October 18, 2023
ICRI 2023 Fall Convention

Lower St. Anthony Falls Dam Sill Joint Repair

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Agenda…

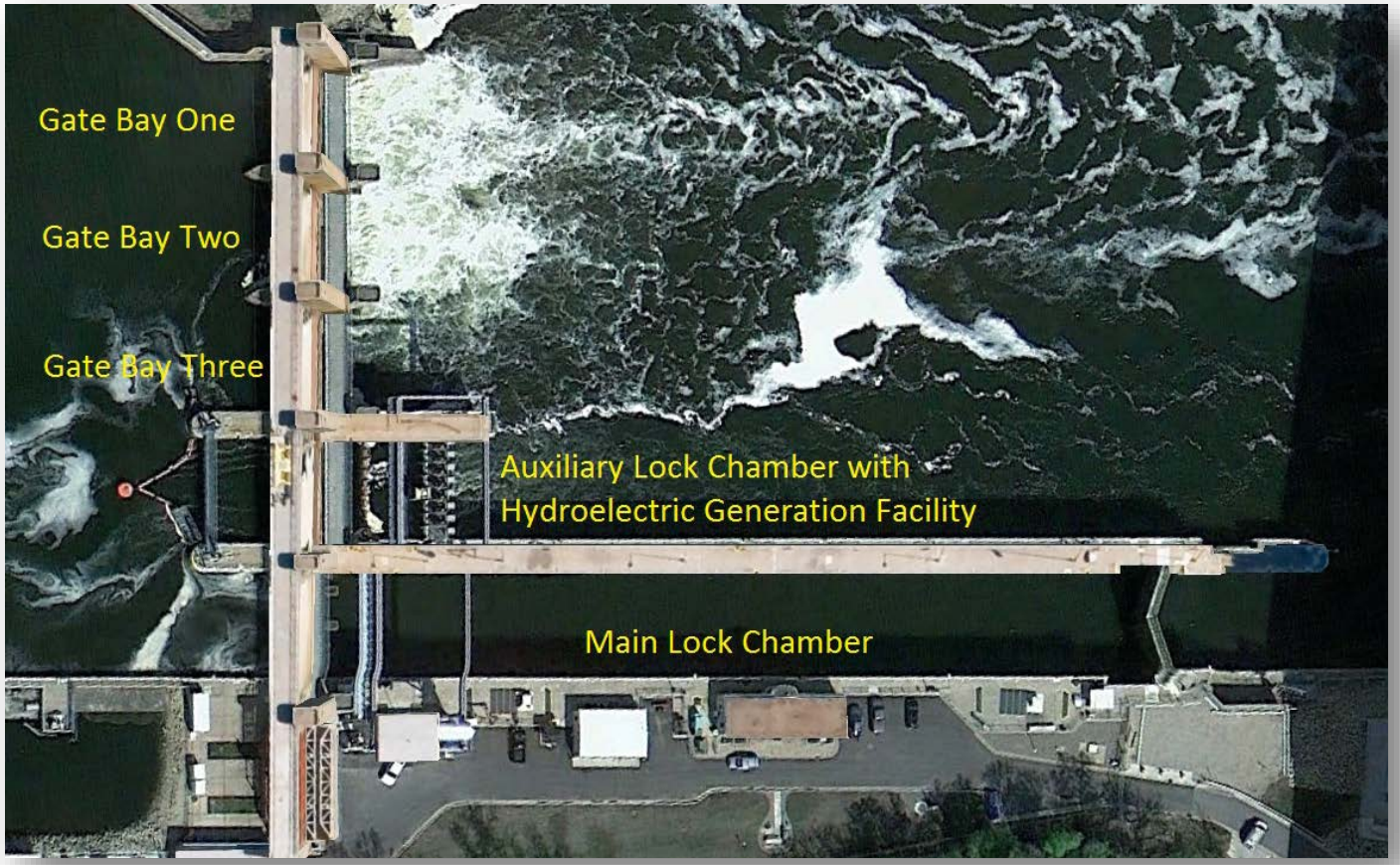
- Location
- Overview
- Our Main Concern
- Foundation Conditions
- Dewatering Bulkhead
- On-Site Engineering
- Concrete Sill Joint Inspection
- Repair Procedures
- Concrete Placement, Curing and Testing
- Construction Schedule and Cost
- Recommendations
- Conclusion
- Questions

