

February 04, 2019

Kayla Dow – Aquatics Operations Supervisor
City of Fort Saskatchewan, Harbour Pool
10001 – 94 Avenue
Fort Saskatchewan AB T8L 3V4

Dear Kayla,

**RE: Harbour Pool – City of Fort Saskatchewan
Main Pool, Warm Pool, and Whirlpool Additional Testing**

RJC No. EDM.118534.0003

As per your request, Read Jones Christoffersen Ltd. (RJC) performed chloride testing work in addition to our March 2018 Structural Assessment report at the Main Pool, Warm Pool, and Whirl Pool within the Harbour Pool Complex located at 10001 – 94 Avenue in Fort Saskatchewan, Alberta.

The intent of this testing was to determine the current extent of chloride content in the concrete and the condition of the underlying concrete structure in areas of debonded tiles on the Main Pool, Warm Pool, and Whirl Pool deck areas, and in areas of parging on the dry side of the pool wall.

RJC performed multiple site visits in December 2018, during a shutdown of the pool facilities. Our assessment included obtaining 20 concrete samples for chloride laboratory testing, and visual review and chain-drag / hammer-sound testing of the concrete structure in areas of tile removal.

Original architectural and structural drawings were available for our review. Harbour Pool structure was constructed in 1982. The architect and structural engineer-of-record was Camrec Facilities Consultants Limited.

Further description of the structure and history is available in our March 2018 Structural Assessment report.

Observations

Tile removal was completed at a total of eight locations of previously identified debonded tiles throughout the pool area. Removal work was completed by the Owner's Contractor in areas identified on site by RJC (See Figure 1). Visual review and sounding of the concrete structure was completed at all locations. The following items were noted:

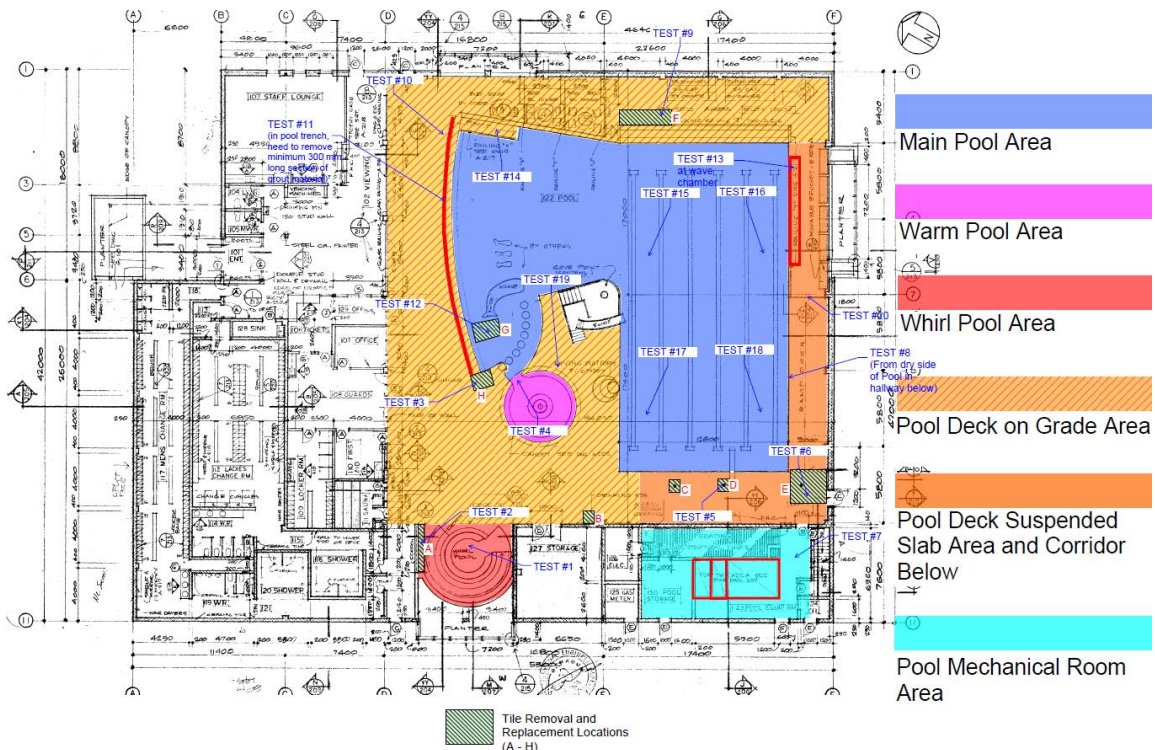


Figure 1: Pool Deck Area – Chloride Test Locations (1-20) and Tile Removal Areas (A-H)

- It is our understanding that repairs and waterproofing are being completed by the Owner's Contractor as per recommendations within our March 2018 Structural Assessment report. RJC was not involved with the repair program.
- The concrete slab-on-grade surfaces at Tile Removal Area A, adjacent to the Whirl Pool, appear to be in good condition. No issues were identified.
- Concrete delamination due to corrosion of steel reinforcement and concrete spalling was identified at Area B (Photo 1). Concrete spalling appears to be the result of differential movement at an existing expansion joint in the slab-on-grade structure. The existing reinforcement exposed at the concrete spall is experiencing significant signs of corrosion.



