Appendix C

Presentations

This appendix provides the MS Word PowerPoint presentations of the state-of-practice regarding dam service and/or emergency spillways. All the presentations presented at the workshop are included in this appendix as documentation of the state-of-practice and research needs as seen by the presenting experts.

Presentation 1:
Hydraulic Design of Labyrinth Weirs and Fuse Gates

HYDRAULIC DESIGN OF LABYRINTH WEIRS

Henry T. Falvey & Associates, Inc.

Outline of Presentation

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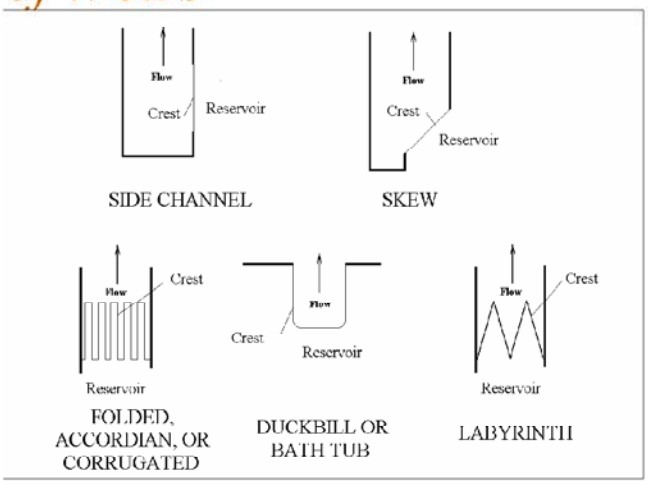
Types of Weirs



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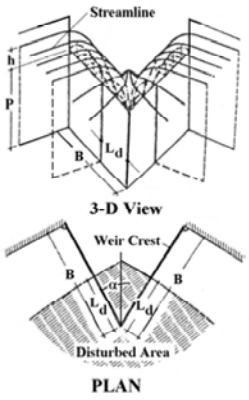
Nappe Interference



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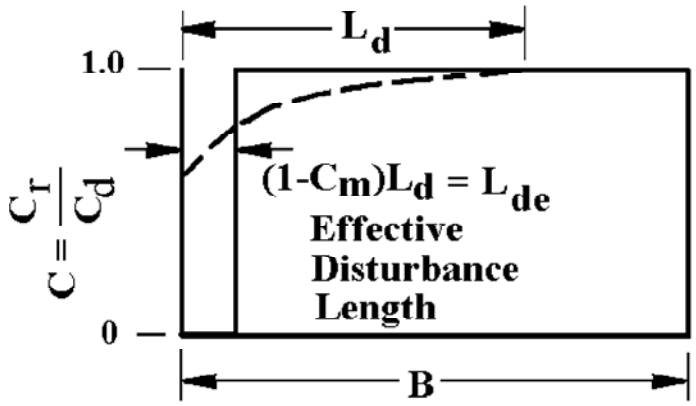
Effective Disturbance Length



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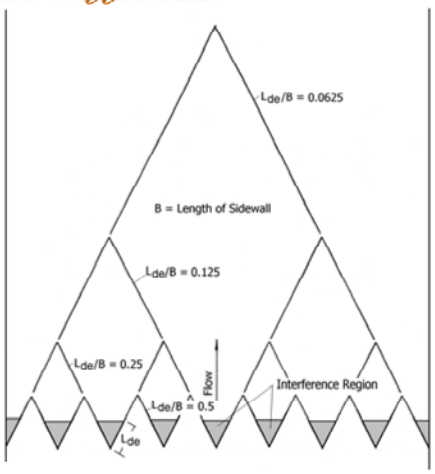
Interference Effects



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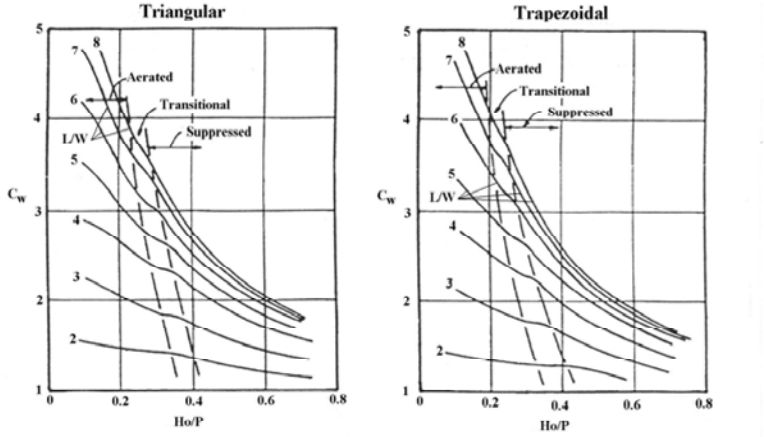
Design Curves – Lux/Hinchliff