Concrete Placement - Gate Bay One, November 9th 2012

Site Location…

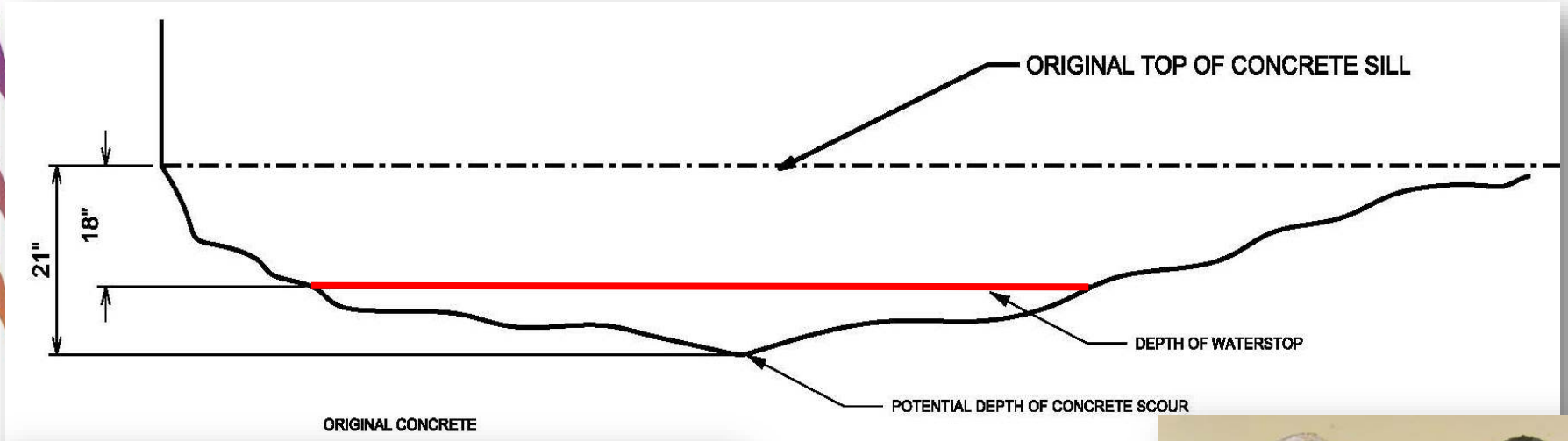
Site Overview…

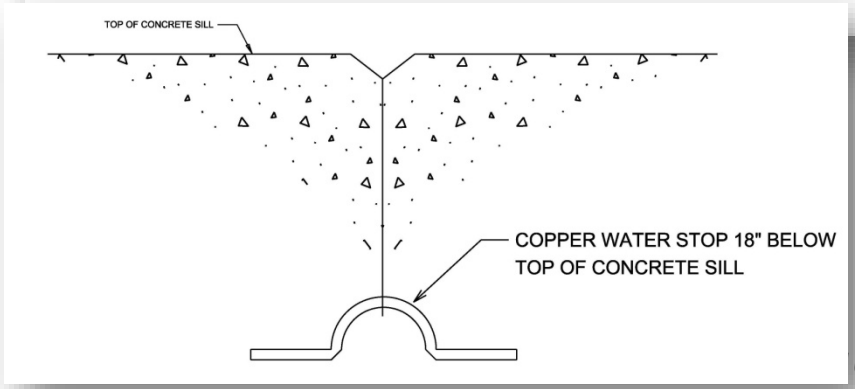
- Main lock chamber is 56 ft wide by 400 ft long.
- Auxiliary lock chamber, housing a hydroelectric generation facility.
- Movable dam with three 56 ft wide tainter gates.



Our Main Concern…

- Compromised / Failed Water-stops.
- Gate bay 3 has experienced 18 – 21 inches of concrete scour in the monolith joint.
- The depth of the water stop is 18 inches below the concrete sill.



