Attachment 4

City of Peterborough

CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

STRUCTURAL UPDATED REPORT
SOUTH SUPPORTING ICE RINK WALL
MEMORIAL CENTRE, PETERBOROUGH (ON)

PREPARED FOR
THE CITY OF PETERBOROUGH
BY
CARVAJAL STRUCTURAL ENGINEERS INC.

CSE PROJECT-2022.18

Professional Engineers
Alberta-British Columbia-New Brunswick
Ontario -Nova Scotia - Saskatchewan

JUNE, 2018

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APPENDICES

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Property & Energy Manager
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Peterborough (ON), K9H 3R9
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File: 2022.18 – South Supporting Ice Rink Wall Structural - Update Report
Peterborough Memorial Centre - 151 Lansdowne St., Peterborough (ON) K9J 1Y4

As requested, Carvajal Structural Engineers Inc. (CSE) has completed an updated structural assessment of the existing Ice Rink Pad (slab) and South Supporting Wall at the above captioned site. The following report provides a factual summary of our understanding of the work, our findings, and the associated recommendations for the South Supporting Wall.

1.0 UNDERSTANDING OF WORK

CSE has been retained to monitor the condition and structural performance of the south wall.

The load bearing south wall provides structural support for the trench header pipes, cooling pipes, the original ice rink slab, the second ice rink, the suspended slab over the header trench, and the dasher boards above. It also acts as a retaining wall for the sandy backfill material below the ice rink slab.

The south wall is a critical component of the overall ice rink and the two (2) ice rink slabs and needs to be replaced as scheduled prior to winter 2021.

As part of our responsibility, CSE has performed regular monthly site visits to review the progression of the walls deterioration. Our objective is to determine when the condition has progressed to a point where the deteriorated condition, in our Professional Opinion, is no longer safe and imposes health & safety concerns with it's continued use.

This report will summarize the results and observations of our continued review and the associated health & safety concerns that are now present. The results of our initial review and recommendations were summarized in our report "Structural Assessment of Existing Ice Rink Slab" dated July 31, 2016. Sections of this report have been duplicated in this follow up report for ease of reading and continuity.

The purpose of our review is to provide a Structural Professional Opinion on the progression of deterioration for the south wall (wall). Our scope of work is defined as follows:

1. Perform visual reviews of the south wall on a monthly basis.
2. Perform a delamination survey (sounding) on the south wall on a monthly basis.
3. Record any changes in the crack widths where tell-tales crack monitors that were installed to monitor any crack growth on the wall.
4. Formulate a structural opinion on the progression of deterioration for the south wall and its health & safety concerns.
5. Prepare a factual report that summarizes the conditions found, the areas of concern and our associated follow up recommendations.

2.0 DESIGN REVIEW LIMITATIONS

Please be advised that any information contained in this report is derived from our field measurements, our own field observations and the available structural drawings. Any third-party use of this information is restricted since our report incorporates a measure of experience with similar structures. This report is solely provided to the City of Peterborough (City). CSE takes no responsibilities or liabilities for any third-party use of this information without prior consultation with CSE. Please note that CSE reserves the right to update our observations, analysis and recommendations should additional relevant information become available.

3.0 DESCRIPTION OF STRUCTURE

The existing building is an approximate 45,000 square foot multi-purpose arena located in Peterborough (ON), with its main function serving as a hockey arena. The building was constructed in 1955. The layout of the arena consists of an Ice Rink Pad in the center with seating surrounding its perimeter. The main focus of this review was on the structural ice rink pad.

The original construction of the slab is a 5" thick suspended structural concrete slab cast on a steel deck. The slab is supported along its length by a series of 8" thick concrete block foundation walls, which are spaced at 8'-8" o/c. Below the slab is a crawl space. In addition, the underside of the slab was not visible since it is covered with the steel deck and cork insulation. The extent of the review of the masonry foundation walls and underside of the slab was limited to the first bay at the south end of the slab. In addition, the underside of the slab was not visible since it is covered with the steel deck and cork insulation. Directly below the dasher boards, the foundation walls are constructed of reinforced concrete.

Based on our review, it is our understanding that the existing slab has been structurally modified since its original construction Circa 1979. The structural modifications included the complete removal of all the dasher boards and the complete installation of a new 4 ½" – 5" thick concrete slab (topping) with a hard "trap rock" surface hardener complete with new brine pipes and header trench. The new topping was cast on top of the original slab. The existing rink pipes were abandoned, and new PVC pipes were re-routed into the new topping and connected to the brine pipes. The PVC pipes run from south to north and loop back at the north end of the rink to return to the brine headers pipes.

No structural information is available for the design of this new topping since it is most likely a non-structural slab. This report assumes that the topping is non-structural.

Modifications also included building up the perimeter of the slab around the ice pad at various locations. The build-up included non-structural concrete, which has been sloped to achieve the elevation of the new slab.

4.0 VISUAL OBSERVATIONS REVIEW & TESTING

Commencing during the month of June 2017, the existing south wall has been reviewed for any significant signs of progressive deterioration on a monthly basis. The results of our monthly reviews can be found in Appendix "B".

The following findings summarize our observations for the visual review, hollow sounding survey and tell-tale crack progression monitoring survey review. See photographs in Appendix "A".

4.1 South Wall - Visual Survey

In general, our visual review on the condition of the south wall has revealed that deterioration of the wall has been progressing at an accelerated rate. Concrete deterioration was noted over the full length of the wall. As well, many cracks and areas of frost damaged/spalled/delaminated concrete were observed. The extent of deterioration continues to expand.

The upper portion of the wall where the cooling lines penetrate the slab displayed the worst conditions of deterioration due to extensive concrete frost damage, while the visual deterioration of the face of the interior and exterior of the wall appeared to progress at a slower rate. Please note that the upper portion of the wall, which directly supports the suspended slabs, is where the highest level of frost damage was identified.

Furthermore, deteriorated concrete continues to fall from the top of the wall along the floor of the header trench.

4.2 South Wall - Delamination / Hollow Sounding Survey

The foundation wall was sounded with a hammer over the accessible portions of the wall. In general, the wall was found to be in poor to very poor condition, with many hollow sounding areas identified.

Based on the results of our monthly reviews, the extent of deterioration is continuously progressing at an accelerated rate. Significant concerns are expressed with the degree of concrete deterioration along the top portion of the wall since it provides structural support to the ice rink slabs and other components.

