

# Markland 1200' Gate Replacement and Wall Quoin Refurbishment

July 11 – November 17 2011

Craig Moulton and Kevin Vessels  
Louisville District



US Army Corps of Engineers  
**BUILDING STRONG**®



# Markland Locks and Dam

- 110' X 1200' Main Chamber
- 110' X 600' Auxiliary Chamber
- 12 - 100' Wide Tainter Gates
- Hydropower Plant
- Went into service in 1963



# Lifting Lugs for Existing Leaves



New lifting lugs for gate tie into the second girder



# Removal of Existing Gate Leaves



Lifting the existing gate leaves in the wet



# Drop-Off Existing Leaves for Storage and Retrieve New



Laydown the old gate at McAlpine and pick up the new gate



**BUILDING STRONG®**

# Miter Gate Machinery

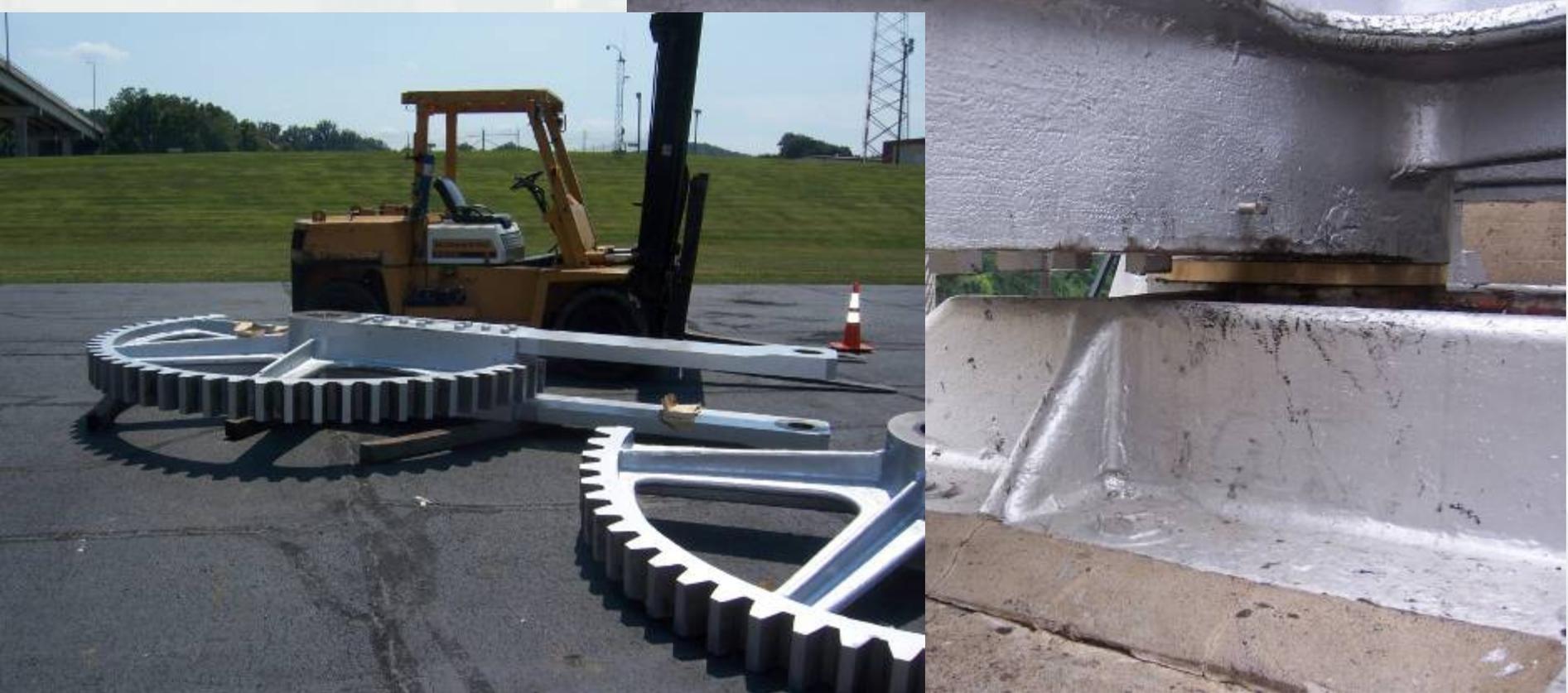


Miter gate machinery operating radius was changed to improve operating conditions



