JOHN DAY DAM
JOHN DAY NAVIGATION LOCK
1968 - Project completed and pool filled.
Post tension anchors installed in navigation lock gate and tainter valve monoliths (5,6,29,30,27,28,7,8,) as a result of problems at Ice Harbor before lock was filled.
Seepage noted at D/S toe of North embankment (right abutment) 5 days into initial filling @ pool.
July 1968 structural inspection cited areas of spalling concrete and water flowing down stair treads in the powerhouse gallery.
March 1969: First Periodic Inspection cited spalling, cracking, inadequate reinforcement

Subsequent reports indicate increasing amount of cracking, spalling, failed waterstops and leaking.

Continuous monitoring and repairs on lock monoliths, concrete, etc.

Waterstop repair contract, tainter valve shaft concrete removal contracts (2001)
Historical Contd’

• Primary Problems necessitating repair (2003)
  – Monolith 8 split in two pieces
  – Monolith 27 in danger of failure
  – Monolith 8 valve shaft spalling and Tainter valve out of service – no operational redundancy
  – Leakage into backfill and boneyard (sinkholes)
  – Monolith movement, cracking, spalling, etc.
  – Customer complaints
Boneyard Sink Hole
Monolith 8 Service Gallery – Tainter Valve Shaft
Monolith 8 Service Gallery
Concrete Cracking
Navigation Lock
Monolith 8 Tiltmeter Array

Lockward Displacement vs. Landward Displacement

Elevation (Feet)

Displacement (Inches)

-0.5 0 0.5

Lock Empty
Lock Full
Shaft Pressurized

Routinely Lock Cycle Monolith Deformation With Tainter Valve
Shaft Out of Operation
(Pressure Equalized With Lock Chambers)

- 5/13/2003 13:50
- 5/14/2003 10:33
- 5/16/2003 10:49
- 5/26/2003 4:00
- 6/2/2003 7:00
- 6/25/03
- 6/30/03

1/19/2003 1:35
4/30/2003 8:30
5/13/2003 13:50
5/14/2003 10:33
5/16/2003 10:49
5/26/2003 4:00
6/2/2003 7:00
6/25/03
6/30/03

160 180 200 220 240 260 280
John Day Navigation Lock – Confirmed Crack Planes
John Day Navigation Lock – Confirmed Crack Planes

- Crack M27-1 to be repaired using epoxy adhesive grout in typical fashion.
- Crack M27-2 to be repaired using paste-epoxy adhesive for condition similar to Monolith 8 Bulkhead Slot.
Lift joints at 5’ o.c.

Leaking lift lines during routine Tainter Valve operations
John Day Monolith Repair Contract Investigation

- Stress analysis
- Monolith drilling for crack location
- Instrumentation/monitoring
- Concrete testing
- Finite Element Analysis
How/Why did this happen?

- Navigation Lock is not reinforced adequately
- Concrete strength/quality is variable
- Foundation is inconsistent and of questionable quality
- Previous repair measures may have caused cracks which have progressed
- Waterstop failure due to movement of monoliths allows water into monolith
Monolith Repair - Contract

Lift Joint Repair, Monolith 6&8 Crack Repairs

Monolith 8 Structural Repair

Monolith 27 lift joint and Structural Repair

Concrete Removal and Precast Panel Installation
John Day Monolith Repair
Construction issues

• Construction scheduling/considerations of high concern due to lock outage impacts
• Schedule shift due to Anchor testing
• Lock outage in March to be extended to 1 month to perform below tailwater drilling
• 12 hour outages above tailwater after outage
• Best Value contracting method determined in best interest of the Government
• Critical Contract/Last chance for repair
Post Tensioning Design

- Solid A722 150 ksi Anchors were selected for design.
- Anchors were designed to resist the hydrostatic load at 0.6Fy.
- An additional 40% increase in required number of bars was then allocated.
- In addition, drilling tolerances have been reduced to ½ a degree – or within 4” in a 40’ deep core.
- Tight tolerances will also help prevent hitting existing PT, existing shafts, existing voids, etc.
John Day Navigation Lock
Monolith 8

• Anchor Stressing

• Every anchor is proof tested to 150% of the design load (0.6Fy).

• Several anchors in rock are creep tested to 150% DL for 8 hours.

• 150% DL is the Corp’s single anchor failure criterion. (PTI Criteria 133% DL)

• Anchors locked off at 0.6Fu.
• Anchor Details

  • Double corrosion protection for anchors installed in rock.
  
  • Single corrosion protection for anchors installed in concrete.
  
  • Recessed Anchorage zones with tensile zone reinforcement.
  
  • Removable anchor caps to allow for retensioning/lift off testing.
John Day Navigation Lock
Monolith 27

• Monolith 27 Post Tensioning Design Cont…:
  • New PT was angled and smaller bars were used to eliminate the need to develop bars in the rock strata.
  • Fewer monolith penetrations and the no existing PT made the location of these new anchors much less complicated.
  • Anchorage details similar to monolith 8 repairs.
John Day Navigation Lock
Monolith 27
John Day Navigation Lock
Concrete Rehabilitation

- Monolith Joint Isolation/Sealing
- Concrete Repair Monolith 6
- Concrete Lift Sealing
- Crack Sealing/Repair
- Backfill Drain Rerouting
Monolith 8/10 Joint Isolation

1. Isolate joint from crack to prevent epoxy grout from bonding joint.

2. Drill two vertical 10-inch dia access shafts.

3. Place expanding chemical “foaming” grout to fill Polyurethane Injection Zone

4. Grout Crack.
John Day Navigation Lock – Concrete Rehabilitation

Monolith 8 El. 263.0 Service Gallery

Crack M8-1

El 263.0 Gallery

Drilled Shafts

Bulkhead Slot

Lock Face  Flow
John Day Monolith Repair Contract
Joint Sealing Mock-up Testing

Effectiveness of joint filler

Drilled shaft
Simulated monolith joint
Monolith Joint - Paste Epoxy Injection

- Monolith joint
- Injection Ports
Post Tension anchor holes

Epoxy Injection Ports
**Paste-Epoxy Injection**

- Paste-Epoxy injection allows a controlled placement due to a predictable and consistent epoxy distribution “bulb.”
- Applicable in a “blind” crack situation

**Paste-Epoxy Injection Procedure**

1. Stage 1 injection until epoxy is observed at 2\(^{nd}\) port above.
2. Stage 2 injection at intermediate ports.
John Day Navigation Lock
Monolith Repair Successes

• Structural Integrity restored
• Normal Lock Operation
• Leakage to backfill reduced
• Leakage to lock face reduced
• Joints/cracks sealed
• No significant contract claims
John Day Navigation Lock Monolith Repair Costs

- Original contract estimate $5.6 million
- Contract Cost $11.7 million

High cost due to

- Tight timeframe
- Tight Construction Tolerances
- Work Within an Operating Lock
John Day Navigation Lock

Portland District
Corps of Engineers

Thanks for
Listening

Questions ?