Photo 1: Delamination at expansion joint below Tile Removal Area B

- Concrete delamination due to corrosion of the embedded steel reinforcement, in the suspended structural slab, was identified at Areas C and D, adjacent to existing floor drain locations (Photos 2 and 3).



Photo 2: Delamination at Tile Removal Area C



Photo 3: Delamination at Tile Removal Area D

- Unbonded grout at the expansion joint in Area E was noted at the southwest end of the pool deck, adjacent to the emergency exit doors (Photo 4).

Cracking in the suspended slab was also observed running in line with the floor drain in this area (Photo 5). Visual review of the slab soffit identified efflorescence staining directly below the surface crack, indicating moisture penetration through the tile and grout finishes, and through the structure at this location.



Photo 4: Unbonded grout at expansion joint

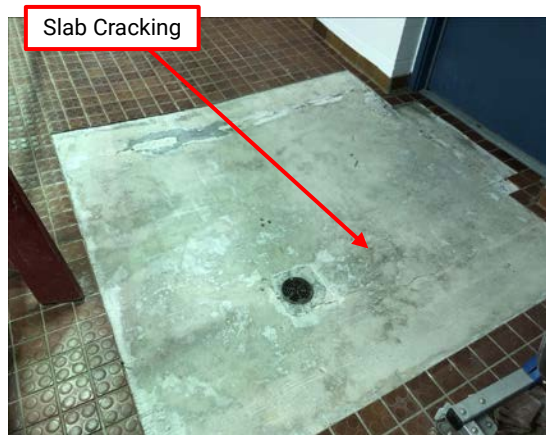


Photo 5: Slab cracking at Tile Removal Area E

- Unbonded grout adjacent to the floor drain trench was identified at Area F (Photo 6). The grout in this area appears to have been installed to allow for sloping towards the trench.

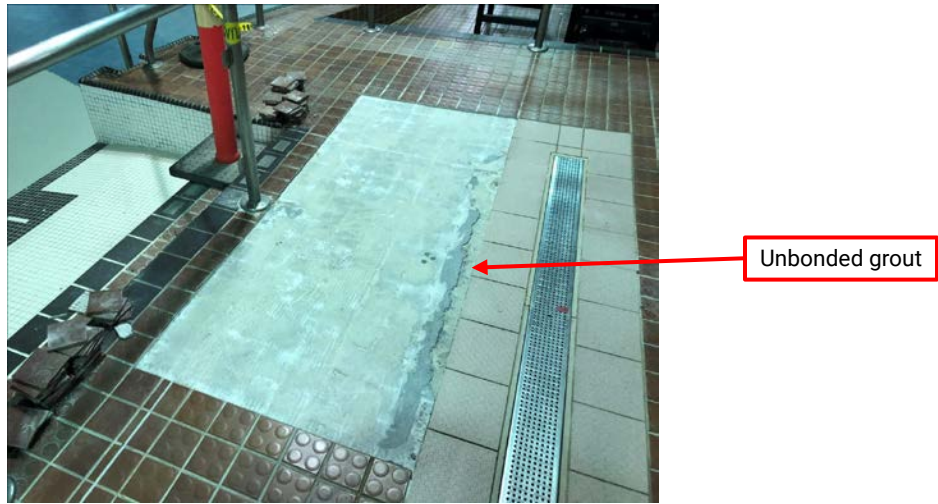


Photo 6: Spalled grout sloping material at Tile Removal Area F

- Significant debonded tile was observed at the west end of the Main Pool area, adjacent to the Warm Pool, Area G. Review of the structural drawings indicated a control joint located in the area of removal. The joint is approximately 2" deep and a moist sand/clay material was identified in the joint (Photo 7). Moisture appears to be migrating below the tiles in this area along the joint.

The concrete structure generally appears to be in good condition; however, unbonded grout was identified at the mechanical penetration (Photo 8) during hammer sounding.



Photo 7: Control joint at Tile Removal Area G Photo 8: Unbonded grout at Tile Removal Area G

- Concrete delamination and spalling were identified at Area H, at the existing expansion joint intersection (Photo 9 and 10). Concrete spalling appears to be the result of differential movement at an existing expansion joint in the slab-on-grade structure.



Photo 9: Tile Removal Area H



Photo 10: Concrete delamination at expansion joint

Chloride Ion Content Testing

Chloride ion testing of the suspended slab, slab-on-grade, and Main Pool wall was performed as part of the assessment in order to identify if the present extent of chloride contamination within the concrete structure has reached or exceeded the level required to initiate corrosion of the reinforcing steel bars, embedded in the concrete slabs and wall.

The generally accepted threshold quantity of chloride required to initiate corrosion of steel embedded in concrete is 0.025% by weight of concrete, provided that oxygen and moisture are present.

