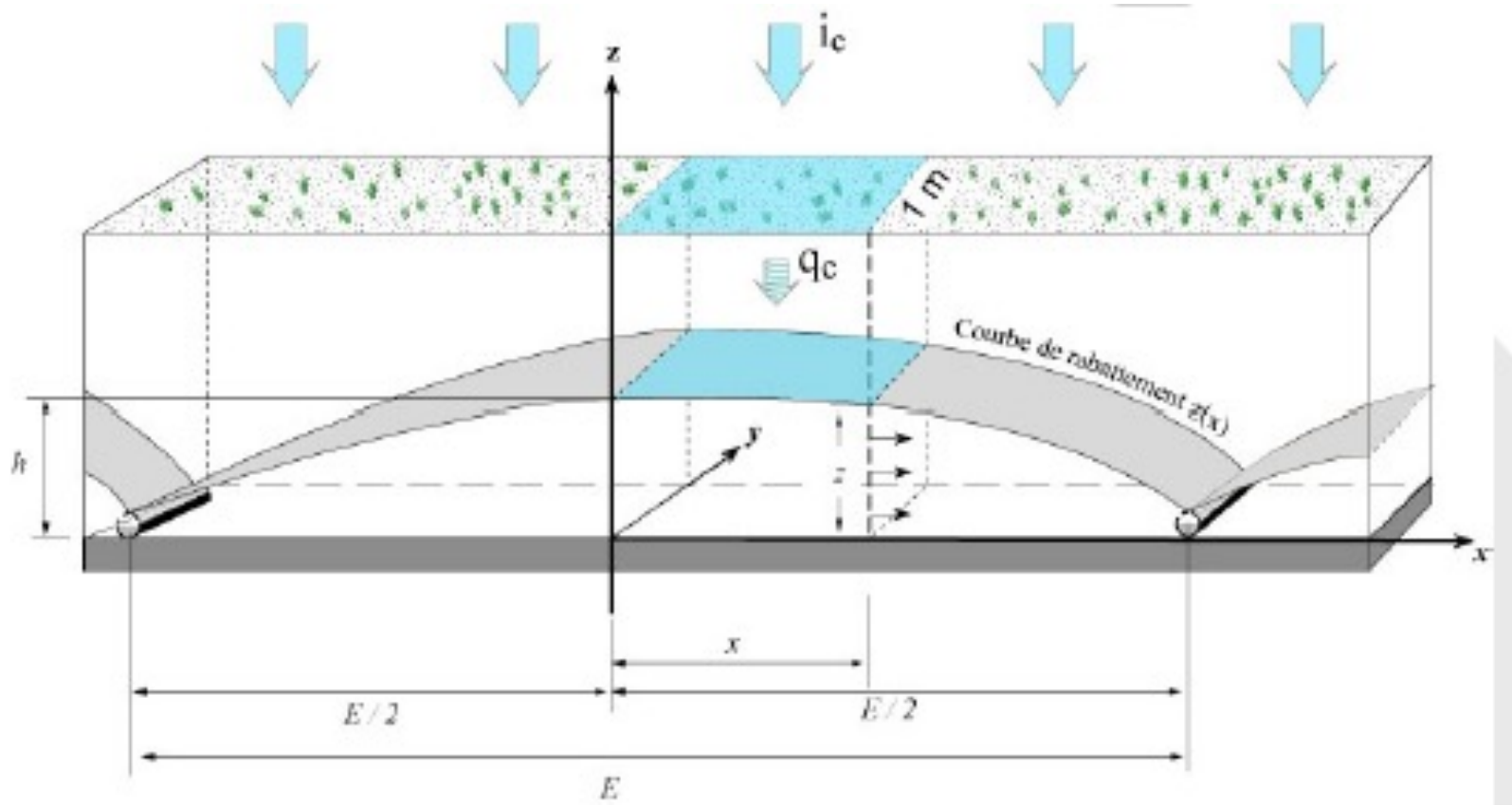
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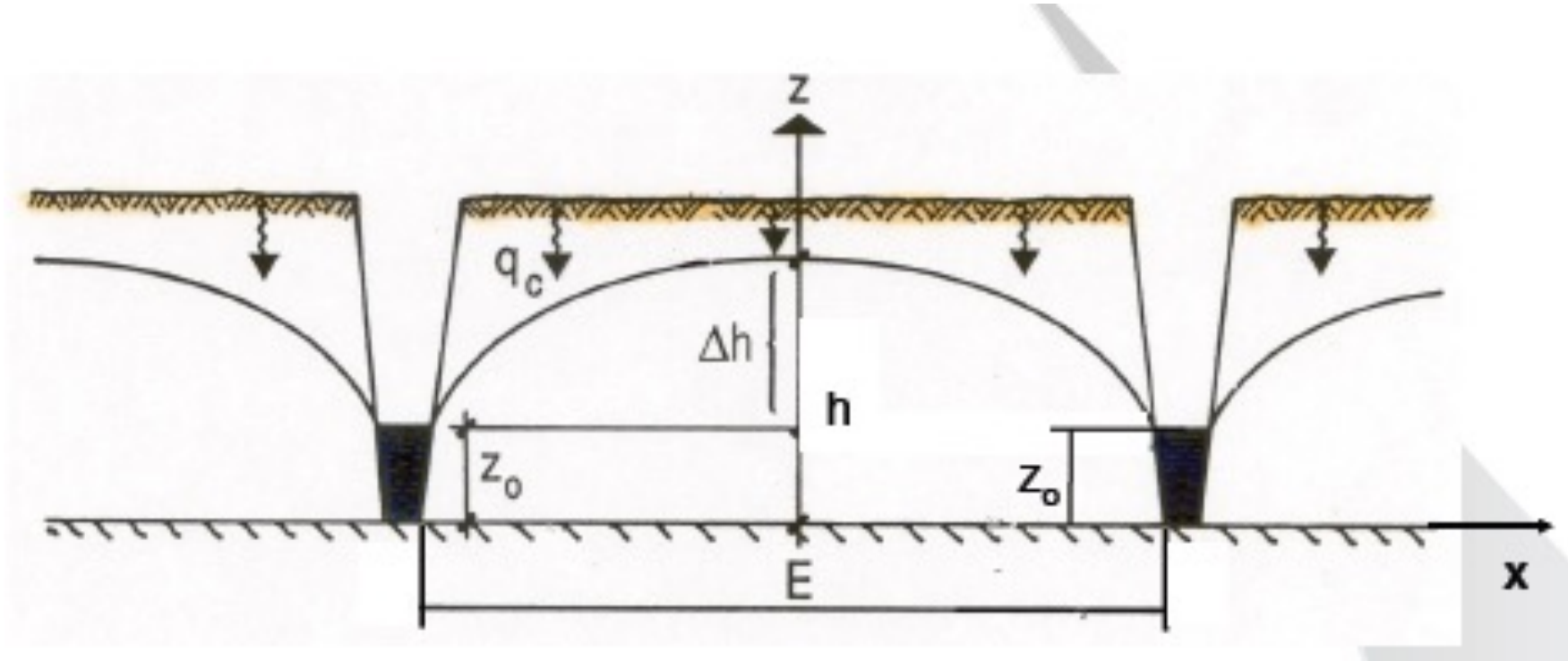