4.3 South Wall - Tell-Tale Crack Progression Review

A total of three (3) full height cracks along the wall were selected for crack progression monitoring. No significant horizontal cracks were identified or monitored. Based on our review, no significant crack growth has been identified for the cracks being monitored. No changes in the readings of the tell-tale monitors have been noted.

4.4 South Wall – Test Areas (Frost Damage)

A total of four (4) areas were selected to test for the depth of frost damaged / delaminated concrete on both faces of the south wall. A chipping hammer and/or drill was used to remove the loose concrete to a level of sound concrete. The results indicated that the concrete is a gravelly mix. Depth of frost damage ranged from 70mm to 80mm on each side of the wall. The depth of frost damage at the top of the wall towards the east end exceeded the above noted limits, however CSE did not extend the removals beyond this depth.

Please refer to attached Appendix "A" for photographs of the test areas.

4.5 Suspended Slab- Zamboni Pathway to the Ice Rink

During our review on the wall performance during the 2017-2018 winter season, CSE identified concerns with the suspended slab portion where the Zamboni travels from its storage area to the ice rink. Shoring of this slab section is being recommended until the slab can be fully repaired/replaced. Shoring needs to be installed prior to the 2018-2019 ice installation.

5.0 SUMMARY OF FINDINGS

Based on our observations, the condition of the south wall that supports the ice rinks is continuing to deteriorate. During the winter season of 2017-2018, the degree of deterioration observed appeared to be accelerating at a higher rate.

The following bullet points will summarize the results of our findings.

- The concrete foundation wall at the south end (below the dasher boards) of the rink was observed to be in poor to very poor condition. Concrete deterioration was noted over the full length of the wall, as well as many cracks and areas of frost damaged / spalled / delaminated concrete. The extent of deterioration continues to expand at an accelerated rate. The observed visual condition of the top of the wall is of a significant concern and shoring/complete replacement is warranted.
- The results of the hollow sounding surveys indicate that the extent of damage is progressing slowly along the full height of the wall but the progression is more rapid at the top of wall where the cooling pipes penetrate the slab. The observed hollow sounding condition of the top of wall is of a significant concern and repairs are warranted.
- The performance of the suspended slab pathway for the Zamboni is being recommended to be shored for structural safety reasons.
- The results of the vertical crack monitoring have not revealed any significant progression of crack width.
- The extent of deterioration for the south wall and suspended slabs area over the Zamboni path has progressed to a point, were in our Professional Opinion, the walls and slab need to be shored before they can be returned to service for the ice rink installation.

6.0 COMMENTS & RECOMMENDATIONS

In general, the condition of the perimeter foundation wall along the south side of the rink where the pvc cooling pipes are fed from the header pipe and penetrate the topping edge is in an advanced state of deterioration and continues to deteriorate. This south wall needs to be shored/replaced prior to the next ice season.

In summary, the following recommendations are being provided to the City of Peterborough under our understanding that the complete ice rink will be replaced in 2018 or 2019.

- Continue to monitor the south wall and Zamboni path slab on a monthly basis for any signs of significant movement.
- Install shoring along the Zamboni path, as deemed possible. Significant interferences are present along this path due to the trench header pipes.

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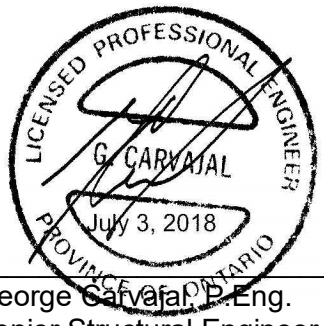
- Install shoring for the section of ice rink that is supported by the south wall. This shoring will need to be installed in the interior between the south wall and 1st intermediate masonry wall. The shoring being recommended is to fill the 1st cavity completely with a self-compacting backfill. Although it will not be possible to attain full bearing with the slab's underside, the backfill will provide the required shoring to prevent any significant collapse of the rink slab and any associated health & safety concerns.

We trust the above is to your satisfaction, should you have any further questions, please do not hesitate to contact the undersigned.

Yours truly,

Claire Miller, E.I.T
Structural Designer
Structural Rehabilitation Engineer
CSE Structural Forensic & Rehabilitation Services
Carvajal Structural Engineers Inc.



George Carvajal, P.Eng.
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Structural Rehabilitation Specialist
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Carvajal Structural Engineers Inc.
BCIN 31226

File: 2022.18

CC: M. MacGillivray (City), CSE Files

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APPENDIX A

PHOTOGRAPHS

CARVAJAL STRUCTURAL ENGINEERS *INC*
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- Test Area No.1
- Location: Between Grid Line 25-26 Outside Wall Face, Top of Wall
- Comments: No concrete removed by CSE. Concrete observed to be gravelly and crumbled easily. Depth of frost damage exceeded 80mm. Actual depth of damage not confirmed.

PHOTOGRAPH NO.1

- Test Area No.2
- Location: Grid Line 6 Outside Wall Face
- Comments: Drill used to remove damaged concrete to a level of sound concrete. Depth of damage approximately 65mm.

PHOTOGRAPH NO.2

- Test Area No.3
- Location: Grid Line 3 Outside Wall Face, Top of Wall
- Comments: Chipping hammer used to remove loose concrete. Approximate depth of 70mm frost damaged concrete.

PHOTOGRAPH NO.3

- Test Area No.4
- Location: Between Grid Line 4-5 Inside Wall Face
- Comments: Chipping hammer used to remove damaged concrete to depth of sound concrete. Approximately 70mm depth to level of sound concrete.

PHOTOGRAPH NO.4

APPENDIX B

MONTHLY MONITORING REPORTS

CARVAJAL STRUCTURAL ENGINEERS *INC*
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CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

GENERAL CONFORMANCE REVIEW

DATE OF REPORT	DATE OF FIELD REVIEW	TIME OF FIELD REVIEW
Aug, 3 2017,	Jul, 25 2017,	9:00 AM

PROJECT	PROJECT No.	WEATHER CONDITIONS
TS_Wall Monitoring	1897	24 Degrees C

TITLE	REPORT No.	PAGE No.
Memorial Arena Wall Monitoring - Review No.2	002	1 of 1

PURPOSE OF SITE REVIEW & ATTENDANCE

The above captioned site was visited for the purpose of performing a monthly review of the condition of the existing South Wall. Representatives from CSE and TS Engineering were present.