Concrete samples were selected and sampled at 20 representative locations throughout the facility. Refer to Figure 1 for the approximate locations of the 20 samples. The samples were collected from the concrete slab surface at a depth of approximately 20 to 40 mm below the concrete slab surface. The concrete powder samples were then laboratory tested using CSA A23.2-4B analysis method to assess the percentage of chloride ion existing within the concrete matrix.

The results are summarized as follows:

Sample No.	Location	Test Depth (mm)	Water Soluble Chlorides (% by Weight of Sample*)
1	Whirl Pool (S.O.G.)	20 to 40	0.0108%
2	Whirl Pool Deck (S.O.G.)	20 to 40	0.0077%
3	Pool Deck – at Warm Pool (S.O.G.)	20 to 40	0.0076%
4	Warm Pool - (S.O.G.)	20 to 40	0.0106%
5	Pool Deck (Suspended Slab)	20 to 40	0.0101%
6	Pool Deck (Suspended Slab)	20 to 40	0.0115%
7	Mechanical Room (Suspended Slab)	20 to 40	0.240%
8	Main Pool Wall (Dry Side)	20 to 40	0.0182%
9	Pool Deck (S.O.G.)	20 to 40	0.0191%
10	Pool Deck (S.O.G.)	20 to 40	0.0361%



Sample No.	Location	Test Depth (mm)	Water Soluble Chlorides (%) by Weight of Sample*
11	Pool Deck Trench Drain (S.O.G.)	20 to 40	0.0818%
12	Main Pool	20 to 40	0.0183%
13	Wave Pool Chamber	20 to 40	0.0276%
14	Main Pool (ramp)	20 to 40	0.0192%
15	Main Pool (S.O.G.)	20 to 40	0.0172%
16	Main Pool (S.O.G.)	20 to 40	0.0104%
17	Main Pool (S.O.G.)	20 to 40	0.0077%
18	Main Pool (S.O.G.)	20 to 40	0.0165%
19	Pool Deck (S.O.G.)	20 to 40	0.0130%
20	Pool Deck (Suspended Slab)	20 to 40	0.0341%

*Green indicates very low concentrations; Yellow indicates concentrations approaching threshold; Red indicates concentrations exceeded

The chloride testing performed indicates that this threshold limit has been exceeded at four test locations (Nos. 10, 11, 13, and 20). Concentrations are approaching the threshold at eight locations (Nos. 7, 8, 9, 12, 14, 15, 18, and 19). Very low concentrations were recorded at the Whirl Pool, adjacent deck, and at select locations in the Main Pool and surrounding deck (Nos. 1 to 6, 16, and 17). We also noted that the testing did not identify high chloride contamination at debonded tile locations.

We note that the structure was changed to a salt-cell chlorination treatment system in 2012, representing approximately six years of exposure. The levels of contamination indicate that the existing tile and grout system does not appear to be providing adequate protection for the structure from chloride contamination.

Ongoing corrosion of the reinforcing steel and delamination of the concrete is expected to continue to occur in the general locations where the chloride threshold has been exceeded.

Summary and Recommendations

In general, the concrete structure appears to be performing well at this time. Removal of tiles at locations previously identified as debonded appears to be primarily at locations of existing expansion or control joints in the structure and around drain and penetration locations. It appears that movement at joint locations is occurring, resulting in failure of the tiles above, and allowing moisture penetration to occur below. Waterproofing and detailing joint locations to allow for movement would be required to minimize moisture penetration and future deterioration of the tile finishes.

Chain drag testing and hammer sounding of the suspended and slab-on-grade surfaces identified very little deterioration, except at existing drains and mechanical penetrations, which were considered to be in poor condition. Spalled and unbonded grout material were identified at other locations of tile removal. Concrete repair, waterproofing, and detailing at these locations are recommended.



Results from the chloride testing identified that select areas of the structure have exceeded the accepted threshold quantity of chloride required to initiate corrosion of steel embedded in concrete; however, debonded tile did not indicate a high chloride contamination concern at this time. Waterproofing of the structure is recommended to prevent further chloride contamination (opinion of probable cost for replacement of the tile assembly is provided in our March 2018 report).

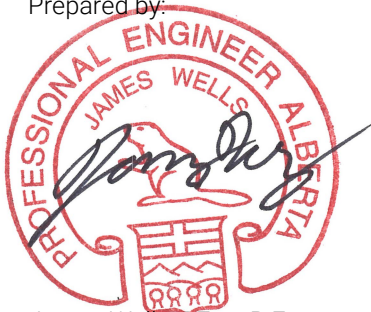
Read Jones Christoffersen Ltd. would be pleased to assist you with implementation of the presented recommendations. We can assist you with technical and administrative requirements for this project. Our services would include preparation of specifications and drawings for contractor pricing of the project, site review services during construction, and contract administration.

We trust the above meets with your present requirements. Should you have any questions or comments regarding this assessment, or if we may be of further service, please contact this office.

Yours truly,

READ JONES CHRISTOFFERSEN LTD.

Prepared by:



James Wells, BEng, P.Eng.
Project Engineer

Reviewed by:

A blue ink signature of Enzo Vercillo, written in a cursive style.

Enzo Vercillo, BSc, P.Eng., LEED AP
Principal

APEGA PERMIT NUMBER: P152