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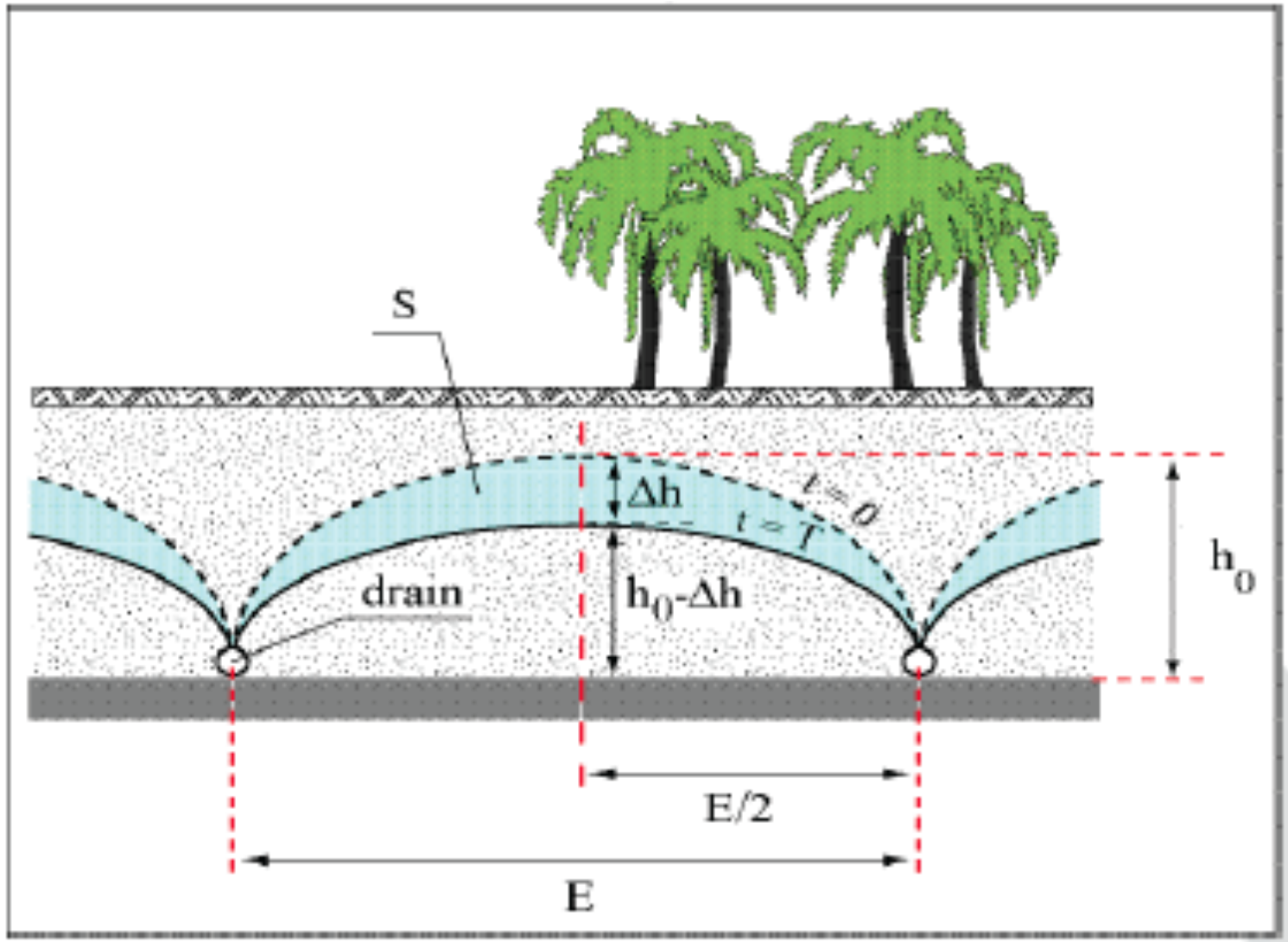