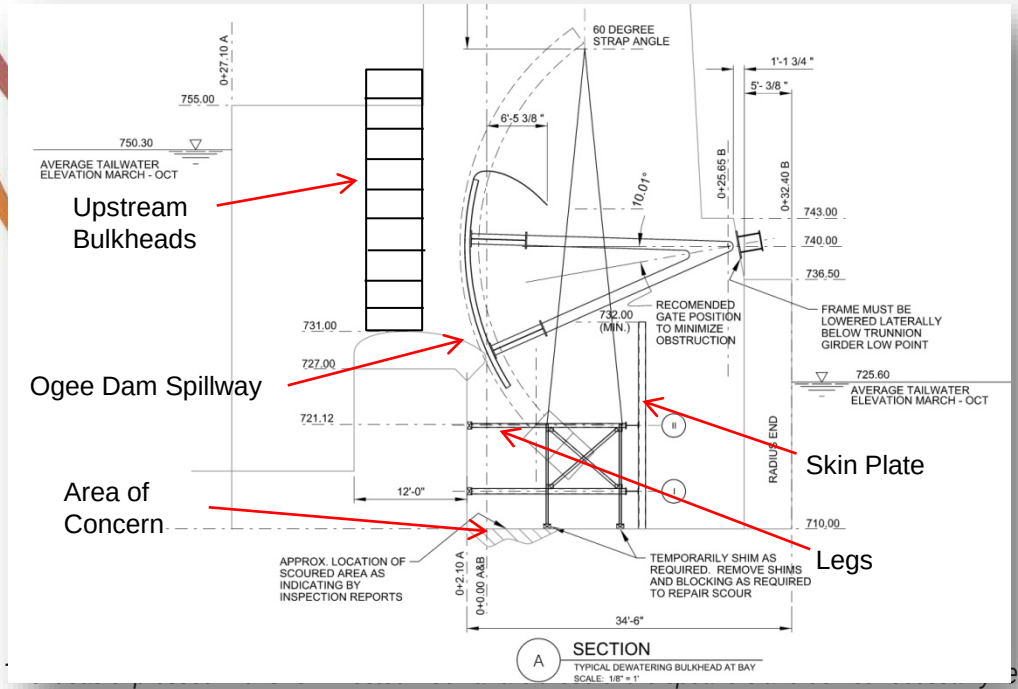


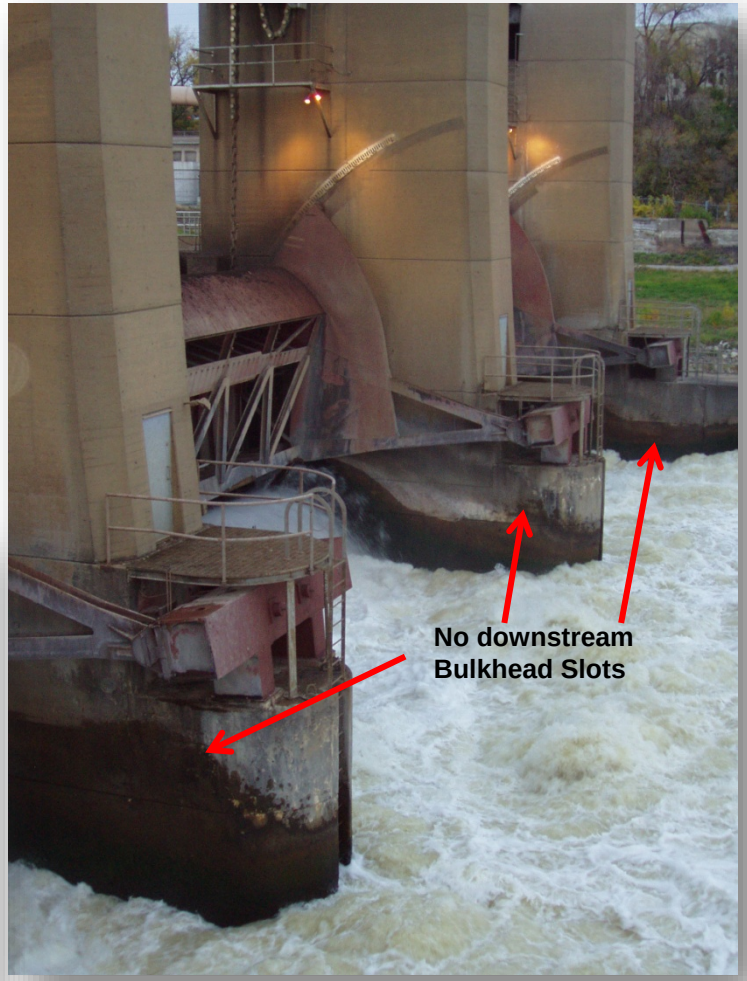
do not necessarily reflect the views and opinions

