

Part 2

BASIC PRECEPTS

regarding

SEEPAGE

FLOW NETS

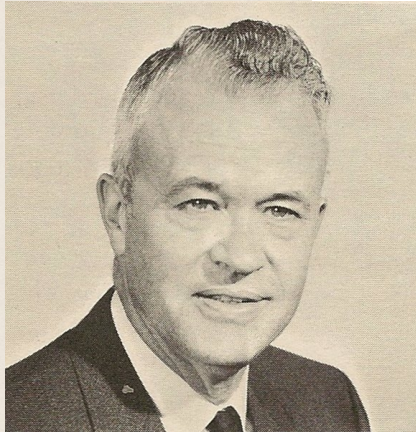
Seepage, Drainage, and Flow Nets

Harry R. Cedergrén (1911-96) received his BSCE from the the University of Washington in 1938 and MS in soil mechanics from Harvard in 1939, under Prof. Arthur Casagrande. He worked for the Army Corps of Engineers, the California Division of Highways, and the CA Department of Water Resources for about 30 years before becoming an independent consultant, in 1964. His textbook on **Seepage, Drainage, and Flow Nets** is the definitive reference on seepage and drainage through soils for engineering purposes. A 3rd Edition soft cover version was reprinted in 1997 and is currently available from [Amazon.com](https://www.amazon.com) or downloadable from [Google books](https://books.google.com)

SEEPAGE, DRAINAGE, AND FLOW NETS

THIRD EDITION

HARRY R. CEDERGRÉN

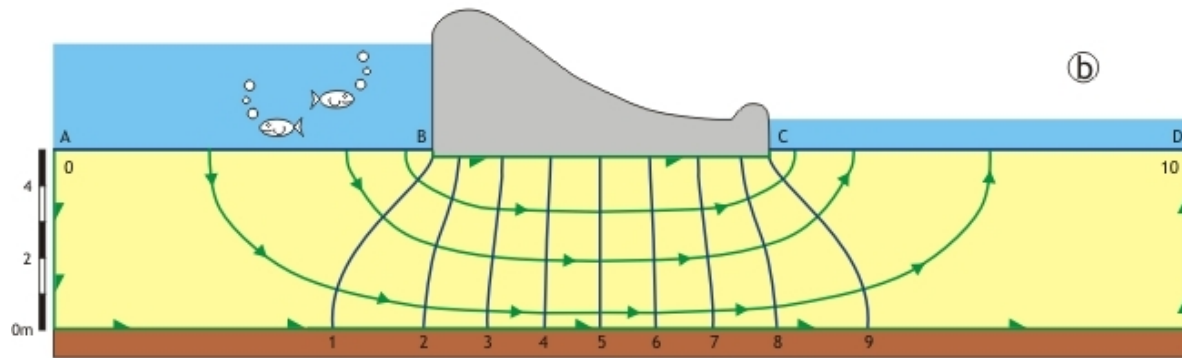
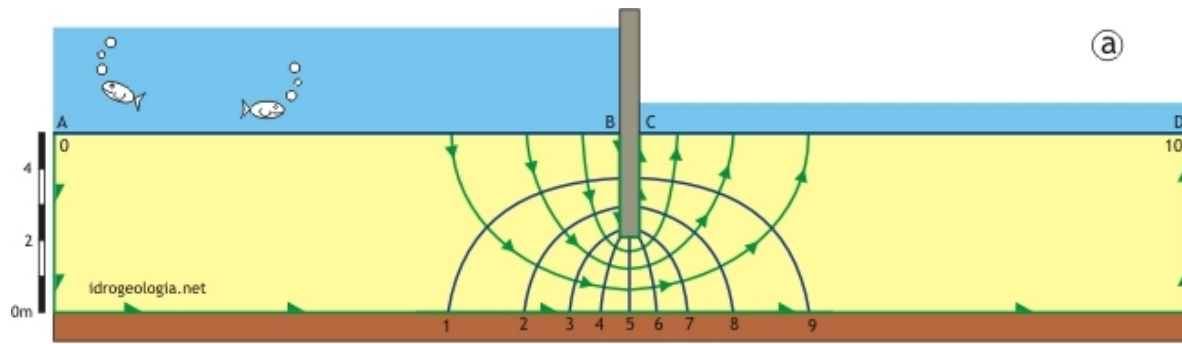