CURRENT ACTIVITY

No activity was occurring at the time of our visit.

PARTS REVIEWED

1. Crack Growth (Tell-Tale Crack Monitors)
2. Concrete Delaminations
3. Debris on Ground

COMMENTS

1. The tell-tale crack monitors were reviewed to see if there has been any movement and/or crack growth. No changes were noted at Tell-Tale Markers No.2 and No.3. However, a small vertical change in the reading of Marker No.1 was observed. No concerns with this degree of movement are expressed at this time, and we will continue to monitor the crack growth at these locations at the subsequent monthly reviews. Please refer to the Photo Log for photographs of the Tell-Tale readings.

2. A hammer tap was conducted around the perimeter of the previously noted delaminated areas. In general, there was no noticeable increase in the area of delaminated concrete. This test shall continue to be performed at the following monthly reviews to determine if the area of delaminated concrete is increasing.

3. At the time of our visit, CSE documented the debris on the ground in both the header trench and the first bay underneath the ice rink slab. The included concrete spalls and loose cork insulation from the underside of the ice rink slab. It did not appear that there was a significant increase in the amount of debris on the floors in both areas.

Please note that at the time of our site visit we were informed that no heavy equipment had been placed on the ice rink slab since our initial visit on June 23, 2017. We were informed that within the upcoming month the ice rink resurfacer and a small crane will likely be utilized on top of the ice rink slab.

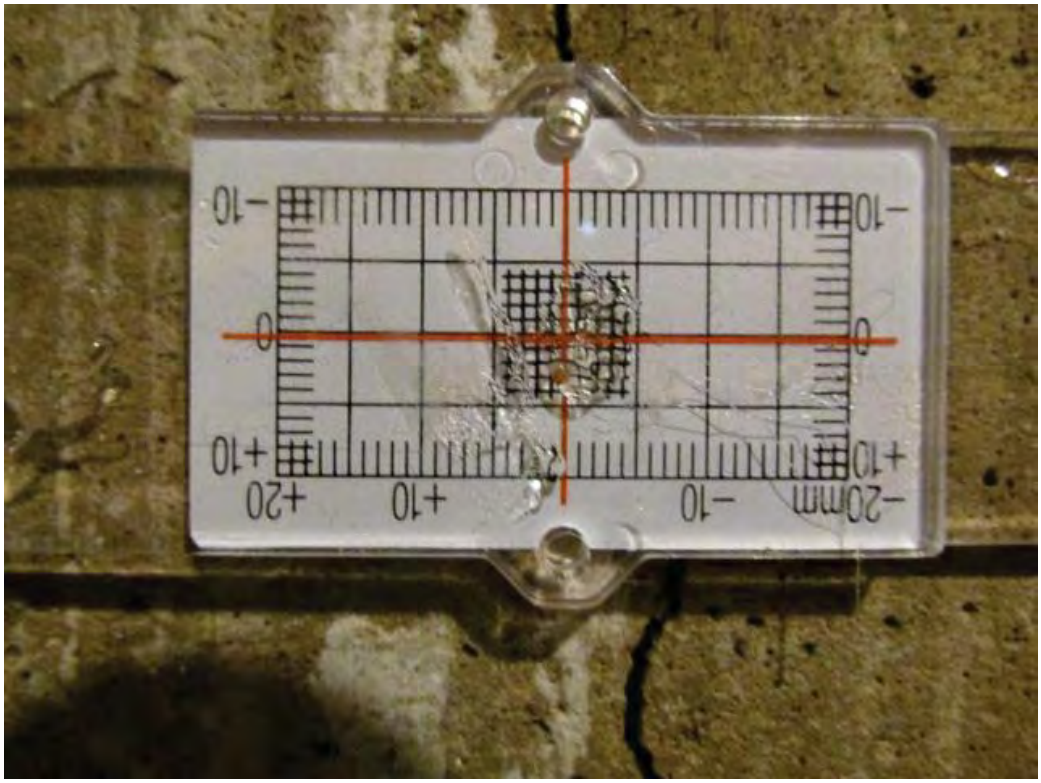
We trust the above is to your satisfaction, should you have any further questions please do not h
undersigned.

SIGNATURE C.Miller / G.Carvajal

- Tell-Tale Marker 1
- Location: Grid Line 10
- Comments: Crack Width is Wide.

PHOTOGRAPH NO.1

- Tell-Tale Marker 1
- Location: Grid Line 10
- Comments: Small Vertical Movement