**BUILDING STRONG®**

# Miter Gate Machinery



Supplied sector arms had to be machined to fit with existing sector gear



**BUILDING STRONG®**

# Miter Gate Machinery

Other modifications



Final Machinery Angle



# Checking Fit on the New Gate



New ASTM A709 anchor arms.  
Designed using original style  
wedges and anchorages



**BUILDING STRONG®**

# Fit Problems



New miter gate was very tight to the wall quoin, similar to the existing miter gate. However, with the new adjustment wedges on the gate, this would not work



# Tensioning Diagonals



Rob Kelsey and Tom Ruf from MVS provided their expertise with tensioning the diagonals



**BUILDING STRONG®**

# Seal Modifications



Transition from vertical to horizontal seal was in the wrong location. The sill was modified from the original drawings by Operations.



**BUILDING STRONG®**

# Seal Modifications Heel



Constructed new seal supports  
from the existing sill.



**BUILDING STRONG®**

# Seal Modifications Toe



When the sill was modified by Operations, the curved section at the toe was replaced by a straight section to avoid complications with fabricating the curved horizontal sill piece.



# Seal Modifications Toe



Toe section was fabricated similar to the heel. Had to modify other, minor parts of the seal also.



# Remove the New Gate



Had to rewater chamber. Had to save all pins to reuse them



**BUILDING STRONG®**

The chamber was dewatered again and we started cutting out the lower old pintle bases. It took a combination of air arcing, core drilling and diamond wire sawing to remove them.



## Horizontal and vertical core drilling



**BUILDING STRONG®**

Diamond wire fed in behind the pintle base after air arcing and core drilling



**BUILDING STRONG®**

# Diamond wire saw



**BUILDING STRONG®**

First time we tried to save as much rebar as we could. Decided on the upper end to remove and reinstall it all.



**BUILDING STRONG®**

Ended up with this after chipping the rest of the concrete away.

