Seepage Control on Dams with Sand/Gravel Filters

Recent Industry Advances

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Presentation Outline

- Background – Seepage and Dams
- Filter / Drain Design Steps – Overview
- Top 10 List of Recent Industry Advances
Seepage and Dams

Stability
Saturation of portions of an embankment causing loss of soil strength

Piping
Movement of soil through an unprotected exit
Stability
Piping
Stability
Piping
Filter sand

Drain Gravel
Embankment Soils – usually fine grained (clay silt)
Reservoir Water Surface

Void caused by Piping

Protected Exit

Sinkhole
Filter / Drain Design Steps

1. Design Sand Filter to be compatible with embankment soils
2. Design Gravel Drain to be compatible with sand filter
3. Design drain pipe to be compatible with gravel drain
Chapter 26  Gradation Design of Sand and Gravel Filters
Embankment Soil
or “Base Soil”
Filter soils must fit in between these 2 lines.
These on-site gravels will not be a good filter – too coarse.
Commercial concrete sand fits pretty good.
Drain Rock
“Filter”

Filter Sand
“Base Soil”
Gradation boundary for drain rock when the base soil is commercial concrete sand.
D448 #57 Coarse Aggregate
Gradation boundary for drain rock when the basesoil is commercial concrete sand
Background – Seepage and Dams

Filter / Drain Design Steps – Overview

• Top Ten List of Recent Industry Advances
TOP TEN LIST

10. Don’t use on-site soils for critical filter / drain applications

- It is rare to find natural materials that can satisfactorily serve as filter

- Tend to be gap graded, prone to segregation during placement

- Generally, have too many clay/silt size particles

- Washing on-site can be problematic for fall construction in Montana

- Uncertainty – variations in gradations and quantity of material
9. Keep fines content down: < 3% in stockpile, < 5% in place

- Sand and gravel tend to breakdown during placement
- Permeability goes down dramatically with increasing clay and silt. A soil with as little as 7% clay can be essentially impermeable
8. ASTM C33 concrete sand is an excellent filter for most embankment dams

- Readily available
- Perfect filter for MOST clay silt soils
7. Don’t overestimate permeability of your concrete filter sand
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6. Put in a chimney filter when repairing your embankment

- Overwhelming evidence of their effectiveness
- Prevents problems from construction defects
  (loose lifts, poor bond between lifts, pervious layers, desiccation, and dispersive soils)
5. If there is a chance of concentrated flows, use 2 stages in your chimney filters.
4. Design toe drain pipes to accommodate an inspection

- Plentiful cases where drain pipes get damaged during construction

**BONUS!!!**

- A pipe that fits a video camera generally has adequate capacity.
3. Make an informed choice of the plastic pipe in your toe drain
Single Wall Corrugated HDPE

Dual Wall Corrugated HDPE

Solid Wall HDPE

- 10X Strength double wall corrugated HDPE

Solid Wall PVC pressure pipe

- 4X Strength double wall corrugated HDPE
2. Always design your toe drains with 2 stages

- Sand can clog pipe perforations
- Must have properly sized drain rock adjacent to perforations
1. Consider using method based specifications

- Type of equipment used for compaction, number of passes of equipment, moisture application is often left up to the contractor.

- Over-compaction of filters and drains, breaks down particles, causing loss of permeability.

- For critical filters and drains, specify exactly how you want them constructed.
References will be posted at:

http://dnrc.mt.gov/wrd/water_op/dam_safety_technical_ref.asp