Foundation Conditions…

Dewatering Challenges…

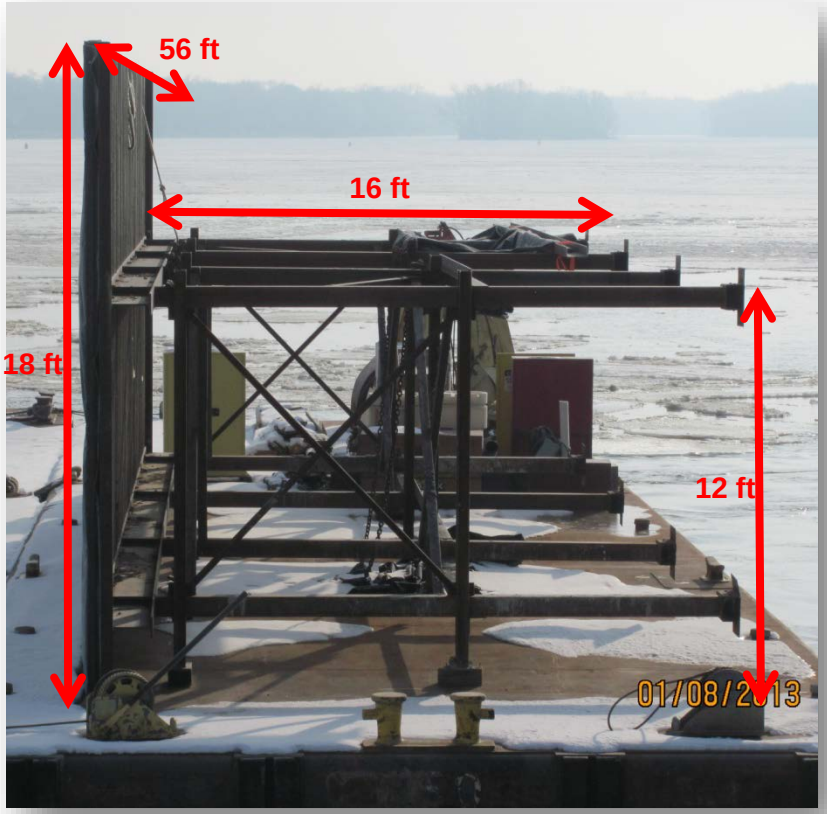
- Gate Bays requires dewatering
- Gate Closure Seal
- Downstream Pier Geometry
  - No downstream bulkhead or reaction slot
  - Ogee Dam Spillway
- Maintaining Flow Conditions





Dewatering Bulkhead Facts…

- Height of Skin Plate: 18 ft.
- Height of Frame: 12 ft.
- Width: 56 ft.
- Depth: 16 ft.
- Weight: 26,000 lbs.
- Wall Clearance: 2 in. on each side.
- Skin Plate constructed from dewatering needles.