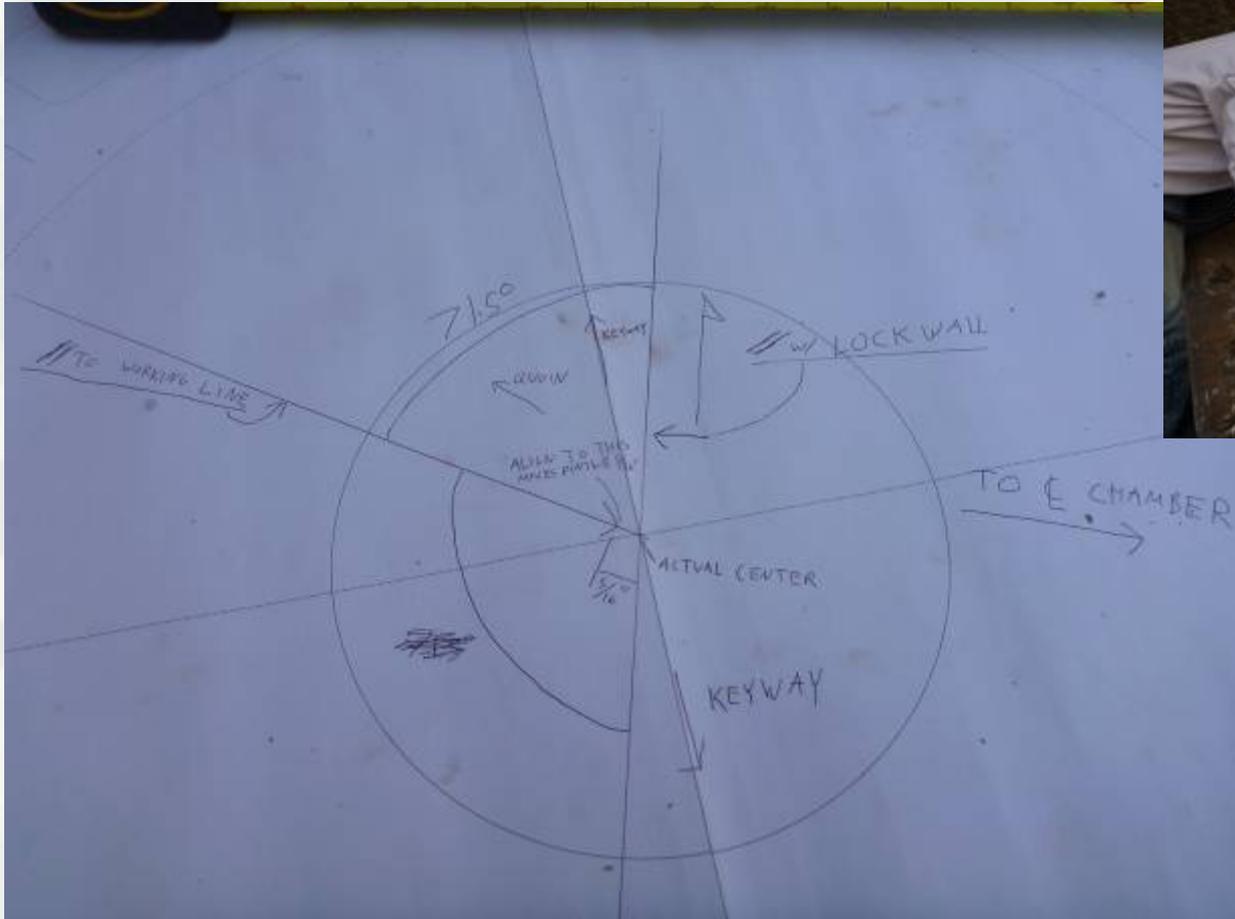


**BUILDING STRONG®**

Prior to removing the pintle bases we surveyed in base lines so we would always know where the centerline of the pintles were originally. We used the baselines to move the pintles 5/16”.



# Pintle Base Template



Used transit and life-size print of pintle base to move it  $\frac{5}{16}$ " along working line



# Drilling template for pintle base bolts



**BUILDING STRONG®**

# Pintle base bolts with pintle base leveling nuts and washers



Pintle base set, anchored and ready for concrete.



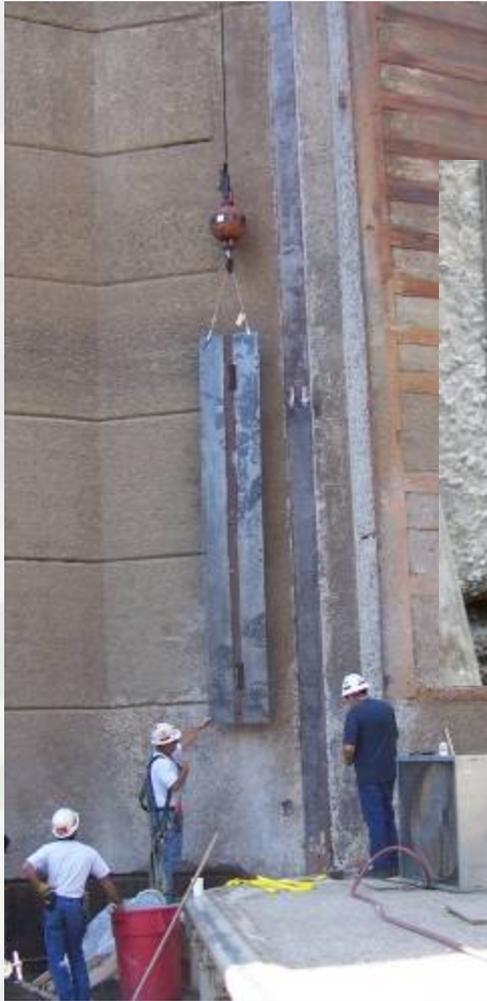
**BUILDING STRONG®**

# Finished Product



**BUILDING STRONG®**

# Climax Milling Machine Setup



Drilling templates were supplied to drill the mounting holes for the Climax beds



**BUILDING STRONG®**

# Setup



Hamar laser system was supplied for aligning the beds. LRS had to create plates and method for aligning laser to wall quoin. Hamar system had issues with daylight.



# Setup



Alignment process was repeated for every bed section.