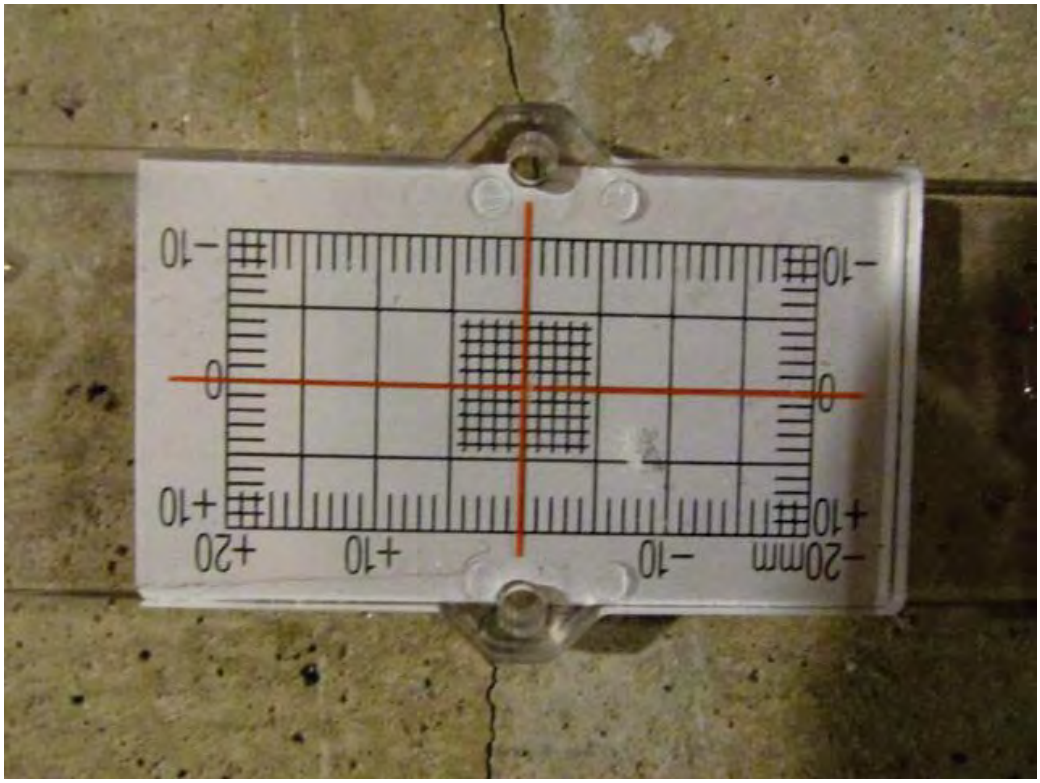


PHOTOGRAPH NO.2

- Tell-Tale Marker 2
- Location: Between Grid Line 14 & 15
- Comments: Crack Width is Medium.

PHOTOGRAPH NO.3

- Tell-Tale Marker 2
- Location: Between Grid Line 14 & 15
- Comments: No Movement (Reading of 0)

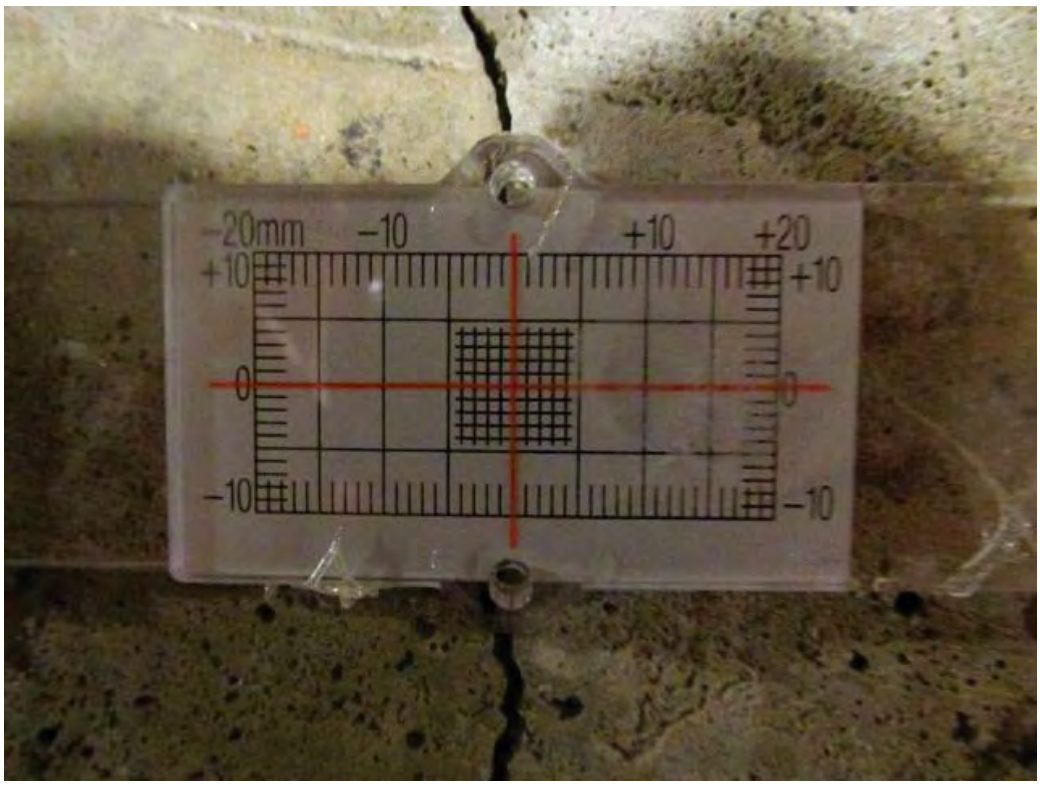


PHOTOGRAPH NO.4

- ▶Tell-Tale Marker 3
- ▶Location: Grid Line 19
- ▶Comments: Crack Width is Wide.

PHOTOGRAPH NO.5

- ▶Tell-Tale Marker 3
- ▶Location: Grid Line 19
- ▶Comments: No Movement (Reading of 0)



PHOTOGRAPH NO.6

CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

GENERAL CONFORMANCE REVIEW

DATE OF REPORT	DATE OF FIELD REVIEW	TIME OF FIELD REVIEW
Aug 31, 2017	Aug 25, 2017	10:00 AM

PROJECT	PROJECT No.	WEATHER CONDITIONS
TS Wall Monitoring	1897	20 Degrees C

TITLE	REPORT No.	PAGE No.
Memorial Arena Wall Monitoring - Review No.3	003	1 of 1

PURPOSE OF SITE REVIEW & ATTENDANCE

The above captioned site was visited for the purpose of performing the August monthly review of the condition of the existing South Wall. Representatives from CSE and TS Engineering were present.

CURRENT ACTIVITY

At the time of our site visit, the rink was being flooded to make ice, which involves the ice resurfacer riding on top of the suspended slab after each pour.

PARTS REVIEWED

No activity was occurring at the time of our visit.

COMMENTS

1. The tell-tale crack monitors were reviewed to see if there had been any movement and/or crack growth. No changes in the readings taken at our previous site visit were noted. We will continue to monitor the tell-tales for crack growth at the subsequent monthly reviews. Please refer to the Photo Log for photographs of the Tell-Tale readings.

2. A hammer tap was conducted around the perimeter of the previously noted delaminated areas. In general, there was no noticeable increase in the area of delaminated concrete. This test shall continue to be performed at the following monthly reviews to determine if the area of delaminated concrete is increasing.

3. The amount of debris on the ground in both the header trench and the first bay underneath the ice rink slab was documented using photographs and compared to the photographs archived from the July monthly review.

Based on our review, there was a significant increase in the amount of debris in the header trench tunnel at the east end. This is the location of the zamboni path above. It is our understanding that the vibrations from the travelling equipment caused loose pieces of the concrete wall and/or slab to dislodge.

