CEMVN-ED-T 14 OCT 2016

MEMORANDUM FOR Chief, Regional and Environmental Planning Division-South (CEMVN-REPD/Troy Constance)

SUBJECT: IHNC Lock Replacement General Re-evaluation Report, Engineering Assessment of the Existing Lock Structure

1. This memo details the current condition/deficiencies of the existing IHNC lock structure and components. The information provided is based on the latest periodic inspection report, "*IHNC Lock, Periodic Inspection No. 11*", dated 25 April 2014. In addition, some information was also taken from the report entitled, *"Operational Condition Assessment (OCA)"*, from inspections performed in 2010 and 2015.

2. The Inner Harbor Navigation Canal (IHNC) Lock was constructed by the Board of Commissioners, Port of New Orleans. Construction began in May 1918 and was completed in February 1923. The lock is classed as a ship lock, and is located in the East Bank, Mississippi River Levee, at the riverward end of the Inner Harbor Navigation Canal. The lock and canal connect the Mississippi River with the Gulf Intracoastal Waterway, Lake Pontchartrain. The lock also prevents the flooding of low areas east of the structure and provides passage of waterway traffic during high water stages of the Mississippi River. The U.S. Army Corps of Engineers, New Orleans District, began operating the lock in 1944.

3. During Periodic Inspection (PI) No. 11, engineers performed a close visual examination of the lock. A total of thirty-three (33) deficiencies were found requiring a remedial action. Presented below are the major inspection findings included within the PI report, requiring immediate attention. Pictures of these items are included within Encl. 1, attached to this memo. The deficient items are, but not limited to:

a. Spalling concrete and exposed, corroded steel reinforcement.

b. Complete corrosion on the flanges of structural support members.

c. Deterioration of the concrete columns and beams in all machinery rooms (including complete corrosion of the reinforcing steel). Machinery Rooms 9 and 10 are considered a safety hazard and are closed to all personnel.

d. Corrosion of the dewatering bulkheads.

- The PI report concluded the following about the structure condition: The 93-year-old IHNC Lock continues to function for its design mission, providing navigational traffic between the Mississippi River and Lake Pontchartrain; however, its advanced age is making that more difficult the longer it remains in service. Though the lock is stable

and operationally adequate, its condition is very poor. Operations Division is currently replacing electrical and mechanical components, which should extend the operation for several more years until the entire lock can be replaced. In addition, the lock walls are currently 0.8 feet deficient based on the 1973 MR&T Flow Line Report.

4. The OCA assessment noted similar deficiencies as the PI Report including:

a. Spalling of concrete in various locations.

b. Corroded sheet pile on the Northeast dolphin, resulting in loss of fill material.

c. Damaged/deteriorated timber guide walls.

- As noted in the OCA reports, operational restrictions have been put into effect in some locations to prevent complete failure of components. Within the OCA reports, items given an "F" rating indicate failure or imminent failure requiring immediate funding and repair. The most noted deficiency was spalled concrete with exposed steel reinforcement. Comparing photos from previous reports, the spalling of the concrete has further deteriorated.

5. The IHNC Lock is currently undergoing an unwatering event. During this event the machinery, electrical, and miter gates (1, 2, 7, & 8) are being replaced. This will give the lock additional years of operation, but does not address the main structural deficiency which is spalling of concrete, and replacement of steel reinforcement, which could lead to problems in the future.

6. Additionally, it should be noted that the existing lock is not designed for an unwatering load case. An unwatering event results in unacceptable safety factors for flexure and flotation in the chamber. The lock was designed using obsolete codes, and the reinforcement is inadequate for modern concrete design. Currently, extensive monitoring is required during an unwatering, but continued deterioration of the concrete and steel reinforcement may preclude future maintenance unwatering of the chamber.

7. Based upon the PI, the OCA Rating Reports, and the stability of the lock during an unwatering event, it is concluded that the overall condition of the existing lock is poor. There is significant wear of the concrete and steel reinforcement due to the age of the structure. Due to the continued deterioration of the structure, maintenance unwatering will eventually be unsafe without extensive retrofit of the existing structure. Retrofit of the existing lock will be costly and create additional delays to navigation. Based upon the vast amount of deficiencies, replacement of the lock is recommended.