Dewatering Procedure…

On Site Engineering…

Gate Bay 3

Gate Bay 2

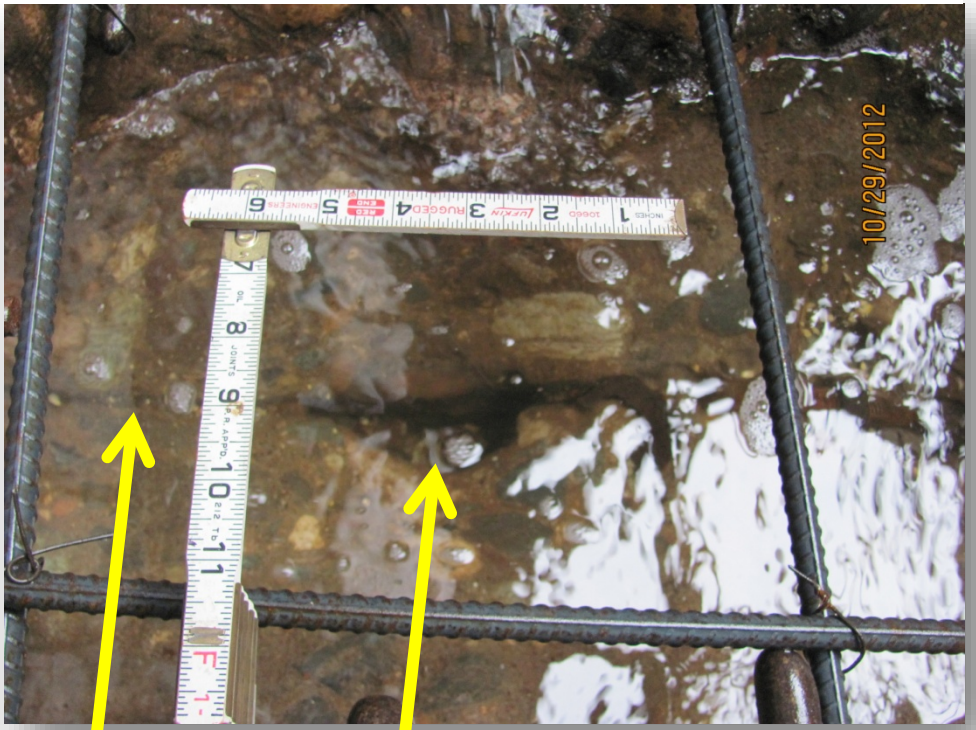
Gate Bay Inspections…

Gate Bay 3

Gate Bay 2

Gate Bay Inspections…

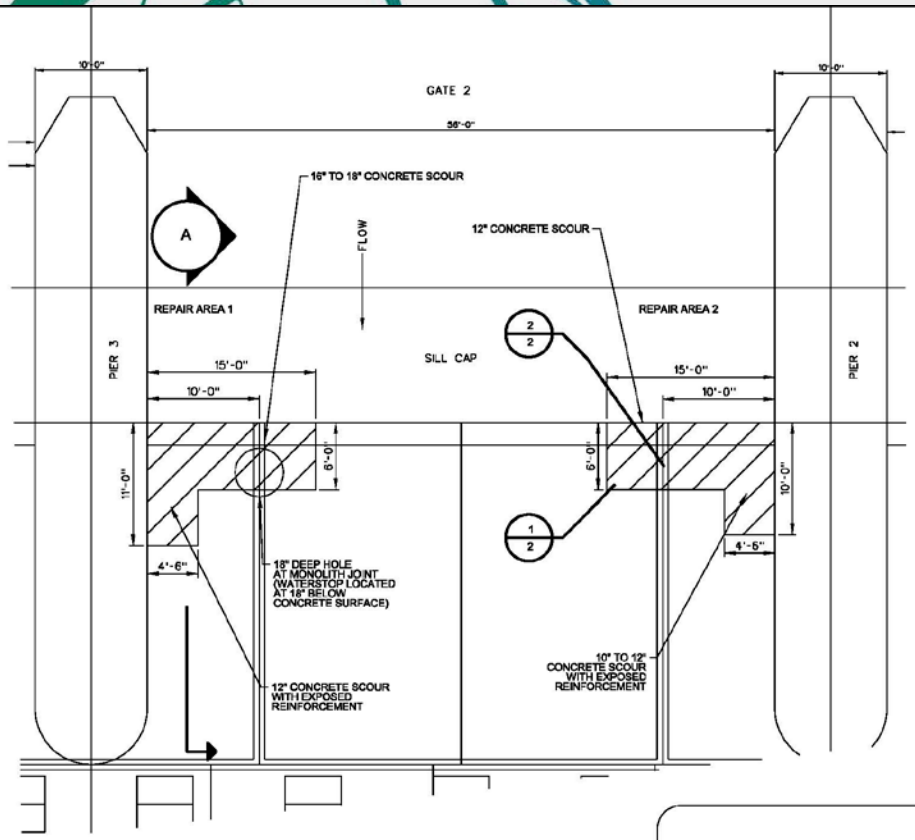
Gate Bay 3, Western Monolith Joint



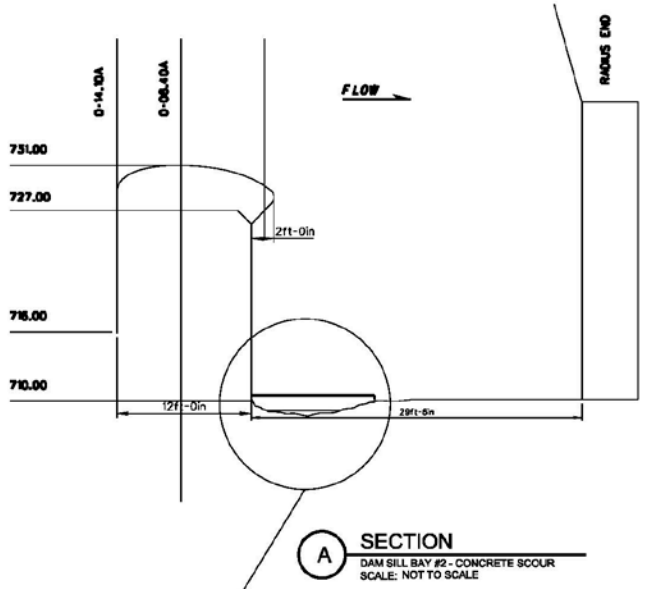