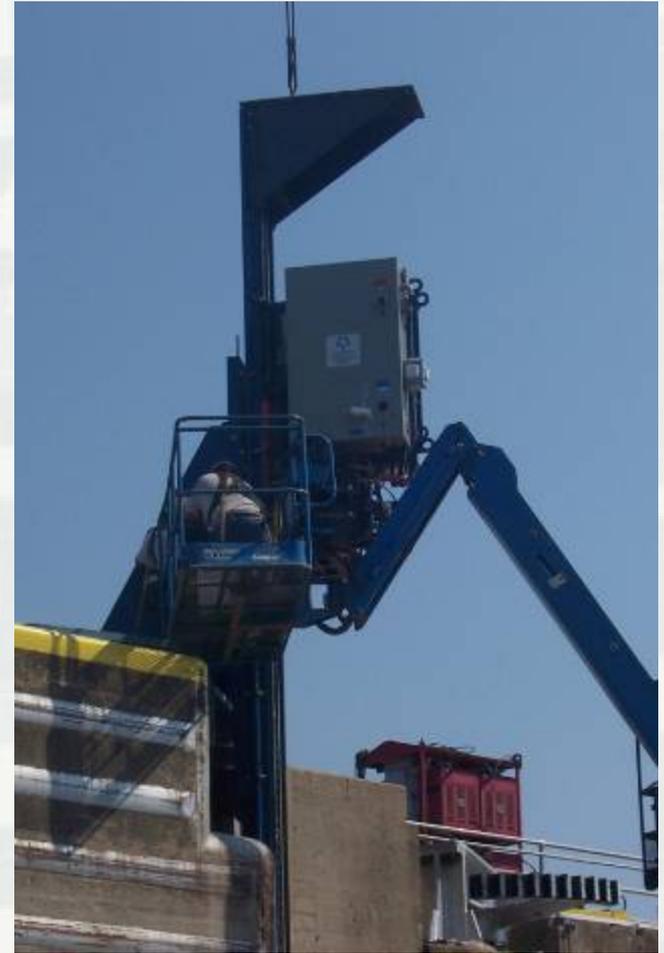
# Setup



Climax supplied bracket and plate for extension above the wall quoin. LRS had to supply the lower extension bracket. The mounting plate needed to be aligned to the beds already mounted to the wall.