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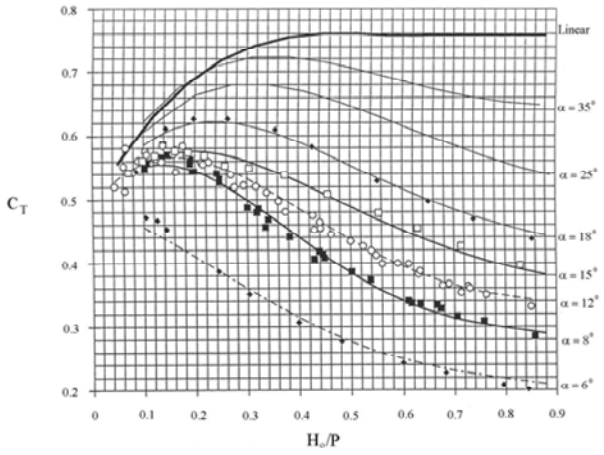
Design Curve - Tullis



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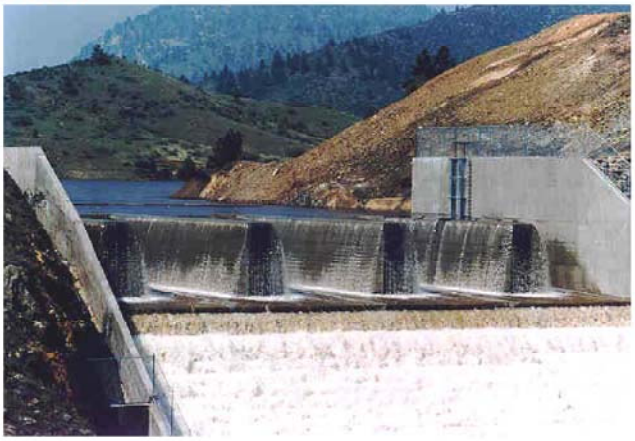
Nappe Oscillation – Milton Reservoir



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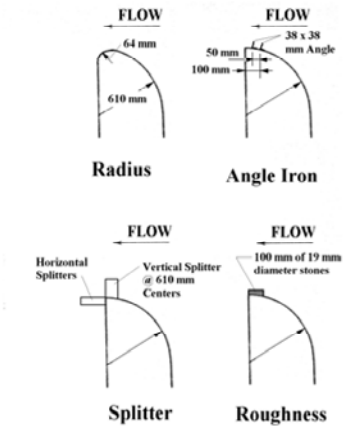
Solutions to Nappe Oscillation



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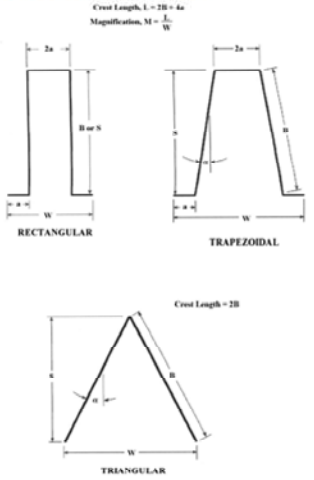
Geometric Definitions



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Design Considerations – New versus Old

- Lux recommends $0.45 < H_o/P < 0.55$ $W/P = 2.5$, and $2 < L/W < 6$.
- New criteria allows Ho/P to be as high as 0.90, W/P is superceded by interference ratio (L_{de}/L) and L/W superceded by efficacy.

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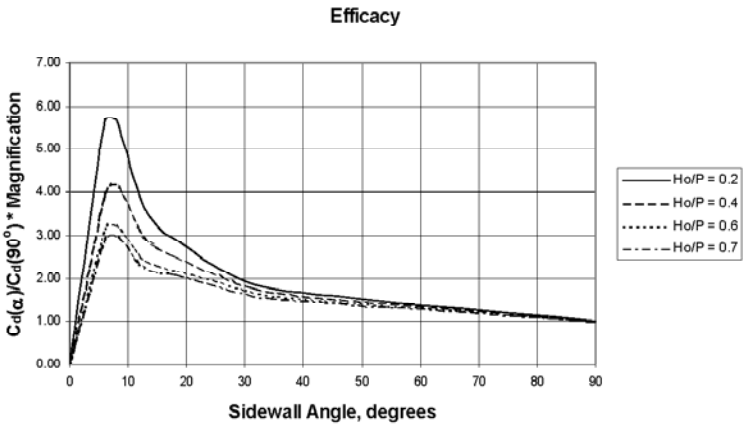
Design Considerations - Efficacy