2” diameter hole

Monolith Joint

Repair Procedures…



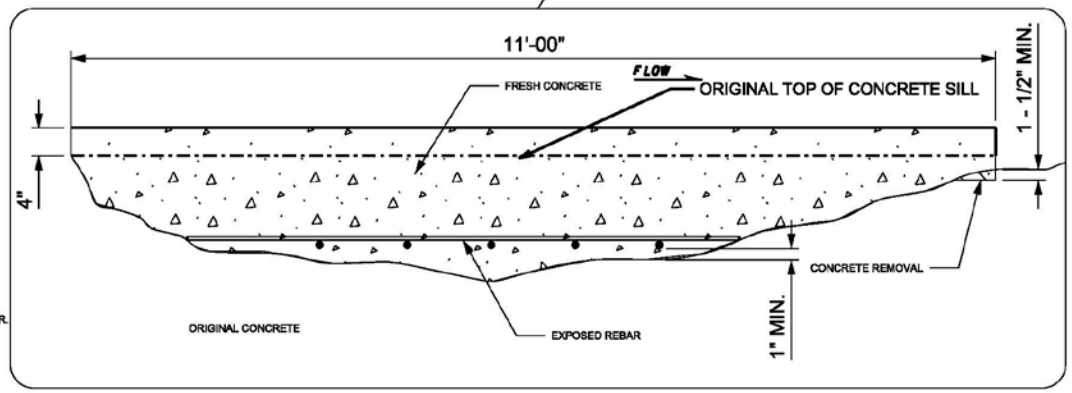
PLAN
DAM SILL BAY #2 - CONCRETE REPAIR AREAS



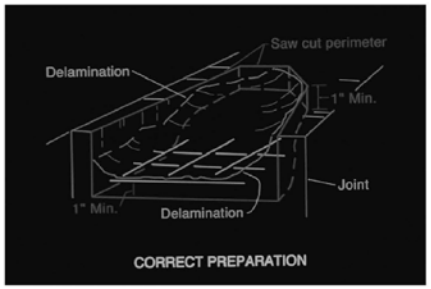
A SECTION
DAM SILL BAY #2 - CONCRETE SCOUR
SCALE: NOT TO SCALE

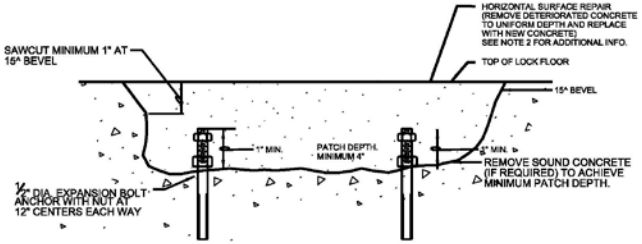
NOTES:

1. THE PERIMETER OF THE REPAIR AREA SHALL BE SAW CUT TO A MINIMUM DEPTH OF 1-1/2". IF THE SHAPE OF DEFECT MAKES IT AVISABLE, THE REMAINDER OF THE CONCRETE REMOVAL MAY BE CHIPPED BELOW THE VERITCAL SAW CUT AND CONTINUED UNTIL A HORIZONTAL SURFACE IS OBTAINED. (SEE HORIZONTAL CONCRETE REPAIR DETAIL)
2. 1/2 INCH MECHANICAL ANCHORS (WEDGE ALL) SHALL BE INSTALLED EVERY 12 INCHES ON CENTER BOTH WAYS. NOTE MECHANICAL ANCHORS ARE NOT REQUIRED TO BE INSTALLED WHERE EXPOSED REINFORCEMENT IS PROVIDED. REINFORCEMENT BARS SHOULD NOT BE LEFT PARTIALLY EMBEDDED; CONCRETE SHOULD BE REMOVED TO PROVIDE A CLEARANCE OF AT LEAST AN INCH AROUND EACH BAR EXPOSED MORE THAN 1/3 ITS CIRCUMFERENCE.
3. IF POSSIBLE CLEAN CONCRETE SUBSTRATE FREE OF DEBRIS (WATER, ICE, SAND, DUST, GARBAGE, ETC.).
4. CONCRETE MIX DESIGN ID 8036P PROVIDED BY CEMSTONE SHALL BE USED. NOTE: WHEN ORDERING CONCRETE THE ADMIXTURE Z-60 AND A VMA, PRE CEMSTONES RECOMMENDATIONS SHALL BE ADDED TO THE MIX.
6. ROUGHLY 4 INCHES OF ADDITIONAL CONCRETE IS NEEDED. THIS IS INTENDED TO PROVIDE ADDITIONAL CONCRETE COVER.
5. THE REPAIRED AREAS SHALL BE MOIST CURED FOR 3 DAYS AND NOT SUBJECTED TO TURBULENT FLOWING WATER CONDITIONS UNTIL THE END OF THE THIRD DAY. IF THE AMBIENT TEMPERATURE DROPS BELOW 40 DEGREES F THERMAL CURING BLANKETS SHALL BE PLACED ON THE REPAIRED AREAS THROUGHOUT THE CURING PERIOD.

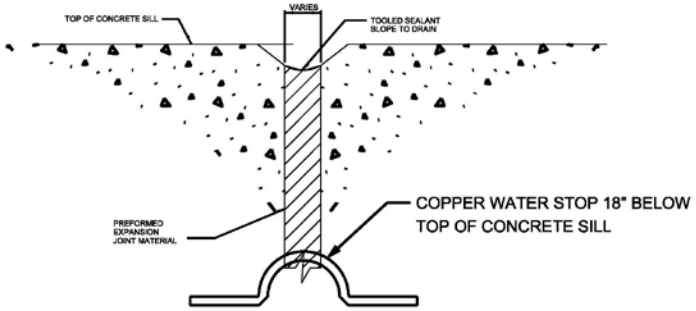


Repair Procedures…





1 TYPICAL DETAIL
HORIZONTAL CONCRETE REPAIR - (WHERE REINFORCEMENT IS NOT PRESENT)
SCALE: NOT TO SCALE



2 TYPICAL DETAIL
HORIZONTAL MONOLITH EXPANSION JOINT
SCALE: NOT TO SCALE

GENERAL INFORMATION			
Date:	7/14/2013		
Project:	LSAF - Dam Sill Repair		
Application:	Exterior - Dam Sill		
Contractor:	M & R		
Computed By:	Ready Mix Supplier		
MIX DESIGN			
		w/c =	0.38
Materials	ASTM	lbs	Vol (ft^3)
Portland Cement - Type I/II	ASTM C 150	670.00	3.41
Silica Fume (5% Replacement)	ASTM C 1240	54.00	0.38
Coarse Aggregate - 3/4 inch (Granite)	ASTM C 33	1605.00	9.42
Fine Aggregate	ASTM C 33	1320.00	7.95
Water		275.00	4.41
Air Entrainment	ASTM C 260	1.5 oz.	1.63
HRWRA - Type F	ASTM C 494	36 oz.	(5.0 oz./cwt)
MRWRA - Type A	ATSM C 494	22 oz.	(3.0 oz./cwt)
CHECK			
	Total Volume	26.90	ft^3
	Unit Weight	144.20	pcf
MIX DESIGN SPECIFICATIONS			
Placement Temperature	55 - 65	°F	
Water - Cementitious Ratio (w/cm)	0.38		
Slump	4 to 6	inches	
Air Content (ASTM C 231)	4.5 - 7.5	%	
28 Day Compressive Strength (ASTM C 39)	6000	psi	
NOTES:			
1. Surfaces to receive concrete shall be clean, damp and free from frost, ice, mud, loose particles, foreign matter, and water.			
MATERIAL VOLUME			
1st Lift	Order	13.00 cy	