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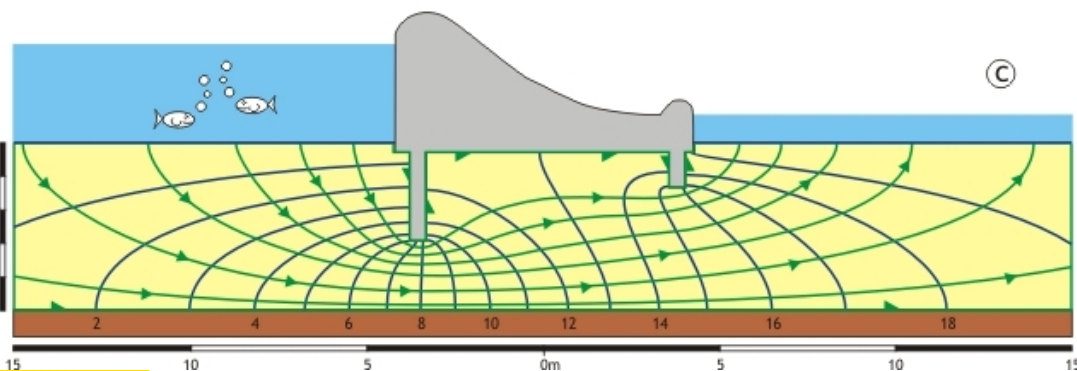
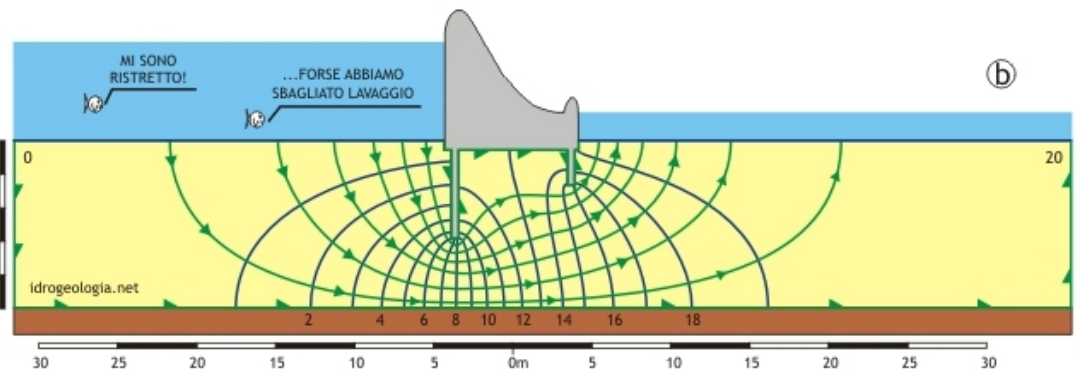
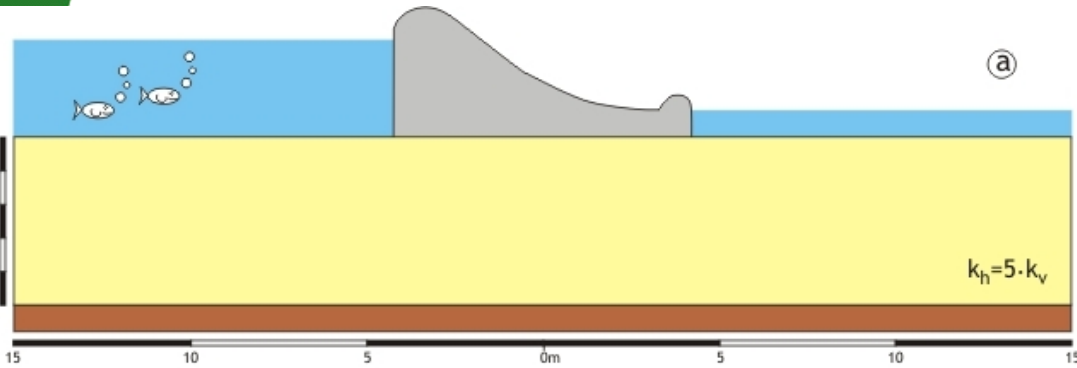
New York • Chichester • Brisbane • Toronto • Singapore