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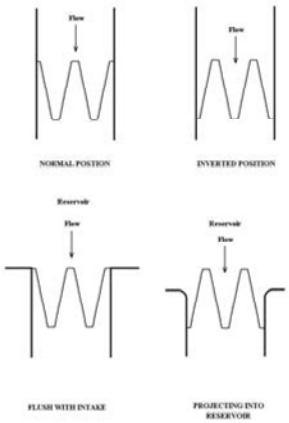
Design Considerations - Position



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Research Needs

- Crest Shape
- Interference Verification
- Need for Splitters on Crest
- Approach Flow Considerations
- Raised Invert Effects

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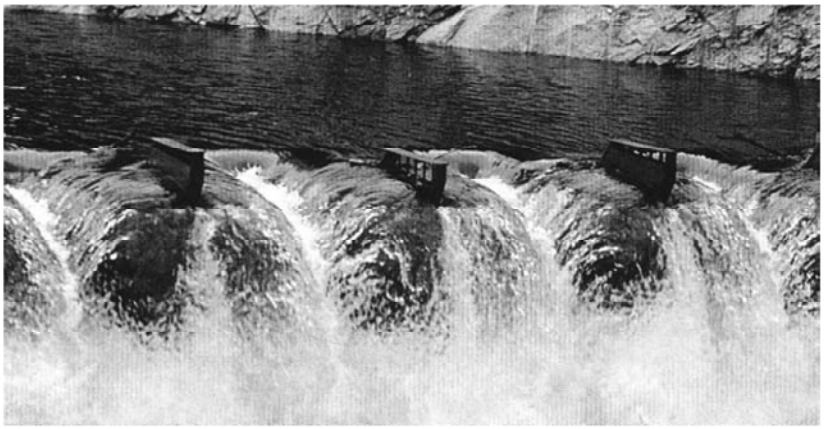
FUSEGATES



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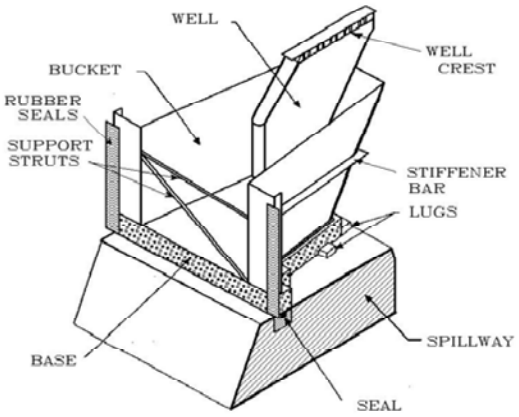
Fusegate Geometry



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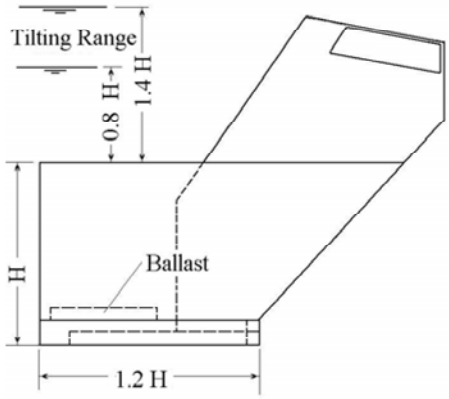
Profile



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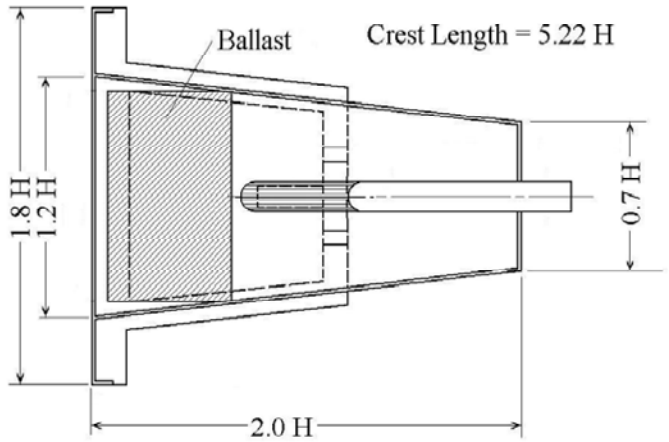
Elevation