4. The condition of the slab underside in the first bay was documented using photographs and compared to the photographs archived from the previous monthly review. Based on our review no additional cork or deck loss was observed and there was no further concrete deterioration, as visible. Please note that the slab and steel deck had started to freeze over due to the flooding of the ice rink, therefore some areas were not visible.

Based on the observed concrete debris observed on the ground. We are of the opinion that some localized shoring be designed and installed along the Zamboni Path between the storage area and the Ice Rink.

Please see the attached photographs relating to our August 25, 2017 site visit.

We trust the above is to your satisfaction, should you have any further questions please do not hesitate to contact the undersigned.

SIGNATURE C.Miller / G.Carvajal

- Debris on Floor
- Location: Between Grid Line 25 and 26
- Comments: Concrete / rubble debris on floor at July, 2017 review.

PHOTOGRAPH NO.1

- Debris on Floor
- Location: Between Grid Line 25 and 26
- Comments: Concrete / rubble debris on floor at August, 2017 review. Please note the significant increase in concrete on the concrete floor.

PHOTOGRAPH NO.2

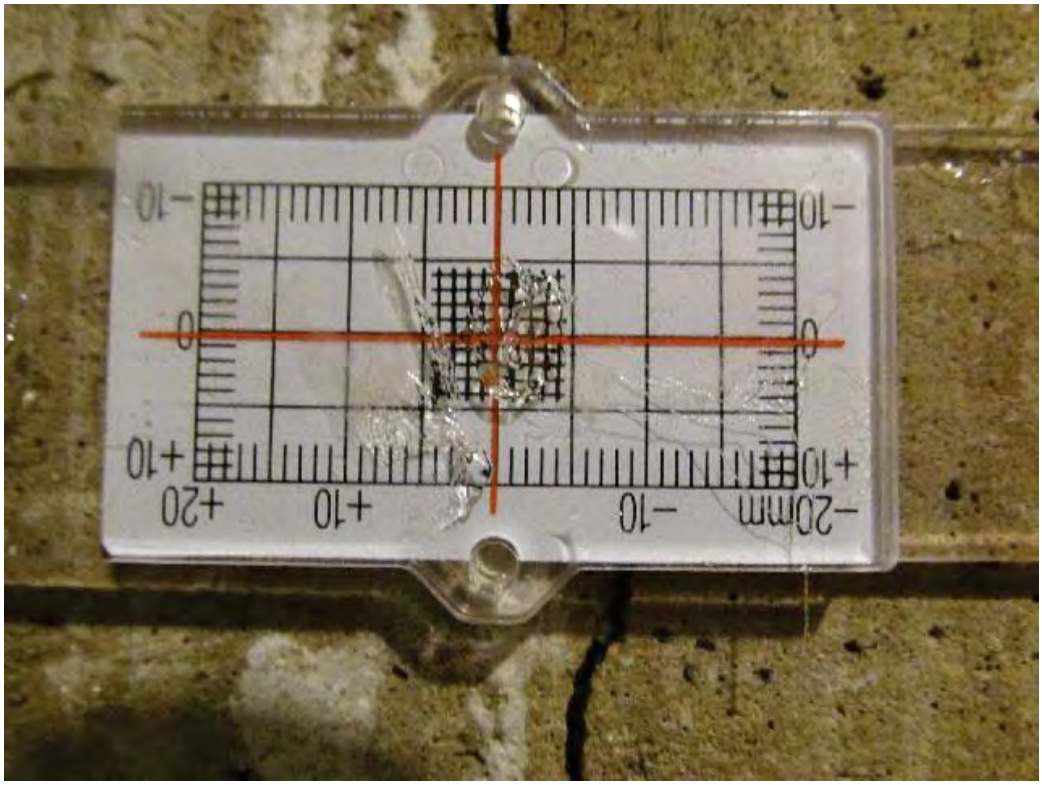
- Debris on Floor
- Location: Between Grid Line 24 and 25
- Comments: Concrete / rubble debris on floor at July, 2017 review.

PHOTOGRAPH NO.3

- Debris on Floor
- Location: Between Grid Line 24 and 25
- Comments: Concrete / rubble debris on floor at August, 2017 review. Please note the significant increase in concrete on the concrete floor.