8. The POCs are Mr. David Lovett, P.E., Supervisor, x2680, and Mr. Jeremy Laster, x1590 Structures Branch.

JEAN S. VOSSEN, P.E.
Chief, Engineering Division

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PD (Sean Mickal)
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OD-H (Landry)

Enclosure 1 – Pictures of Structural Deficiencies

Structural

Inspector: Carl Balint (Structural Engineer)

- Lock/Lock Structure/Lock Walls & Other Lock Structures/Nose Pier Downstream Auxiliary/Deterioration, Stability, and Structural (Foundation is not visible being below the water line.)

IHNC Dolphin NE-1-1.jpg

IHNC 24 Aug 16 NE Dolphin-2-82.jpg

IHNC 24 Aug 16 NE Dolphin-3-83.jpg

IHNC 24 Aug 16 NE Dolphin-4-84.jpg

Observation/Comment: Carl Balint (Structural Engineer), Richard McKenzie (Lock Master), Vic Landry (IHNC Project Manager/Engineer)

Has the component completely failed? No

Does a critical design flaw exist? No

Does the component have observed or documented deficiencies? Yes

Loss of fill that is the center of the stability of the structure. 100% section loss of interlock metal (sheetpile) mainly in the splash zone going down below the water surface.

Is the deficiency significant? Yes

The component exhibits a clear mode of failure: The corroded sheet pile below the pile supported concrete inner wall is allowing the stability fill to spill out into the water. The result is loss of impact resistance.

Does the current state of the component violate the law? No

Is the component likely to fail within the next rating cycle? Yes

The component has already failed. With the loss of stability fill through the corroded sheetpile, it will not sustain impact. If it sustains a vessel impact, it will fail and crumble into the channel. Failure of the nose pier will expose the guard wall to head on vessel impacts, which it is not designed for. Because of the narrow width of the lock chamber (74') and the maximum width of barge tows that travel through the lock (70'), it's highly likely a vessel impact will occur in the future.

Rating: F

Structural

Inspector: Anthony Gallodoro (Civil/Materials Engineer)

- Lock/Lock Structure/Lock Walls & Other Lock Structures/Land and River side Wall Primary/(The following rating logic applies the Deterioration and Structural sub-components)

Spalding concrete and exposed rebar on corners of gate bays and top edge of lock wall deck, image is of east wall gate recesses but is typical of all eight gate recesses.

Deck support column in NW machinery room.

Underside of concrete deck in a machinery room in the west wall.

Pictured are main gate and reverse head gate strut arm openings on NW side of chamber that support the edge of the lock wall deck. These two pictures are typical for all eight machinery room/strut arm openings and show severe spalding exposing the rebar support system.

Steel beam and steel support column placed to reinforce failing concrete deck beam.

Spalding concrete and exposed rebar in machinery room on underside of lock's west wall deck.

Spalding concrete and exposed rebar in machinery room on underside of lock wall deck.

Observation/Comment: Anthony Gallodoro (Civil/Materials Engineer), Richard McKenzie (Lock Master), Vic Landry (IHNC Project Manager/Engineer)

Has the component completely failed? No

Does a critical design flaw exist? No

Does the component have observed or documented deficiencies? Yes

Columns and beams in each of the machinery rooms exhibit severe spalling of concrete to point of exposing rebar. The steel reinforcing is severely corroded exhibiting significant section loss and some locations the rebar is completed corroded and missing. Additionally, spalling and corrosion is also present in walls, floor and ceilings of the tunnels and machinery rooms.

Reference attached document IHNC Lock PI No 11.pdf.

Is the deficiency significant? Yes

The component exhibits a clear mode of failure: Reinforcing steel in columns and beams is severely corroded exhibiting significant section loss and some locations the rebar is completed corroded and missing. As a result, the capacity of these components is reduced. If the columns or beams were to fail, the result would be damage to the operating machinery causing a shutdown of the lock. Due to the reduced capacity, operational restrictions have been put into effect at the lock to prevent significant live loading above the machinery rooms.

Safety Concern: If one of these beams fail while someone is in the machinery room or walking on the lock wall above the failed area, severe injury or death could occur.