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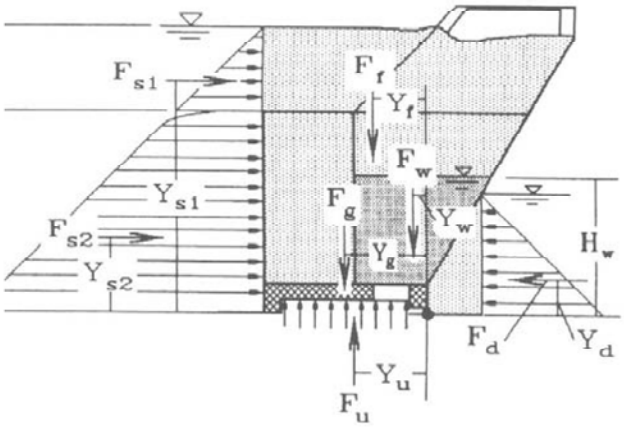
Forces on Fusegate



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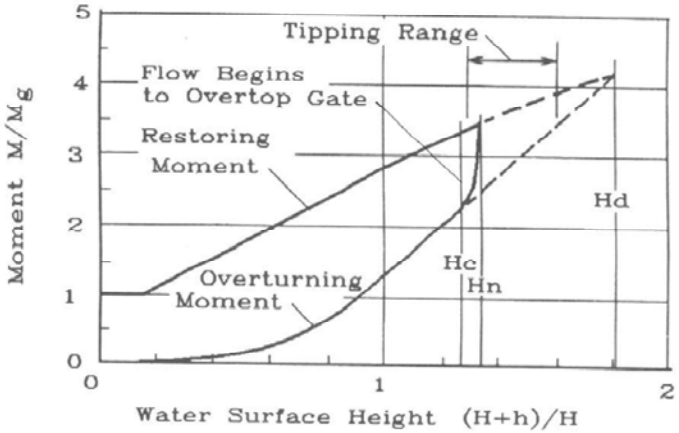
Moments on Fusegates



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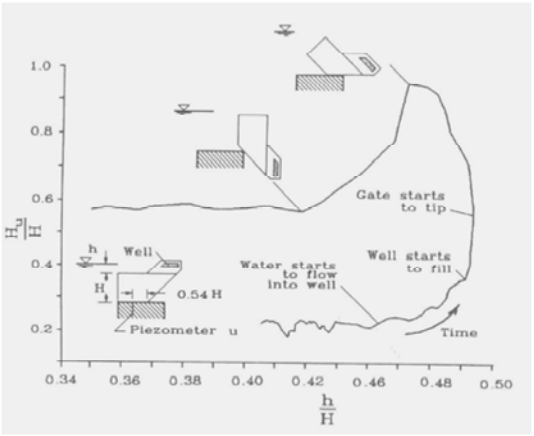
Fusegate Chamber Pressures



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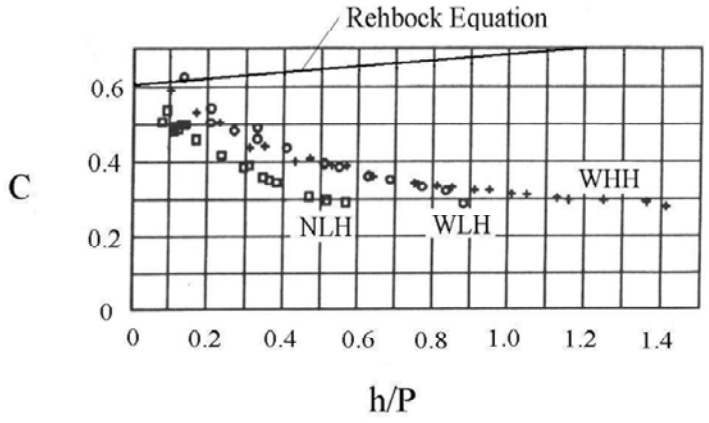
Discharge Characteristics



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Issues with Fusegates

- Wave loading has been studied
- Ice loading has been studied
- Seismic loading has been studied
- Tailwater effect has been studied
- Downstream channel clogging has been studied
- No major research needs

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Presentation 2:
Fuse Plug Embankments —State of the Art and Practice, and Research Needs

Fuse Plug Embankments

State of the Art and Practice, and Research Needs

Tony Wahl

Bureau of Reclamation

Water Resources Research Laboratory

State of the Art

- Design concept by Tinney and Hsu (1961)
  - Proven in their lab tests, Oxbow field test, and 1980's Reclamation lab tests
- Core is inclined downstream
  - Failure is by scouring out non-cohesive supporting zone, causing core to be a cantilevered beam
  - Initiation is **reliable, rapid**
  - Lateral erosion rate is predictable, depends on head and embankment cross section