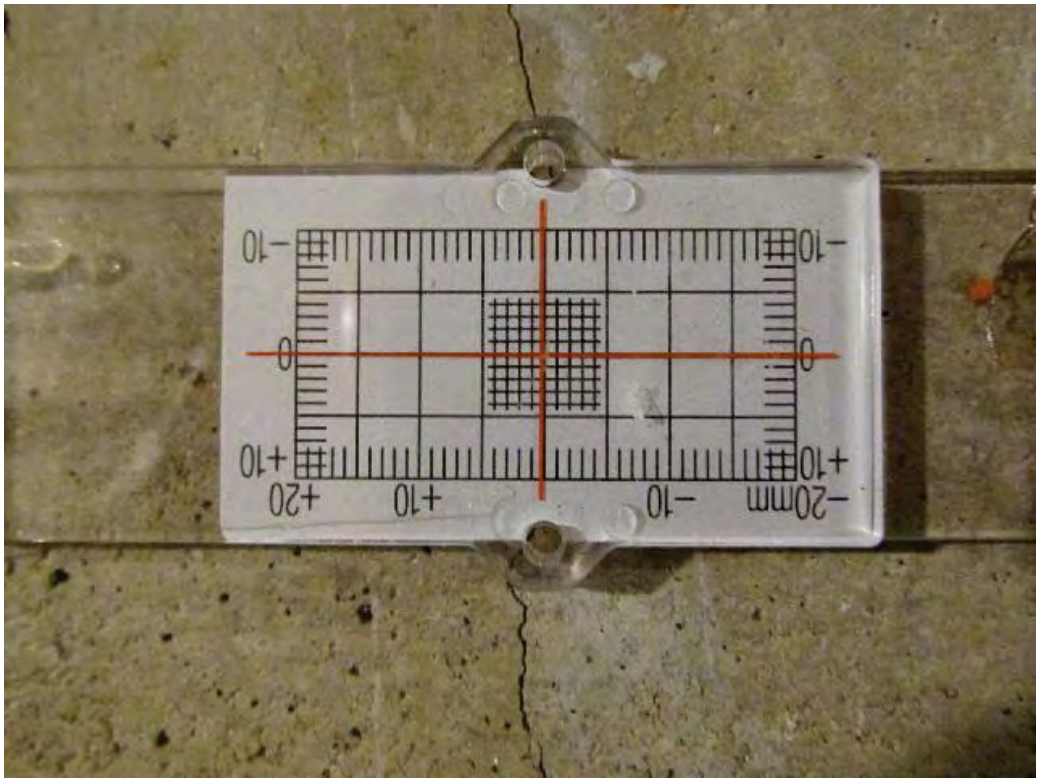
PHOTOGRAPH NO.4

- Tell-Tale Marker 1
- Location: Grid Line 10
- Comments: No additional movement



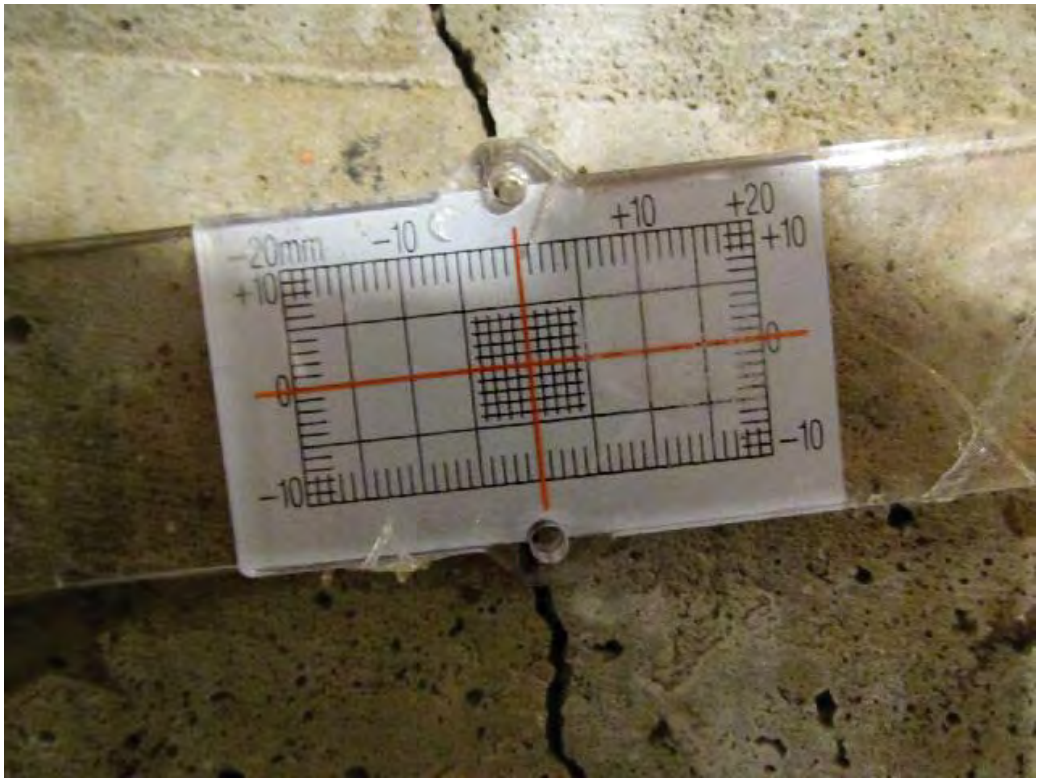
PHOTOGRAPH NO.5

- Tell-Tale Marker 2
- Location: Between Grid Line 14 & 15
- Comments: No movement



PHOTOGRAPH NO.6

- ▶ Tell-Tale Marker 3
- ▶ Location: Grid Line 19
- ▶ Comments: No movement



PHOTOGRAPH NO.7

- ▶ Exposed Deck / Slab
- ▶ Location: Between Grid Line 11 & 12
- ▶ Comments: Typical layer of ice on exposed concrete slab / steel deck

PHOTOGRAPH NO.8

- ► Header Pipes & Brine Pipes
- ►Location: General
- ►Comments: Typical layer of ice on pipes

PHOTOGRAPH NO.9

CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

GENERAL CONFORMANCE REVIEW

DATE OF REPORT	DATE OF FIELD REVIEW	TIME OF FIELD REVIEW
Sep, 28 2017,	Sep, 25 2017,	10:00 AM

PROJECT	PROJECT No.	WEATHER CONDITIONS
TS Wall Monitoring	1897	30 Degrees C

TITLE	REPORT No.	PAGE No.
Memorial Arena Wall Monitoring - Review No.4	004	1 of 1

PURPOSE OF SITE REVIEW & ATTENDANCE

The above captioned site was visited for the purpose of performing the September monthly review of the condition of the existing South Wall. Representatives from CSE were present.

CURRENT ACTIVITY

At the time of our site visit, no activity was taking place.

PARTS REVIEWED

No activity was occurring at the time of our visit.

COMMENTS

1. The tell-tale crack monitors were reviewed to see if there had been any movement and/or crack growth. No changes in the readings taken at our previous site visit were noted. We will continue to monitor the tell-tales for crack growth at the subsequent monthly reviews. Please refer to the Photo Log for current photographs of the Tell-Tale readings.

2. A hammer tap was conducted around the perimeter of the previously noted delaminated areas. In general, there was no noticeable increase in the area of delaminated concrete, and we shall continue to perform this test at the following monthly reviews to determine if the area of delaminated concrete is increasing.

3. The amount of debris on the ground in both the header trench and the first bay underneath the ice rink slab was documented using photographs and compared to the photographs archived from the previous monthly reviews. Based on our review, there was no significant increase in the amount of debris in the header trench tunnel and we will continue to monitor this condition at the following reviews.

4. At the time of our site visit, the slab underside in the first bay was for the most part not visible due to the build-up of ice, with the exception of the east and west ends where there was no ice. As well, it should be noted that a build-up of ice had formed along the top six inches (6") of the South Wall (on both sides), as well as the next wall to the north.