Does the current state of the component violate the law? No

Is the component likely to fail within the next rating cycle? No

Is the life safety of site staff or the end user critically affected by the condition of the component? No

D

Rating: D

Structural

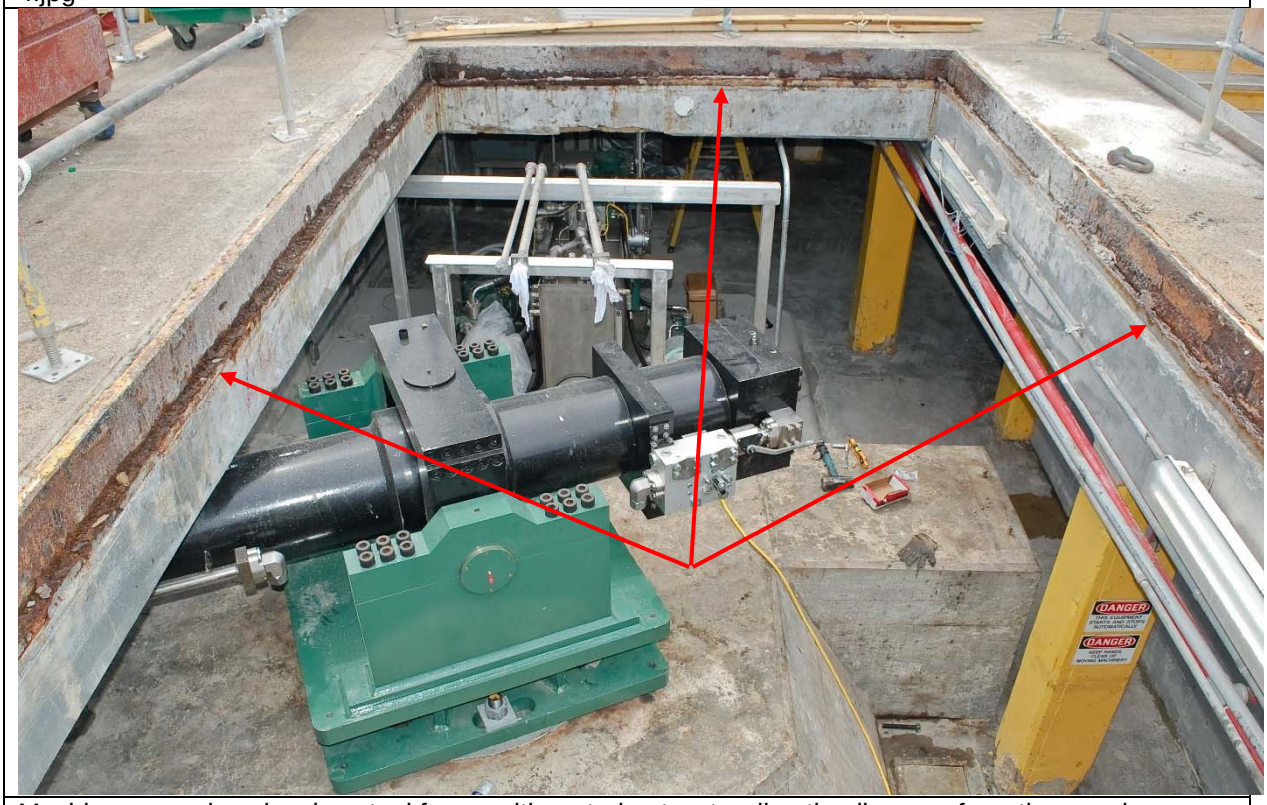
Inspector: Anthony Gallodoro (Civil/Materials Engineer)

- Lock/Lock Structure/Misc Lock Wall Features/Grating-Cover Plates Primary/Concrete Cover Plates

Corroding I-beams supporting hatch cover also showing section loss of beams and hatch recess steel frame. IHNC Lock Photo 04-23-2014No Structure020-1.jpg

IHNC Lock Photo 04-23-2014No Materials070.jpg

Leaking water collecting in oil retention basin. IHNC 09 Sep 16 Dewater Machinery New Flooded-2-4.jpg



Machinery opening showing steel frame with rusted out water diverting lip gone from the opening recess. IHNC 24 Aug 16 Dewater Gate 7 Cylinder New-7-7.jpg

Observation/Comment: Anthony Gallodoro (Civil/Materials Engineer), Richard McKenzie (Lock Master), Vic Landry (IHNC Project Manager/Engineer)

Has the component completely failed? No

Does a critical design flaw exist? No

Does the component have observed or documented deficiencies? Yes

Cracked and spalled concrete hatch covers, rusted out steel frames with significant and missing section loss.

Is the deficiency significant? Yes

The component exhibits a clear mode of failure: The cracked covers and leaking frames is leading to increased section loss of frames and increasing risk of cave-in.

Project Functionality Affected: There is water leaking in through all of the deficient hatch covers creating maintenance issues such as having to manually clean out oil containment basins under the machinery.

Safety Concern: Loads have been limited over some hatch covers due to their weakened condition/state.