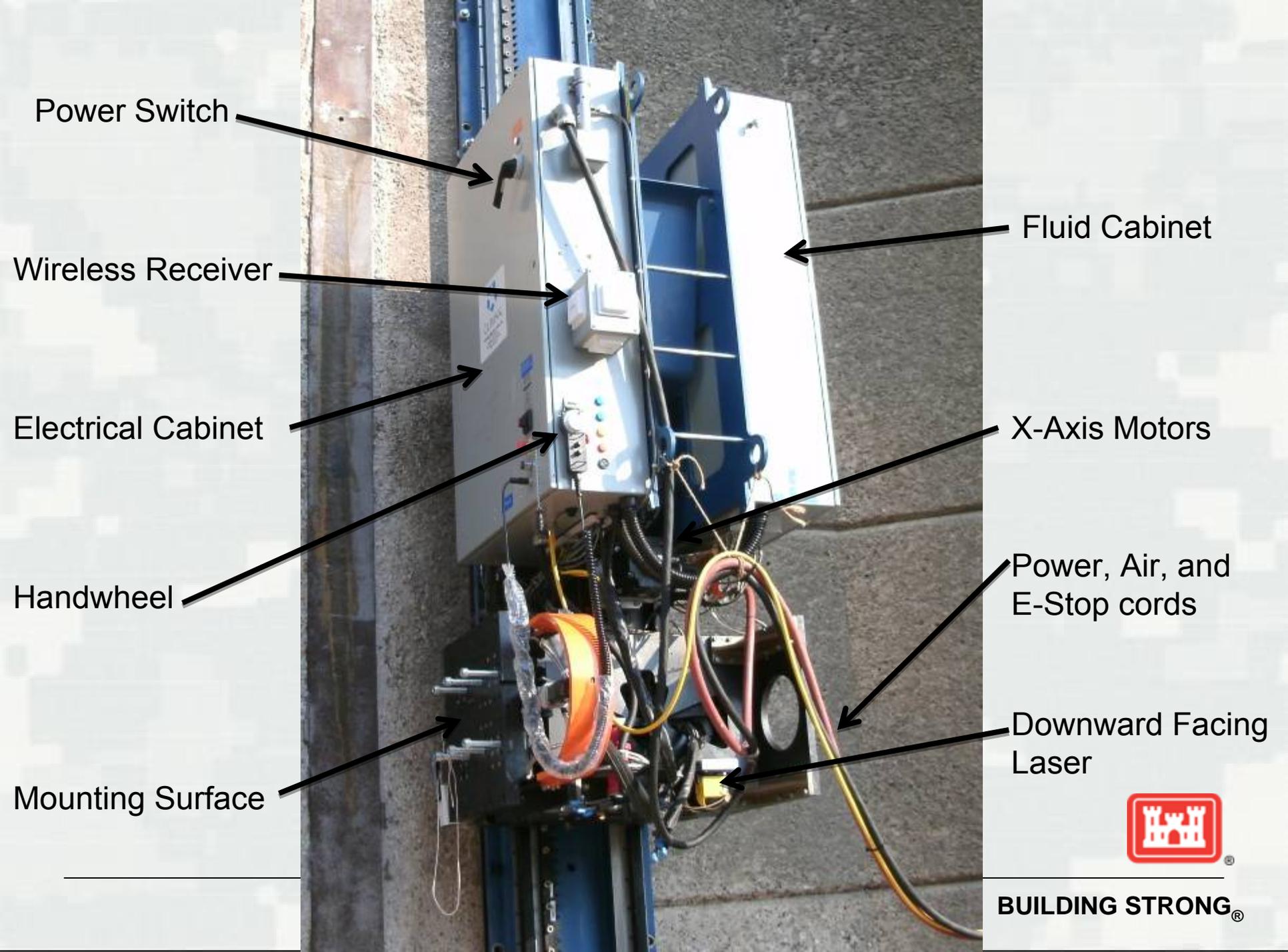
# Setup



LRS designed lifting bracket to remove the Climax Machine from the box, stand it up, and mount it on the top of the wall.