Design Concept

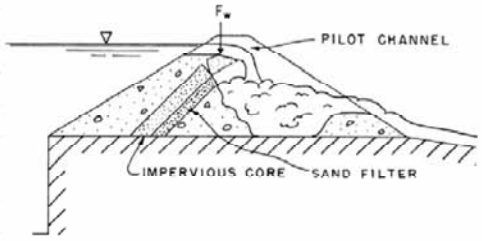


Figure 16 Flow through the pilot channel showing the failure mode of the impervious core.

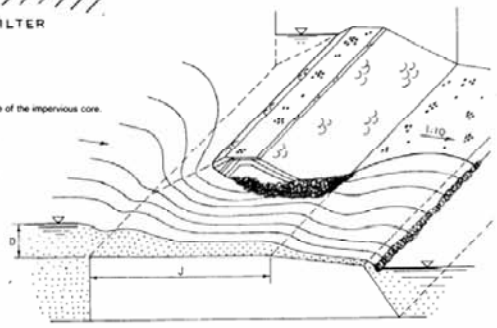


Figure 27. – Schematic of the lateral erosion process. The water flows across the face of the embankment, around the core, and erodes the noncohesive material downstream from the core.

Laboratory Testing

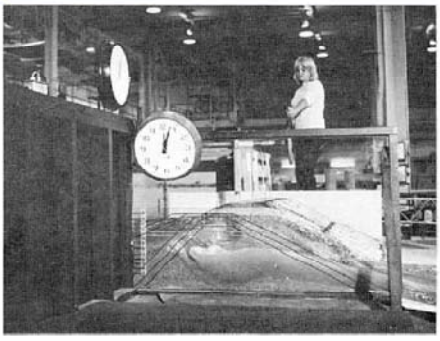


Figure 4. – Initial breach viewed through end wall, test No. 8. P801-D80946.

(d) The lateral erosion rate was determined by timing the erosion between flags. P801-D80952

Figure 26. – Views of the washout process. – Continued

State of the Practice

- How many have been built (or are being built)?
- What design concept are they using?
  - Tinney & Hsu inclined core
  - More traditional embankments
    - Vertical core or homogeneous fill
- Operational history

State of the Practice

- Reclamation fuse plugs
  - Horseshoe and Bartlett Dams
    - 262,000 cfs (~10 yrs)
  - New Waddell Dam
    - 129,000 cfs
  - Jordanelle Dam
    - 5,500 cfs (~10 yrs)
  - Sumner Dam
    - 150,000 cfs (1955)

Fuse Plug at New Waddell

State of the Practice

- Fuse Plugs Built by Others
  - Center Hill Dam (USACE) (USBR consulted)
  - Lake Pontchartrain fuse plug levee (1936)
  - Yahekuo Dam, China (vertical, tapered core)
    - Fuse plugs reported to be widely used in China
  - Arvada Reservoir (10-bay homogeneous embankment)…considering rehab
  - Many, many small dams
    - e.g., 4 dams North Carolina (Nantahala Power)

Operating History

- Very few spillways have operated
  - Oxbow Field Test was a prototype
  - Fuse plug at Silver Lake on Dead River in Upper Peninsula of Michigan *failed(?)* in May 2003.
    - Greater portion than anticipated gave way
    - Apparently eroded too deep…no fixed sill
    - Nobody I talked to was willing to say much right now

Research Needs

- Investigating long-term stability of inclined clay core
  - Cracking due to dessication or differential settlement
    - issues of concern on SRP fuse plugs
  - Contact with floor and side walls
  - Is long-term water storage against a fuse plug desirable, undesirable, or not an issue?

Research Needs

- Designs utilizing other materials that might offer better long-term performance or ease of construction
  - Impermeable membranes
  - Inclined concrete core
- Research to define inventory of fuse plug spillways, their design concepts, and operational histories

Presentation 3:
Crest Parapets and Dam Raising

Crest Parapets/ Dam Raising

Dwayne Fuller
U.S. Army Corps of Engineers
Engineer Research and Development
Coastal and Hydraulics Laboratory

Recent Projects

- **Tygart Dam**, Tygart River, West Virginia, Pittsburgh District
- Original Design Flow, 270,000 cfs
- PMF Flow, 373,000 cfs
- 38% increase