Does the current state of the component violate the law? No

Is the component likely to fail within the next rating cycle? Yes

The hatch covers were designed to prevent water from leaking unto the critical machinery components in the machinery rooms, which are sensitive to moisture. Many of the hatch covers have already failed in keeping water out, some are incapable of carrying a load across their surface and others are in various states of distress.

Photo 3 Spalling, cracks, and exposed steel in the wall below stairs between gates 7 and 9 on northwest side of lock.

Photo 4 Spalling and exposed steel in the wall below stairs between gates 7 and 9 on northwest side of lock.

Photo 5 Large spalls and cracked concrete with exposed steel on the northwest side near hinge for gate 9.

Photo 6 Large spalls and cracked concrete with exposed steel on the northwest side near hinge for gate 9.

Photo 7 Spalls in the northeast corner of the northwest gatebay

Photo 8 Spalls in the northeast corner of the northwest gatebay. Appears to be new.

Photo 9 Spalling with exposed steel in the northeast gatebay near the hinge

Photo 10 Spalling with exposed steel in the northeast gatebay near the hinge

Photo 11 Spalls in top of the west chamber wall near control house.

Photo 12 Spalls in top of the west chamber wall near control house.

Photo 15 New spall with exposed steel in top of west chamber wall.

Photo 16 Spall in top of west chamber wall near light pole number 9.

Photo 21 Delamination (2’x1’) along edge of west chamber wall.

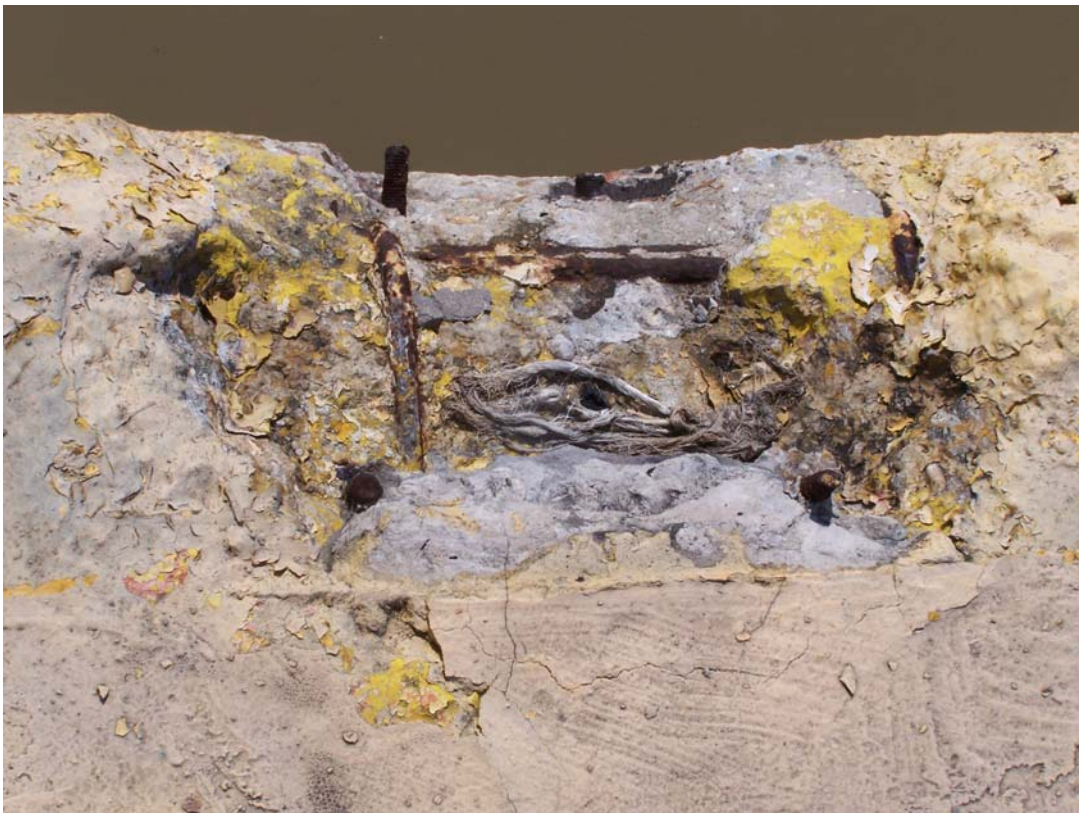


Photo 22 Large spall with corroded steel on top west chamber wall.

Photo 23 Hatch cover behind the west chamber wall near reference marker 8W.

Photo 24 Hatch cover behind the west chamber wall near reference marker 8W.

Photo 25 Hatch cover behind the west chamber wall near reference marker 8W.