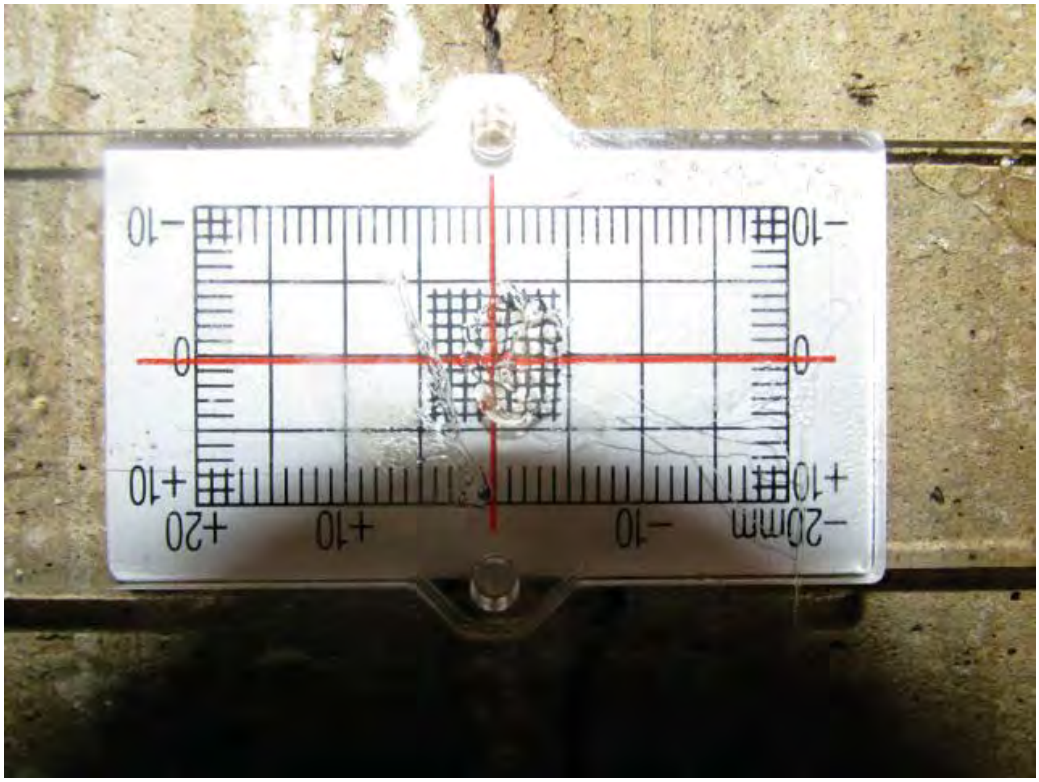
5. A significant amount of moisture was observed on both sides of the South Wall, particularly towards the east and west ends. Moisture / water ponding was also noted on the concrete slab-on-grade at the tunnel ends.

Please see the attached photographs relating to our September 25, 2017 site visit.

We trust the above is to your satisfaction, should you have any further questions please do not hesitate to contact the undersigned.