- **Bluestone Lake Dam**, New River, West Virginia, Huntington District
- Original Design Flow, 430,000 cfs
- PMF Flow, 950,000 cfs
- 120% increase

Typical Model Objectives

- Extend rating curve
- Crest pressures
- Gate and pier pressures
- Energy dissipation component forces
- Stilling basin forces
- Scour pad forces
- Tailrace scour

Tygart Dam

Alternatives

- No action
- Raising the dam (approximately 6')
- Spillway modification (gated spillway with lower crest)
- Auxiliary spillway
- Overtopping
- Dam replacement

Tygart Dam

1:60 Scale Model

Tygart Dam

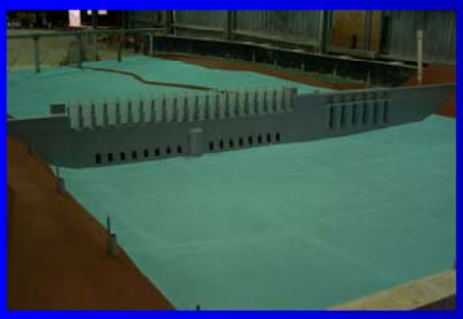
Flows With Existing Structure

Tygart Dam

Redirected Spill

Tygart Dam

Bluestone Lake Dam



1:65 Scale Model

Bluestone Lake Dam

Alternatives

- No action
- **Raising the dam** (approximately 14')
- Spillway modification
- Auxiliary spillway
- **Overtopping (partial)**
- Dam replacement

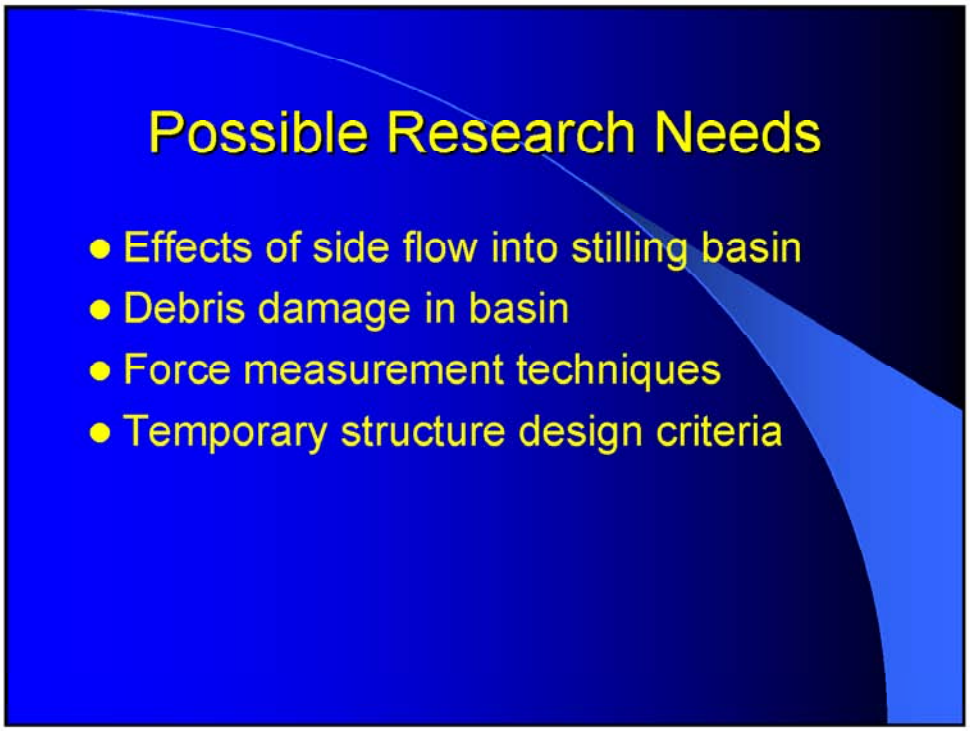
Bluestone Lake Dam

Original Design Flow

High Flow

Concerns

- Spill capacity (PMF passage)
- Stilling basin
- Cavitation (spillway and penstocks)
- Erosion
- Component inadequacy
- Hydraulic loads
  - Forces on side walls
  - Basin forces
  - Forces on temporary structures
- Flow conditions in tailrace
- Debris build-up in basin (side flow)


Possible Research Needs
Effects of side flow into stilling basin
Debris damage in basin
Force measurement techniques
Temporary structure design criteria

Presentation 4:
Gated Spillways: Enlargement, Modification, and Rehabilitation —State of the Practice