Photo 26 Large shallow spall with a failing patch in top of west chamber wall.

Photo 27 Spall in top of west wall near the hinge for the river side gate.

Photo 28 Spall in top of west wall near the hinge for the river side gate.

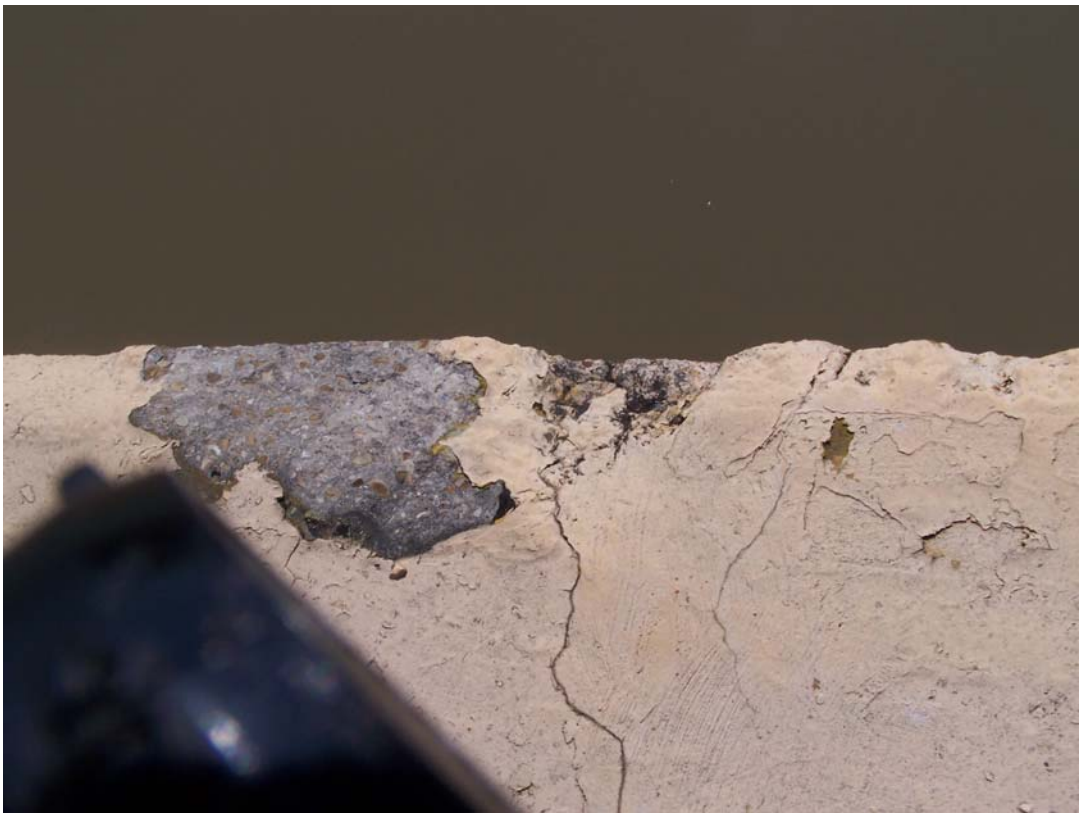


Photo 31 Spalls in west river side gatebay.

Photo 32 Spalls in west river side gatebay.

Photo 33 Failing patch material around the steel plate over the bulkhead recess on the west river side.

Photo 34 Spalls with exposed steel on the east wall on river side near the gate for the bridge.

Photo 37 Spall with corroded steel at the bottom of a column in machinery room #3.

Photo 38 Large spall with exposed steel near the hinge for Gate 3.

Photo 39 2’x2’ delamination in the floor under the 480V distribution panel near Gate 3 hinge.

Photo 40 Spalled beam near valve 11. Bottom steel and spiral wire severely corroded.

Photo 41 Spalled beam near valve 11. Bottom steel and spiral wire severely corroded.

Photo 42 Popout in beam near valve 11 caused by corroding steel.

Photo 43 Popout in ceiling near valve 11 caused by corroding steel.

Photo 44 Spalls in ceiling near valve 11 caused by corroding steel

Photo 45 Spalls in ceiling near valve 11 caused by corroding steel. Further deterioration since last inspection.

Photo 46 Popout in ceiling near valve 11 caused by corroding steel.

Photo 47 Spalls and delaminations at bottom of columns on both sides of hinge for gate 1.