NOTES:

1. WHEN ORDERING CONCRETE SPECIFY MIX ID #: 6036P, YARDAGE, AND ADMIXTURES Z-60 AND VMA PER CEMSTONES RECOMMENDATIONS.
2. EXPANSION JOINTS SHALL BE FORMED AND PLACED TO MATCH EXISTING SEE TYPICAL DETAIL #2 FOR MORE IMFORMATION. IF EXPOSED THE WATER STOP SHALL BE INSPECTED BY ENGINEERING.
3. ANCHOR BOLTS SHALL BE INSTALLED 12 INCHES ON CENTER BOTH WAYS WHERE EXPOSED REINFORCEMENT IS NOT PROVIDED. SEE TYPICAL DETAIL #1 FOR MORE IMFORMATION.

CONTACT INFORMATION:

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EMAIL: jacob.l.fall@usace.army.mil

Gate Bay Repair Procedures…

Gate Bay 3

- 4” wide by 2” deep trench was cut into the concrete.
- ½” anchor bolts were installed 12” on center both ways.
- All missing reinforcement was replaced.
- Each repair formed 4” above original concrete surface.
- The surface was cleaned.

Concrete Placements…

Three concrete placements occurred.

- Oct. 19th – Gate Bay Two – 13 cubic yards
- Oct. 29th – Gate Bay Three – 13 cubic yards
- Nov. 9th – Gate Bay One – 26 cubic yards

Mix Design – High Early Strength

Concrete Placements…

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MATERIAL VOLUME

1st Lift Order 13.00 cy

Concrete Placement…

Concrete Placement – Gate Bay Two

Concrete Placement – Gate Bay Two

Area 1

Area 2

Concrete Placement – Gate Bay Three

Concrete Placement – Gate Bay Three

Area 1

Area 2

Concrete Placement – Gate Bay One

Curing Procedures…

- Moist Curing was applied to each repair according to ACI 308R Guide to Curing Concrete.

Gate Bay 1

Curing Schedule…

- The curing schedule was established based on…
  - ➢ The Concrete Mix Design.
  - ➢ The minimum compressive strength of 6000 psi at 28 days.
- 3 days – 50% of minimum design strength
- 7 days – 75% of minimum design strength
- 14 days – 100% of minimum design strength

Concrete Placement – Compressive Strength

Tested Compressive Strength

- 7 day – 5040 psi
- 14 day – 6365 psi
- 28 day – 7540 psi

Minimum Design Strength 6000 psi at 28 days

Construction Schedule…

- Recommended for Repair 2005.
- Design started January 2009.
  - Final Bulkhead Drawings June 30, 2011.
- Dewatering bulkhead constructed within 1 week in 2012.
- On-site construction 32 days, October 16th – November 16th, 2012.

Construction Cost…

Item(s)	Cost($)
Crane Barge	55,500
Construction – Dewatering Bulkhead	14,000
Cast in Place Concrete	12,000
Travel, Labor, Supplies, and Materials	250,000
Total Cost	**$331,500**

Recommendations…

- Dive Inspection Schedule
  - ➢Initial 6 month dive inspection
  - ➢Periodic Dive Inspection every 5 years
- Up front coordination and communication between….
  - ➢Engineering and Design
  - ➢Locks and Dams / Operations
  - ➢Maintenance and Repair / Contractor

Conclusion …

- This was a unique, challenging, and successful project.
- The success of this project was the result of several key factors including:
  - historically low flow conditions
  - a unique dewatering box that was designed and constructed specifically for this project
  - an effective surface preparation, concrete placement, and curing procedure

Conclusion Continued…

Communication

- Locks and Dams / Operations
- Maintenance and Repair / Contractor
- Engineering and Design

Questions…

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If you have any questions, please feel free to contact me.