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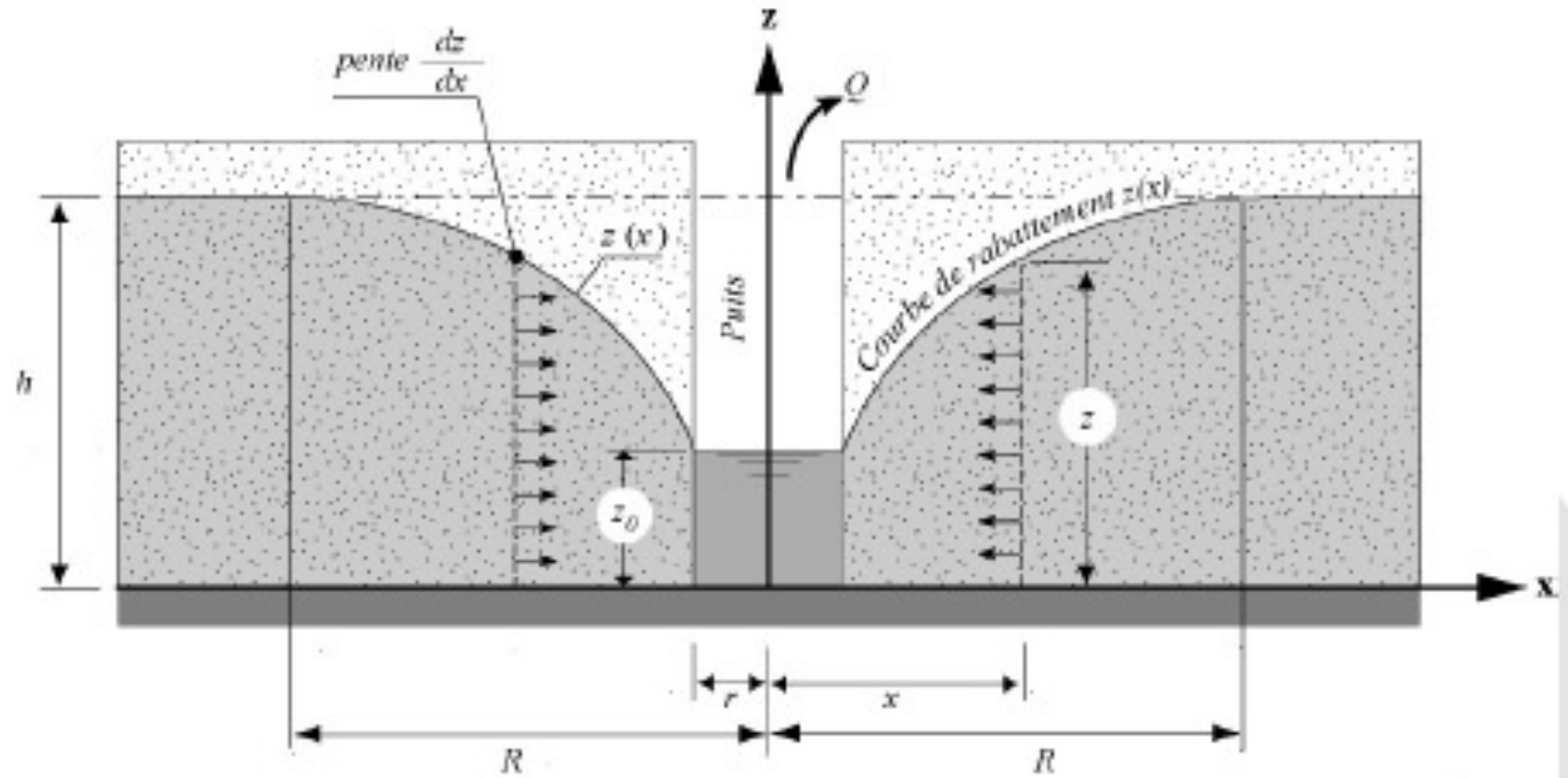
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