**BUILDING STRONG®**



Power Switch



Fluid Cabinet



Wireless Receiver



X-Axis Motors

Electrical Cabinet



Power, Air, and E-Stop cords

Handwheel

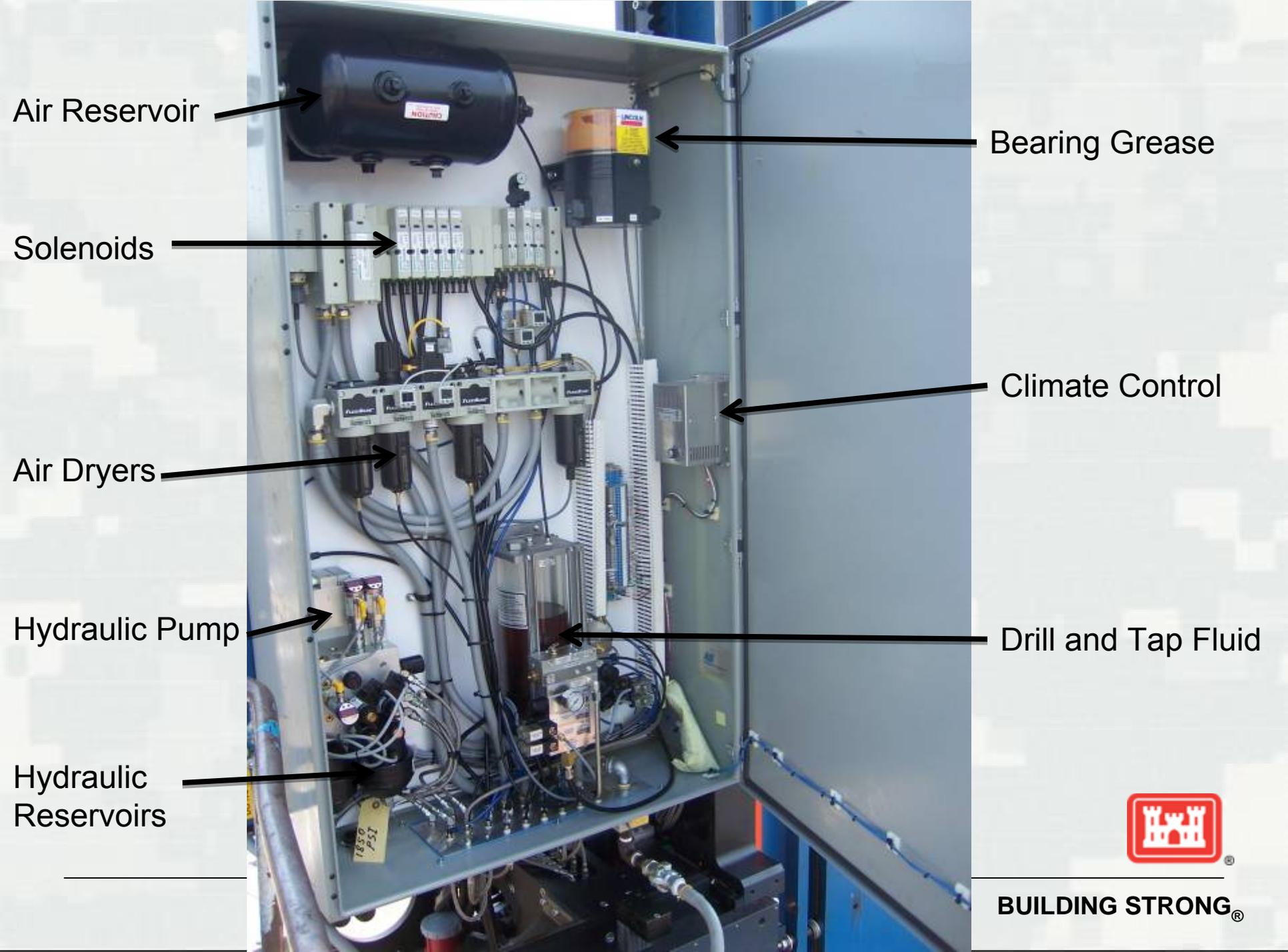


Downward Facing Laser

Mounting Surface



**BUILDING STRONG®**



Air Reservoir



Bearing Grease



Solenoids



Climate Control



Air Dryers



Drill and Tap Fluid



Hydraulic Pump



Hydraulic Reservoirs



**BUILDING STRONG®**

# Milling



5" milling head for most of the quoin. Offset adapter and 1" milling head to get as low as possible.



**BUILDING STRONG®**

# Milling Problems

- Programming
  - ▶ Caused many shutdowns and restarts
  - ▶ Issues mainly with tool changes and restarting milling after breaks
  - ▶ Climax came on-site in winter and fixed the issues
- Air Supply
  - ▶ Had water and pressure problems



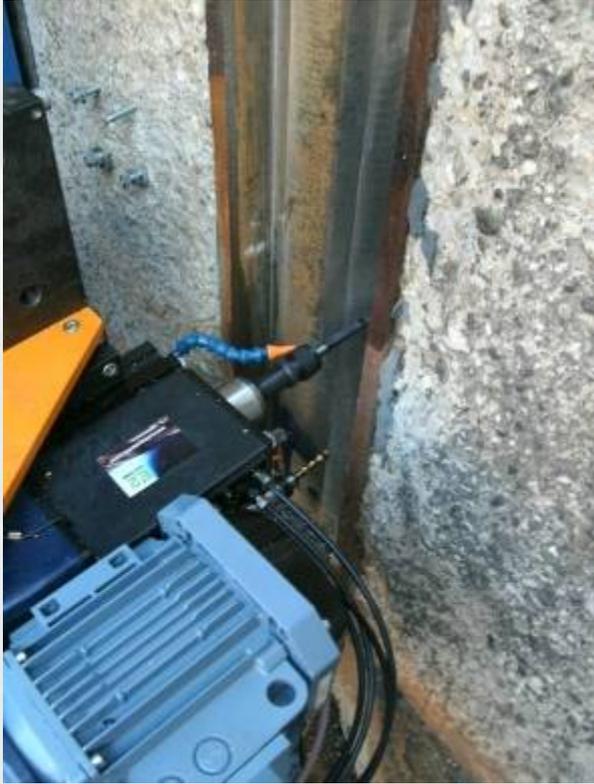
# Milling Problems



Quoin was worn on the downstream edge at the bottom. This caused a misalignment of the laser plate that set the “twist” of the milling machine. Therefore, the milling machine ended up cutting the quoin on a slant. In the future, “twist” should be set from the top of the quoin.



# Drilling and Tapping



Went very smoothly. Could drill and tap all but one hole.



**BUILDING STRONG®**

# Finished Quoin Channel



**BUILDING STRONG®**

# New Wall Quoin Blocks



A36 steel blocks with 304 stainless, explosion clad onto it. Designed to simultaneously minimize corrosion of embedded steel and wear surface.

Lessons Learned:

- Need to tolerance total length of blocks
- Need to add spec on total bow of block



# Quoin Block Installation



**BUILDING STRONG®**

# Quoin Block Adjustment



Used string-line to adjust wall quoins to original position.



