

Dry Dams and Levees

Thursday, April 6, one day

This workshop will first define what is meant by a “dry” dam or levee. We will review potential cracking mechanisms in these unsaturated embankments, some of which are unique to flood-control dams and levees in semi-arid environments. Relevant internal erosion potential failure modes will be described with graphics and example event trees, and the presenters will offer suggestions on how to handle intermittent, transient hydraulic loading in the risk evaluation process. Soil physical characteristics and specialized laboratory testing methods for scour and erosion potential will be reviewed in the context of internal erosion failure modes. The workshop presenters will introduce available numerical and physical modelling tools for estimating the response of unsaturated embankments that are subjected to rapid filling and drawdown. Defensive design measures to protect dams and levees from adverse effects of transient hydraulic loading on potentially cracked sections will be summarized. Recommendations for monitoring and inspection of dry dam and levee structures will be presented.



Topics:

- Potential cracking mechanisms
- Internal erosion potential failure modes
- Numerical and physical modelling tools for estimating the response of unsaturated embankments subjected to rapid filling and drawdown
- Defensive design measures to protect against adverse effects of transient hydraulic loading on potentially cracked sections
- Monitoring and inspection of dry dam and levee structures.



USSD WORKSHOP
DRY DAMS AND LEVEES: HOW WILL THEY PERFORM WHEN THE WATER COMES UP?
DRAFT FINAL AGENDA

8:00 AM **Introduction – Rachael Bisnett (MWH, now part of Stantec)**

- Welcome and Introduction of Workshop Participants
- Problem Definition
 - Description and examples of typical “Dry” Dams and Levees
 - Failure and Accident Statistics for First Fill, and Rapidly Loaded and Unloaded Dams and Levees
- Summary of Topics to be covered

8:20 AM **Potential Cracking Mechanisms for “dry” dams and levees – Deb Miller (Miller Geotechnical Consultants)**

- Desiccation shrinkage cracking
- Collapsible foundation soils
- Foundation irregularities and long dams or levees
- Ground subsidence due to groundwater overdraft (including potential for earth fissuring in some locales)
- Stress conditions conducive to hydraulic fracturing on first filling, or subsequent rapid re-fillings following extended dry periods

8:45 AM **Potential Failure Modes – John France (AECOM)**

- Transient Loading Conditions to be Covered
 - Normal seasonal filling and drawdown
 - Unusual rapid flood loading and drawdown
(excludes seismic loading, construction-induced pore pressures and traditional rapid-drawdown from a “steady-state” condition)
- Specific examples and case histories illustrated graphically and by event trees
 - Internal erosion of unsaturated embankment due to hydro-fracturing on “first filling” or subsequent re-filling following extended dry periods
 - Internal erosion (concentrated-leak or scour erosion) initiated in undetected cracks
 - Piping (retrograde internal erosion) in levee foundations
- Discussion of timing and development of internal erosion failure modes under transient loading conditions: duration of loading, cycles of loading and progressive erosion, etc.

9:30 AM **Soil Testing Methods for Erosional Resistance and Scour Potential – Bobby Rinehart and Tony Wahl (USBR)**

- Brief discussion of soil characteristics (plasticity, gradation, uniformity coefficient, etc.) that affect erosion and scour potential
- Description of specialized laboratory testing methods for assessing scour and internal erosion vulnerability of soils – e.g., hole or slot erosion tests, submerged jet erosion test, etc...
- Relate back to PFMs: Summarize how these soil characteristics affect initiation and progression nodes on internal erosion event trees

10:30 AM **Break**

10:50 AM **Panel Discussion and Q&A on Morning Topics – Moderated by John Rice (Utah State University)**

12:00 PM **Lunch**

1:00 PM **Analysis Tools – Transient Unsaturated Seepage Analyses – TBD**

- Why use transient, unsaturated analyses? Isn't steady seepage simpler and conservative?
 - Check validity of potential failure modes – is there sufficient gradient developed within time of loading to initiate piping erosion in levee foundation, for example
 - Provides an overall realistic understanding of time frame for reaching steady state some embankments may not be impounded for sufficient time under either normal (cyclic) operating or design flood events to ever reach steady state seepage
 - Allows calibration of seepage model and soil parameters with piezometric data
- Basic Principles, Analytical and Approximate Graphical Solution Methods – (History, e.g. Cedegren's transient flow nets)
- Numerical Methods and Models for Transient Unsaturated Seepage – (Rapid Fill and Drawdown Problems)
 - FEM models (Plaxflow, Seep/W, Vadose/W, SLIDE, etc.)
 - Finite Difference Models (Flac3D, etc...)
- Recommendations for further study and resources on this topic

1:45 PM **Analysis Tools – Physical Models – Inthuorn Sasanakul (U. South Carolina)**

- Experimental (laboratory-scale) tests (e.g., centrifuge modeling)
- Full-scale experimental studies of dam and levee piping failure modes (e.g., Netherlands/Delft University studies, NRCS studies, etc...)
- Recommendations for further study and resources on this topic

2:30 PM **Break**

2:45 PM **Best Practices for Design and Construction of Seepage Control and Crack-Stopping Elements in Dams and Levees –Gary Wantland (MWH, now part of Stantec)**

- Embankment (Material selection, layout of filter/drain elements, compaction requirements, special compaction (abutments), use of the right compaction equipment)
- Filter and Drain Elements
- Foundation Seepage Control Elements
 - Grout Curtains, blanket grouting, curtain grouting
 - Cutoff Walls
 - Other elements

3:30 PM **Monitoring – Jay Stateler (USBR)**

- “Routine” settlement monitoring, particularly looking for differential settlements that could result in cracking of the embankment
 - Traditional ground-based surveying methods
 - Aerial and satellite-based methods
- Visual monitoring for cracks
- Monitoring during the “first filling” event following a sustained dry period

4:00 PM **Panel Discussion and Q&A on Afternoon Topics – Moderated by John Rice**

5:00 PM **Adjourn**