CHALLENGES IN MANAGING AN AGING INFRASTRUCTURE

Lessons Learned from a Near Miss at the Lake Manatee Dam (Central Florida, 2014)

by

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OUTLINE

Case History – Lake Manatee Dam

- What Causes Failures?
- Description of Dam
- Integrating Historical Data
- Lessons Learned
- Ongoing Engineering
Why Constructed Facilities Fail

1) Uncertainty
   - Environmental Loadings
   - Foundation Conditions
   - Construction Materials
   - Engineering Models…

2) Faulty Observations
   - Bad Instrumentation
   - Improperly Located Instruments
   - Inability to Observe…

3) Human Factors
HUMAN FACTORS

Experience / Training
- Modeling Paradox
- Decreasing # of Sr. Professionals
- Field Evaluation Process…

Data Integration
- Easier to See Changes (Differentiation)
- Too Much Data
- Frequent Changes in Engineer-of-Record

Aversion to “Bad” News
- Don’t Want to Say Something is Wrong
- Group Think
SOLUTIONS

Experience / Training
- Models Tied to Physical Behavior
- Just Because We Can… Doesn’t Mean We Should
- Teach Junior Staff How to Think

Data Integration
- Periodic In-Depth Reviews
- Be Patient
- Focus on Fundamental Behavior

Aversion to “Bad” News
- Have the “Risk” Discussion
Lake Manatee Dam
(completed 1967)

Phase I $20M Emergency Installation of Cutoff Wall (2014)
Phase II Void Repairs / Pressure Relief System (on-going)
3,700 ft long zone-earth embankment with service and emergency spillways
Typical Embankment Section

Downstream

Upstream

Permeable Shell

Cutoff Trench

Impervious Core
Original River Course
Service Spillway Plan View

Flow

End Sill

Stilling Basin

Sheet Pile
Cut Off Wall

No surface erosion protection designed here
Service Spillway Section

Section A-A

Approach Slab
Tainter Gates
Ogee Spillway
Stilling Basin
End Sill
Driven Piling

Sheet Pile Cut Off Wall Below Spillway Approach Slab
Sheet Pile Cutoff Wall Below End Still
Conclusion from 2013 Inspection Report

“The Lake Manatee Reservoir Dam is well maintained and is in very good overall condition.”
During Construction
Florida Testing Laboratories

1) Modified Sheepsfoot Roller
2) Compaction at 12 to 15 mph
3) Soil processing did not create uniform water content
First (1978)
U.S. Army Corps of Engineers

1) Vortices in reservoir STA 8+00 and Raw Water Intake

2) Spillway designed for 100-yr flood

3) Loss of soil under concrete steps behind south training wall

4) Depression 4’ diameter 3’ deep behind South Training Wall

5) Excessive erosion downstream of stilling basin, concrete over riprap added
Data Integration

Second (1979)

1) Multiple boreholes in embankment lost circulation, low blow counts and W-O-H materials

2) Very loose conditions at bottom of core at STA 17+00

3) Erosion of downstream slope just north of spillway continues

4) Depression 3' diameter 2' deep behind South Training Wall

5) Possible artesian pressures at STA 17+50 in toe area

6) Toe drain not functioning, collecting sediments and wet spots along toe of south embankment
Data Integration

Third (1980 - 1985)

1) Large area with severe erosion on west end of north training wall
2) Erosion undermining stairway next to training wall
3) Depression 3’ deep at edge of downstream apron
4) Shoreline erosion downstream of spillway apron and sheetpile walls
5) Wet area at downstream toe STA 12+00
Fourth (1986 - 1988)

1) Boring through crest at STA 17+00 lost circulation and found soft material

2) Erosion along sheetpile wall next to north approach slab

3) Fill between north sheetpiling and training wall removed by erosion

4) Severe erosion on downstream riverbanks undermining surface protection

5) Erosion along sheetpile wall next to south approach slab

6) Erosion undermining stairway behind south training wall

7) Depression along southwest corner of training wall

8) Depressions at locations of old baffle blocks

9) Toe Drain Settlement
1) Depression along north approach wall below water
2) Depressions along north approach wall above water
3) Erosion adjacent to north approach slab
4) Depressions, erosion along north sheetpile cutoff and surface of slope
5) Depression, cracking and erosion in roadway STA 14+25
6) Deflection of wall up to 2", two new holes in backfill
7) Seepage through wall between concrete and sheetpiling
8) Seepage from downstream north channel bank
9) Separation of sheetpile wall and loss of material behind
10) Deterioration of apron
11) Depressions and wet zones over toe drains, irregular downstream slopes
12) Depression behind south approach wall
Critical Seepage Paths

- **Manatee River Head**: approx. 1 ft
- **Lake Manatee Reservoir Head**: approx. 39 ft
- **Shortest Seepage Paths**
Original River Course
Conclusion After Analysis

1) Lake Manatee Dam is in a severely distressed state

2) Without immediate intervention there is a high risk of an uncontrolled release of reservoir, most likely following a large rainfall event and opening of spillway
Lessons Learned

1) Focusing on Changes in Behavior Not Good for Long-Term Developing Conditions

2) Avoid Group Think

3) Integrate Historical Data
Ongoing Engineering

1) Void Filling and Approach
   Channel Repairs

2) Integrating Data - Behavior During
   Emergency Repair, Additional Borings,
   Dye Studies, Hydrogeologic Studies

3) Design
Questions??

wood.