**BUILDING STRONG®**

# Quoin Block Backing Material



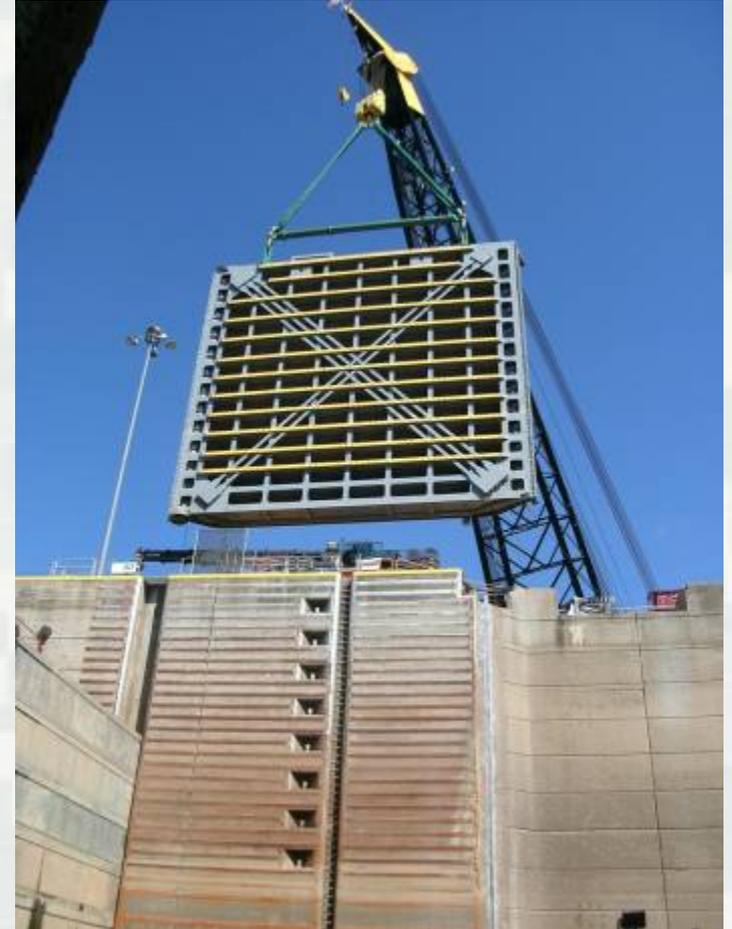
1/2" pipe had too much friction for Copps



Funnels worked well, just had to wait for lower section to dry



# Setting the Gates Over the Wall



Developed new method for setting gate in the dry.  
Will save 1 week per gate movement.



**BUILDING STRONG®**

# Gate Adjustments



Wedge adjustment system allowed only  $\frac{1}{2}$ " total adjustment. Developed new adjustment method to prevent removing the blocks to add shims.



**BUILDING STRONG®**

# Gate Adjustments



There was a pre-existing problem with the gate leaves that caused the quoin blocks to be adjusted all the way in and 1" larger miter blocks to be installed. The wedge adjustment system did not have a large enough adjustment range to accommodate this even after we moved the pintles. The quoin blocks had to be sent to a contractor to be milled. To install shims behind the miter blocks, the blocks had to be completely removed.



# Gate Adjustments



Could not adjust bottom quoin block out to wall quoin. Used polymer steel to fill the gap.



**BUILDING STRONG®**

# Gate Stop Modifications



Designed gate stop was in the wrong position



# Gate Stop Modifications



# Upper Recess Latches



No upper recess latch  
designed with gate



**BUILDING STRONG®**

# Lower Recess Latch



Original gate latch was welded to fit. The upper end had modifications done that were not transferred to the new gate.



# Walkway Modifications



Walkway was too big to fit with the existing supports and concrete.



**BUILDING STRONG®**

# Walkway Modifications



# Quoin Block Measurement



After the lower end measurements did not work well, needed an accurate system for the upper end.



# Lessons Learned

- Small steps add up to a lot of time
- Repair methods should be planned out fully ahead of time, accounting for “what-ifs”
- Better maintenance records
- More time to review drawings for details
- Need more adjustment in contact blocks



# Where We Are Now

- Lower end complete
- Upper end needs the gate quoin blocks installed and adjusted
- Going back June 18<sup>th</sup> – September 4<sup>th</sup> to remove the upper gate, mill the wall quoins, and reinstall the gate



# Questions?



---

**BUILDING STRONG®**