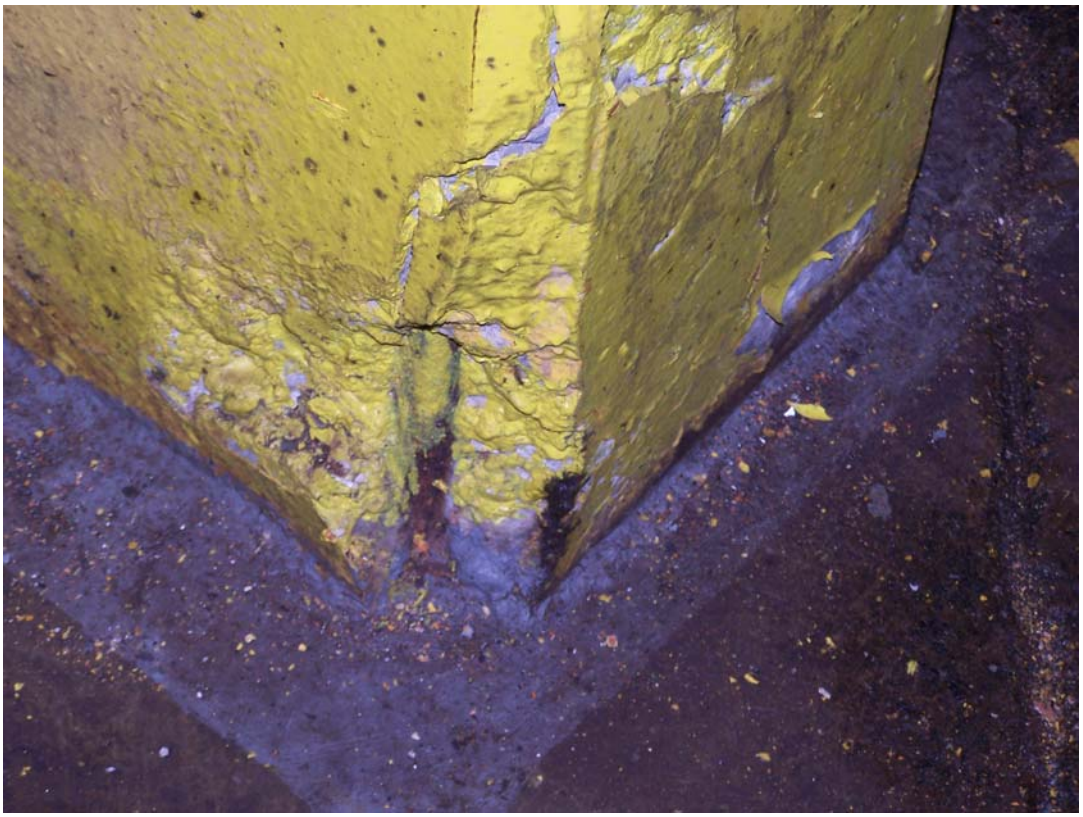


Photo 48 Spalls and delaminations at bottom of columns on both sides of hinge for gate 1.

Photo 49 Spalls and delaminations at bottom of columns on both sides of hinge for gate 1.

Photo 50 Spalls and delaminations at bottom of columns on both sides of hinge for gate 1.

Photo 51 Popout in beam over gate 1 hinge.

Photo 52 Popout in beam over gate 1 machinery.

Photo 53 Popout in beam over valve 12 caused by corroding steel.

Photo 54 Delaminated area in ceiling over valve 12.

Photo 55 Spalling with corroded steel in ceiling over gate 3 machinery.

Photo 56 Spalling with corroded steel in ceiling over gate 3 machinery.

Photo 57 Spalls caused by corrosion of steel at the bottom of the wall in room 3.

Photo 58 Spalls and popouts in the ceiling of room 3.

Photo 65 Popouts at the bottom of the wall in room 3.

Photo 66 Small shallow delamination in the West tunnel wall.

Photo 69 Bottom of hatch cover in west tunnel.

Photo 70 Bottom of hatch cover in west tunnel.

Photo 71 Bottom of hatch cover in west tunnel.

Photo 72 Popout in the bottom of west tunnel wall.

Photo 73 Popout in the bottom of west tunnel wall.

Photo 74 Popout in the bottom of west tunnel wall.

Photo 77 12” x 7” delamination in west tunnel wall.

Photo 78 Termite damage in walls of storage area in room 5.

Photo 83 Cracks in top of wall around sump pump in room 5.

Photo 84 Large spalled area of wall in room 5. Corrosion and spalling continue.