GATED SPILLWAYS

ENLARGEMENT, MODIFICATION
AND REHABILITATION
STATE OF THE PRACTICE

GATED SPILLWAYS

- Determine Function and Needs
- Risk Neutral
- Types
- Design & Research Needs

DETERMINE FUNCTION AND NEEDS

- High Head vs. Low Head
- River Flows
- Storage Issues of Large Floods (>100 Yr)
- Maintenance
- Attendance issues

DESIGN AND DATA NEEDS

- River Flows
  - Normal
    - Annual river flows
  - Minimum Flows
    - Is a bypass needed?
  - Maximum Flows
- Storm Storage

DESIGN AND DATA NEEDS (cont)

- Climatic Conditions
  - Temperature changes
  - Winter Conditions
- Reservoir fluctuations
- Vandalism
- Security Issues
- Debris

DESIGN AND DATA NEEDS (cont)

- Controls & Automation – operate remotely or onsite
- Emergency power
- Flow measuring capability

TYPES

- Slide Gates
- Wheel Gates
- Radial Gates
- Drum Gates
- Crest Gate
- Rubber Dams
- Fusegates
- Flashboards

Slide Gates (Unbonneted)

Wheel Gates

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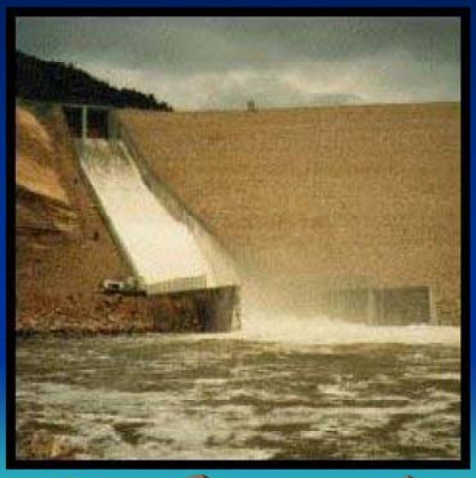
August 26 and 27, 2003

Radial Gates



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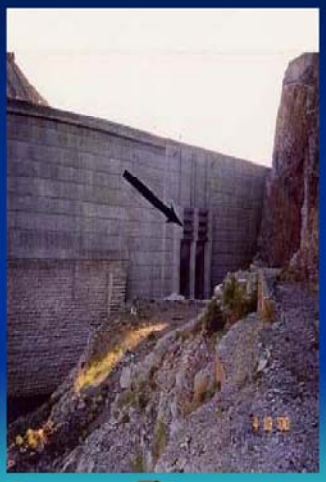
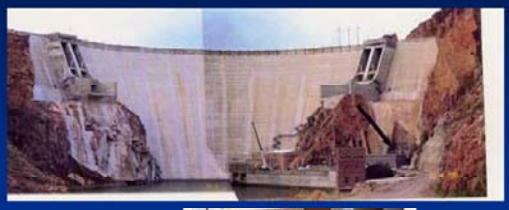
Top Seal Radial Gates





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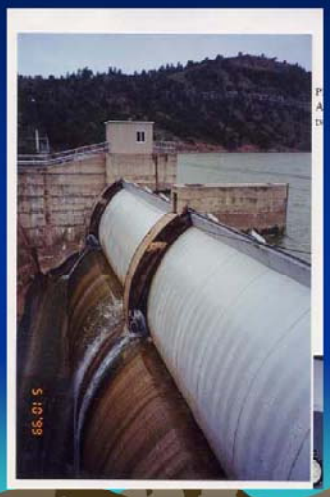
Drum Gate