Cedergrán's classic text appeared in 1967, followed by a second edition in 1979, and a third in 1989, available on Google books.



- Seepage Flow Nets** - Cedergren employed **Darcy's Law** to craft flow nets that model subsurface flow. The arrows delineate **flow paths** while the **equipotential lines** are shown in blue. These are useful for estimating the hydraulic pressure **head loss** that occurs with flow distance.

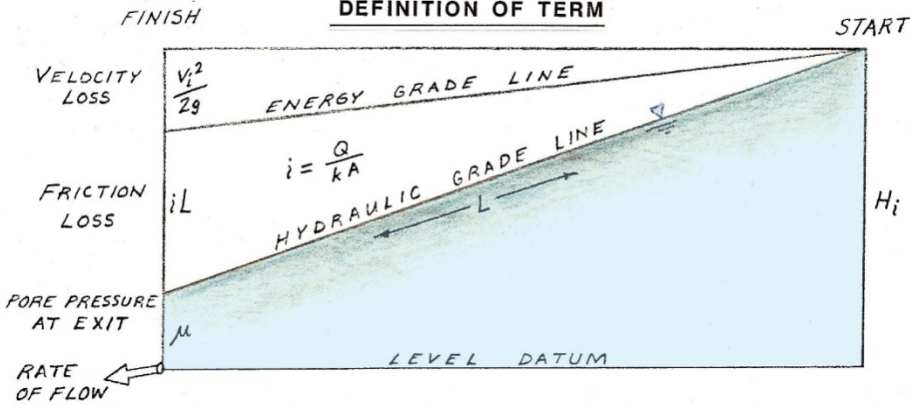
Impacts of flow obstructions



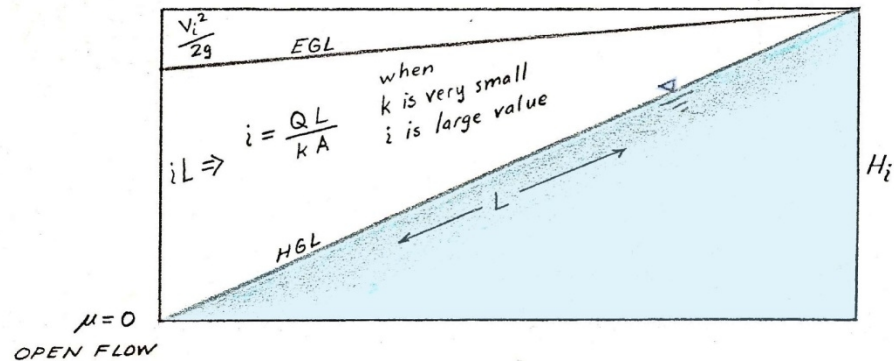
- **Pore water pressures** are influenced by the tortuosity and length of the flow paths
- **Model at lefts** assumes a horizontal permeability, k , about $5X$ k , the vertical permeability
- **Note the impact of widening the dam's base and thickening its cutoff walls**