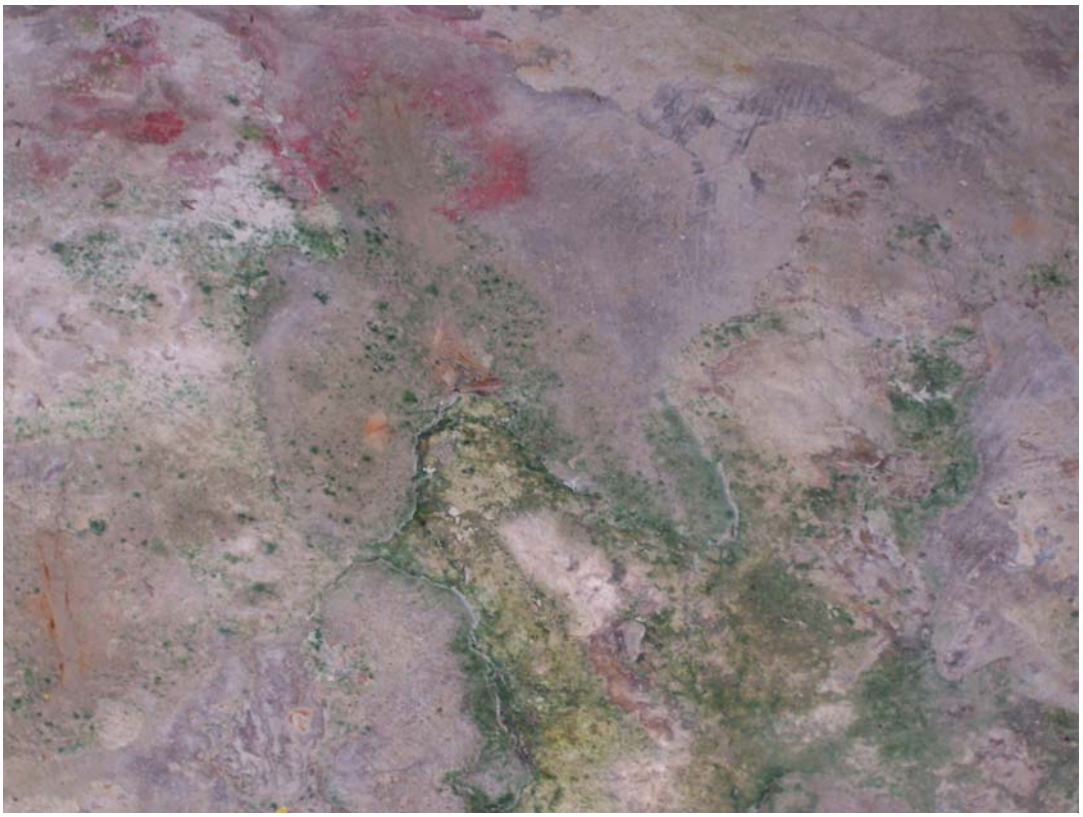


Photo 85 Failed patch in the floor of room 5.

Photo 86 Popouts at the bottom of the wall in room 5.

Photo 87 Popouts at the bottom of the wall in room 5.

Photo 88 Spall at the bottom of column in Room 5.

Photo 89 Spall at the bottom of column in Room 5. Delamination continues about 19” up.

Photo 90 Corner of column in Room 5.

Photo 93 Spalls and corroded steel in beams over machinery in room 5. Note steel beam and columns added to support these beams.

Photo 94 Spalls and corroded steel in beams over machinery in room 5. Note steel beam and columns added to support these beams.

Photo 95 Spalls and corroded steel in beams over machinery in room 5. Note steel beam and columns added to support these beams.

Photo 96 Spall at bottom of column and steel column added to support deteriorated concrete beams and columns.

Photo 97 Spalls and corroded steel in beams over machinery in room 5. Note steel beam and columns added to support these beams.

Photo 98 Spall with corroded steel in beam over machinery in room 5.

Photo 99 Spalled beam with corroded reinforcing over opening for gate 7.

Photo 100 Spalled beam with corroded reinforcing over opening for gate 7.

Photo 103 Crack and spall in the bottom of beam in room 7.

Photo 104 Spall with corroded steel in bottom of beam in room 7.

Photo 105 Bottom of column in the wall in room 5. Delamination continues up the column.

Photo 106 Bottom of column in the wall in room 5. Delamination continues up the column.

Photo 109 Spall at the bottom of the column by the gate under the stairway.

Photo 110 Spalling and corroded steel at the bottom of the column near the louvers by the hinge of gate 5. Damage to about 20” up from floor.