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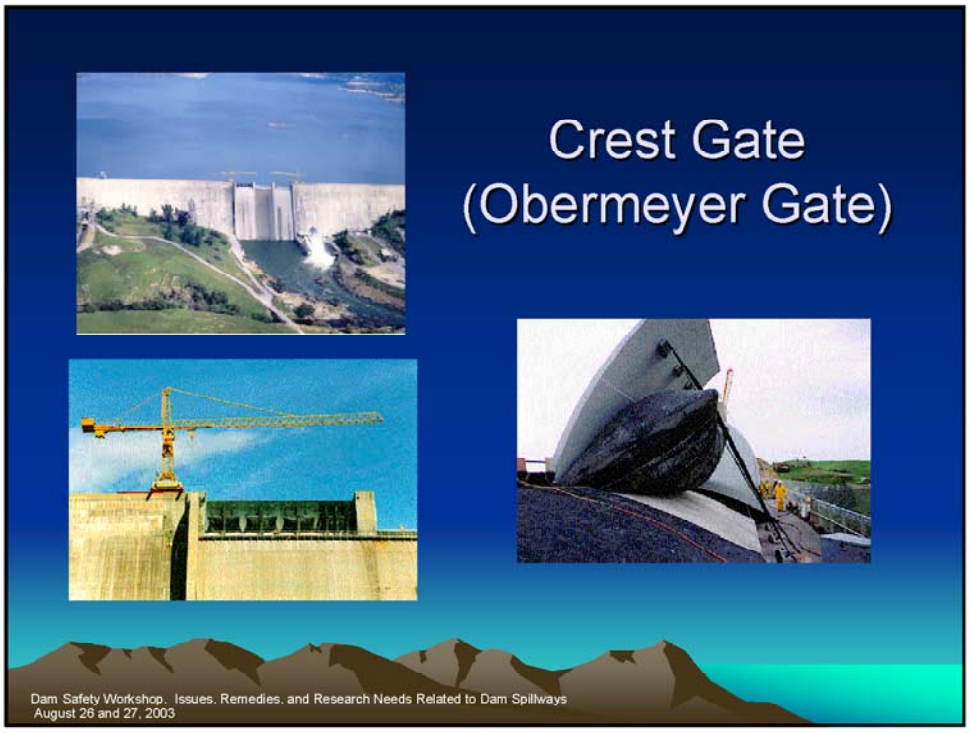
Crest Gate
(Obermeyer Gate)
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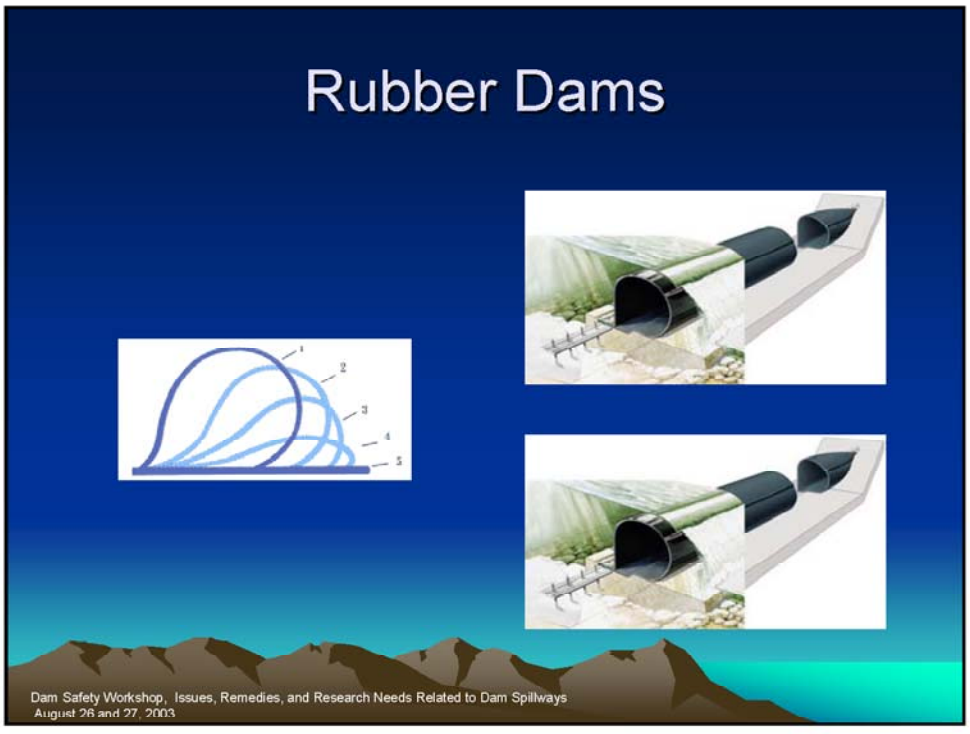
Rubber Dams
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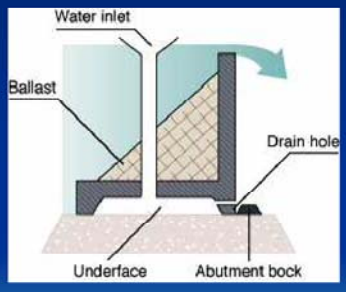
Fusegates (Hydroplus)



Other Types of Gates

- Flashboards
- Cylinder Gates
- Other


RESEARCH NEEDS
• Discharge data
• Submergence effects on discharge
• Extrapolation to other situations
• Flows released during failure
• Seismic and security modifications
• Cost
• Maintenance and Durability
Dam Safety Workshop. Issues. Remedies. and Research Needs Related to Dam Spillways
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