Energy Grade Lines, Hydraulic Grade Lines, and pore pressures

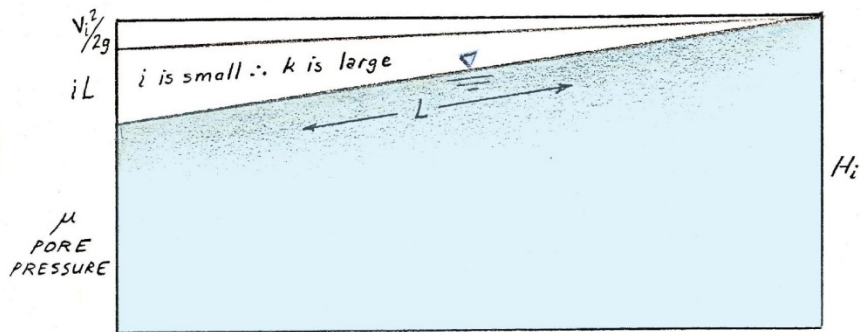
DEFINITION OF TERM



CASE OF OPEN FLOW



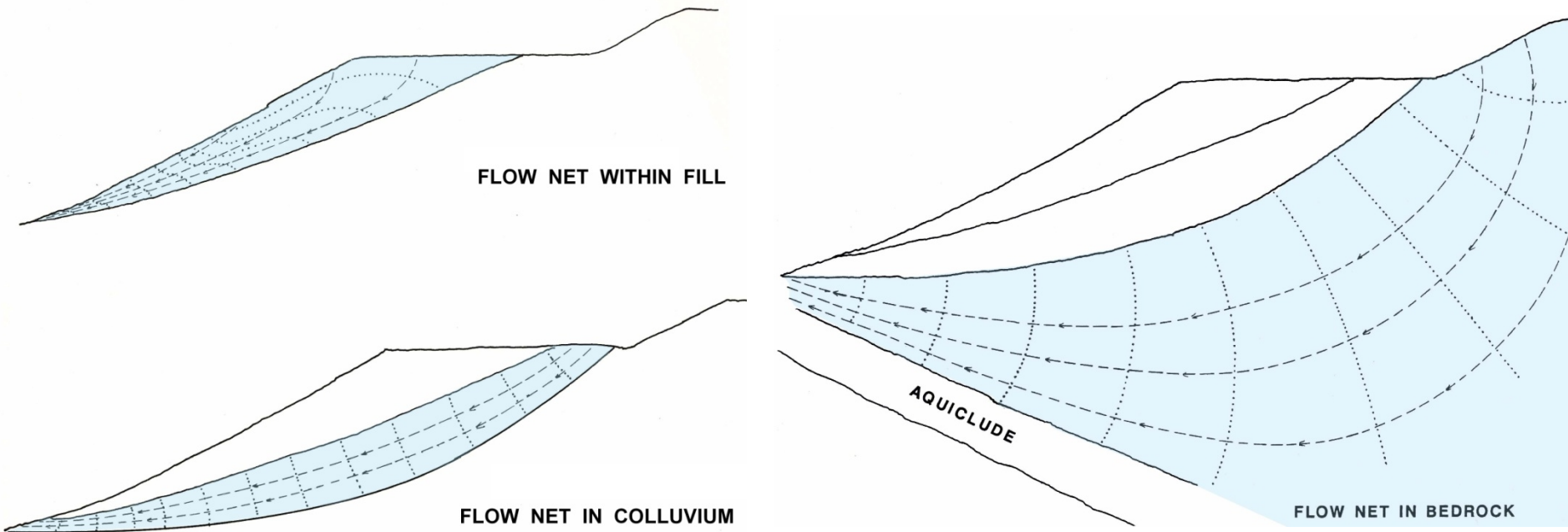
CASE OF FLOW BLOCKAGE



The more porous slopes are more effected by this phenomenon. If flow completely blocked, μ increases to H_e .

- Upper: Definition of hydraulic terms applicable to shallow groundwater flow through porous media
- Middle: When flow is unimpeded the exit pore pressure, u , is negligible
- Lower: If the flow is blocked, high pore pressures can develop, which can trigger slope instability

Different flow nets for units of differing permeability



Seepage flow is governed by the permeabilities of the respective geological units, such as fill, colluvium, and weathered bedrock. Of these, the weathered bedrock is, by far, the most important.