Photo 111 Spalling and corroded steel at the bottom of the column near the louvers by the hinge of gate 5. Damage to about 20” up from floor.

Photo 112 Spalling and corroded steel at the bottom of the column near the louvers by the hinge of gate 5. Damage to about 20” up from floor.

Photo 115 Popouts/spalling along the bottom of the wall near valves 15 and 16.

Photo 116 Popouts/spalling along the bottom of the wall near valves 15 and 16.

Photo 117 Popouts along the bottom of the wall near valves 15 and 16.

Photo 118 Popouts along the bottom of the wall near valves 15 and 16.

Photo 119 Spalls in ceiling near gate 5.

Photo 120 Spalls in ceiling near gate 5.

Photo 121 Spall and corroded steel in beam over gate 5 machinery.

Photo 122 Spall and corroded steel in beam over gate 5 machinery.

Photo 125 Cracks and spalls in beam over Gate 5 machinery.

Photo 126 Spalls in beam over Gate 5 machinery. About mid span of beam.

Photo 127 Spalls in beam over Gate 5 machinery. About mid span of beam.

Photo 128 Deteriorated beam over opening for Gate 5.

Photo 133 Spalled concrete and exposed steel near hinge of northeast gatebay.

Photo 134 Spalled concrete and exposed steel in northeast gatebay.

Photo 141 Spall where handrail post embeds in stairway wall. Handrail is loose.

Photo 142 Spall where handrail post embeds in stairway wall. Handrail is loose

Photo 143 Large area of cracked and spalling concrete behind northeast retaining wall. The whole area sounded hollow underneath.

Photo 144 Large area of cracked and spalling concrete. The whole area sounded hollow underneath

Photo 145 Spalls in north gatebay.

Photo 146 Spalls in north gatebay.

Photo 147 Spalls in east lock chamber wall. (Typical).

Photo 148 Spalls in east lock chamber wall. (Typical).

Photo 151 Spalling with exposed steel near the river side gate hinge.

Photo 152 Spalled/delaminated concrete in Room 2. Has increased since last inspection.

Photo 153 Popouts in Room 2 caused by corroding steel.

Photo 154 Spall with corroded steel in beam in Room 2.

Photo 155 Spall with corroded steel in beam in over machinery for Gate 2.

Photo 156 Spalls and popouts with corroded steel in ceiling of Room 2.

Photo 157 Spalls and popouts with corroded steel in ceiling of Room 2.

Photo 158 Spalling and corroding steel in beam in Room 2. Further spalling has occurred since last inspection.

Photo 159 Spalling and corroding steel in beam in Room 2.

Photo 160 Crack in beam in Room 2.

Photo 161 Crack in beam over Gate hinge.

Photo 162 Crack in beam over Gate 4.

Photo 163 Spall with corroded steel and crack in beam over gate 4.

Photo 164 Diagonal crack in wall near Gate 4.

Photo 165 Termite damage in walls of storage area in Room 2.

Photo 166 Spalled corners at the bottom of column in Room 2 near the tunnel.

Photo 167 Small popout due to clay in east tunnel.

Photo 168 Large spall caused by corroding reinforcing in ceiling of machinery room 6.

Photo 171 Spalling and exposed steel in ceiling of room 6.

Photo 172 Painted spall in ceiling of room 6.

Photo 173 Spalls and corroded steel in beams over machinery in Room 6.

Photo 174 Large spalls with corroded steel in the bottom of the column near the hinge in room 6.

Photo 175 Large spalls with corroded steel in the bottom of the column near the hinge in Room 6.

Photo 176 Cracks in beams by hinge in Room 6.

Photo 179 1’ x 1’ delamination in floor near valve between Rooms 6 and 8.

Photo 180 Spalls with corroded steel in ceiling between Rooms 6 and 8.

Photo 183 Cracks and spalling in the retaining wall on the northeast side.

Photo 184 Cracks and spalling in the retaining wall on the northeast side.

Photo 185 Cracks and spalling in the retaining wall on the northeast side.

Photo 186 Damage to south end of the northwest guidewall.

Photo 187 Damaged concrete at the northwest reverse head gate hinge.

Photo 188 Northwest gatebay wall between the gates.

Photo 189 Spalled corner with exposed steel near the hinge for the southwest gate.

Photo 190 Spalls with exposed steel in the west chamber wall on river side.

Photo 201 Spalls and exposed steel in chamber walls.

Photo 202 Crack in east chamber wall. (Typical of cracks in chamber walls).