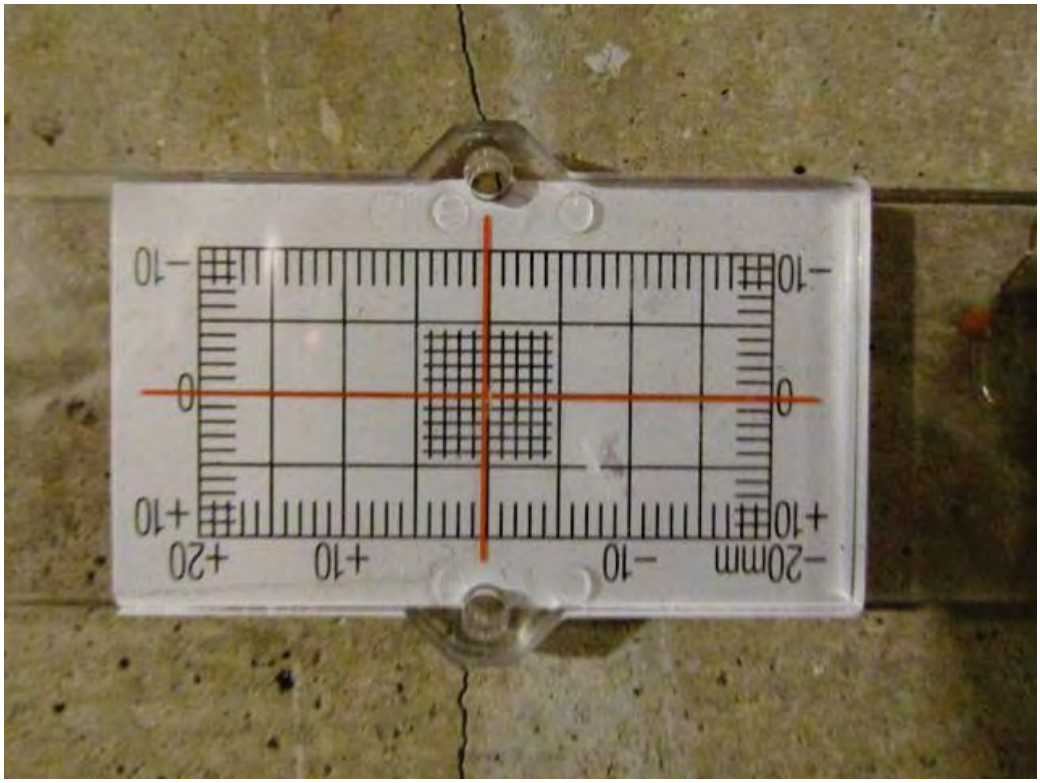
SIGNATURE C.Miller / G.Carvajal

- Tell-Tale Marker 1
- Location: Grid Line 10
- Comments: No additional movement



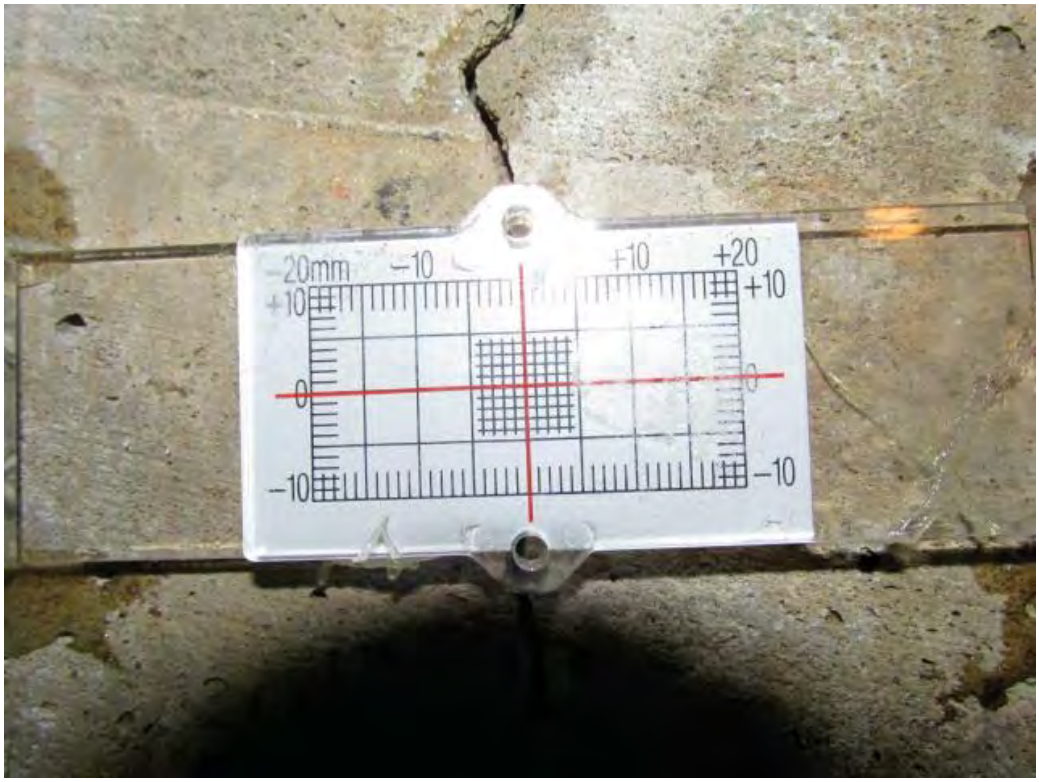
PHOTOGRAPH NO.1

- Tell-Tale Marker 2
- Location: Between Grid Line 14 & 15
- Comments: No movement



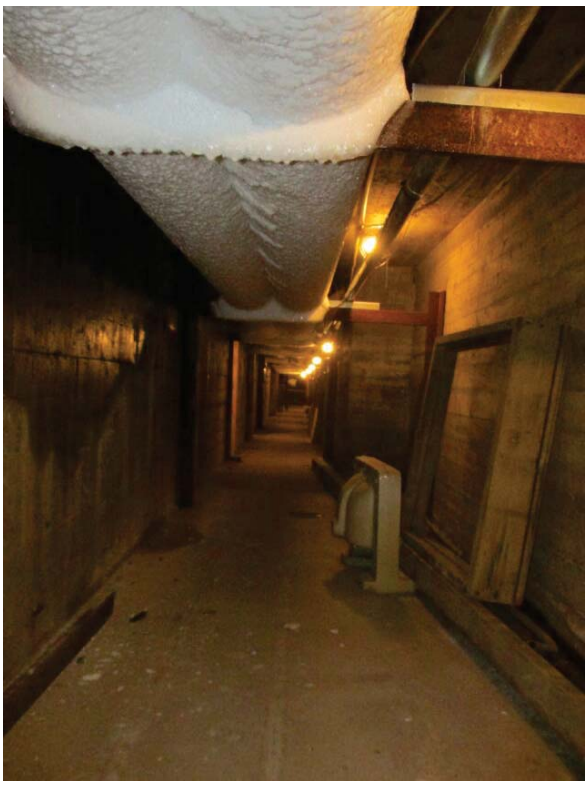
PHOTOGRAPH NO.2

- Tell-Tale Marker 3
- Location: Grid Line 19
- Comments: No movement



PHOTOGRAPH NO.3

- General View of Trench
- Location: Trench
- Comments: Ice build-up on brine pipes



PHOTOGRAPH NO.4

- South Wall
- Location: South (outside) face of wall, between Grid Line 26 & 26
- Comments: Moisture on Wall

PHOTOGRAPH NO.5

- Slab-on-grade
- Location: Between Grid Line 0 & 1
- Comments: Moisture / water ponding on slab

PHOTOGRAPH NO.6

- South Wall
- Location: North (inside) face of wall
- Comments: Ice build-up at top of wall and on underside of slab

PHOTOGRAPH NO.7

CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

GENERAL CONFORMANCE REVIEW

DATE OF REPORT	DATE OF FIELD REVIEW	TIME OF FIELD REVIEW
Oct 29, 2017	Oct 26, 2017	10:30 AM

PROJECT	PROJECT No.	WEATHER CONDITIONS
TS Wall Monitoring	1897	10 Degrees C

TITLE	REPORT No.	PAGE No.
Memorial Arena Wall Monitoring - Review No.5	005	1 of 1

PURPOSE OF SITE REVIEW & ATTENDANCE

The above captioned site was visited for the purpose of performing the October monthly review of the condition of the existing South Wall. Representatives from CSE were present.

CURRENT ACTIVITY

At the time of our site visit, no activity was taking place.

PARTS REVIEWED

- Crack Growth
- Delamination Survey
- Debris on Floors

COMMENTS

1. The tell-tale crack monitors were reviewed to see if there had been any movement and/or crack growth. No changes in the readings taken at our previous site visit were noted. We will continue to monitor the tell-tales for crack growth at the subsequent monthly reviews. Please refer to the Photo Log for current photographs of the Tell-Tale readings.

2. A hammer tap was conducted around the perimeter of the previously noted delaminated areas. In general, there was no significant increase in the area of delaminated concrete, and we shall continue to perform this test at the following monthly reviews to determine if the area of delaminated concrete is increasing.

3. The amount of debris on the ground in both the header trench and the first bay underneath the ice rink slab was documented using photographs and compared to the photographs archived from the previous monthly reviews. Based on our review, there was no noticable increase in the amount of debris in the header trench tunnel, with the exception of a few large concrete spalls on the floor at the west end of the wall. Refer to the Photo Log for photographs. We will continue to monitor this condition at the following reviews.

4. At the time of our site visit, the slab underside in the first bay was for the most part not visible due to the build-up of ice, with the exception of the east and west ends where there was no ice and the cork insulation / steel deck / concrete was visible.

5. Please note that the moisture that was observed on the South Wall at the previous site visit has now dried up.

Please see the attached photographs relating to our October 26, 2017 site visit.

We trust the above is to your satisfaction, should you have any further questions please do not hesitate to contact the undersigned.

SIGNATURE C.Miller

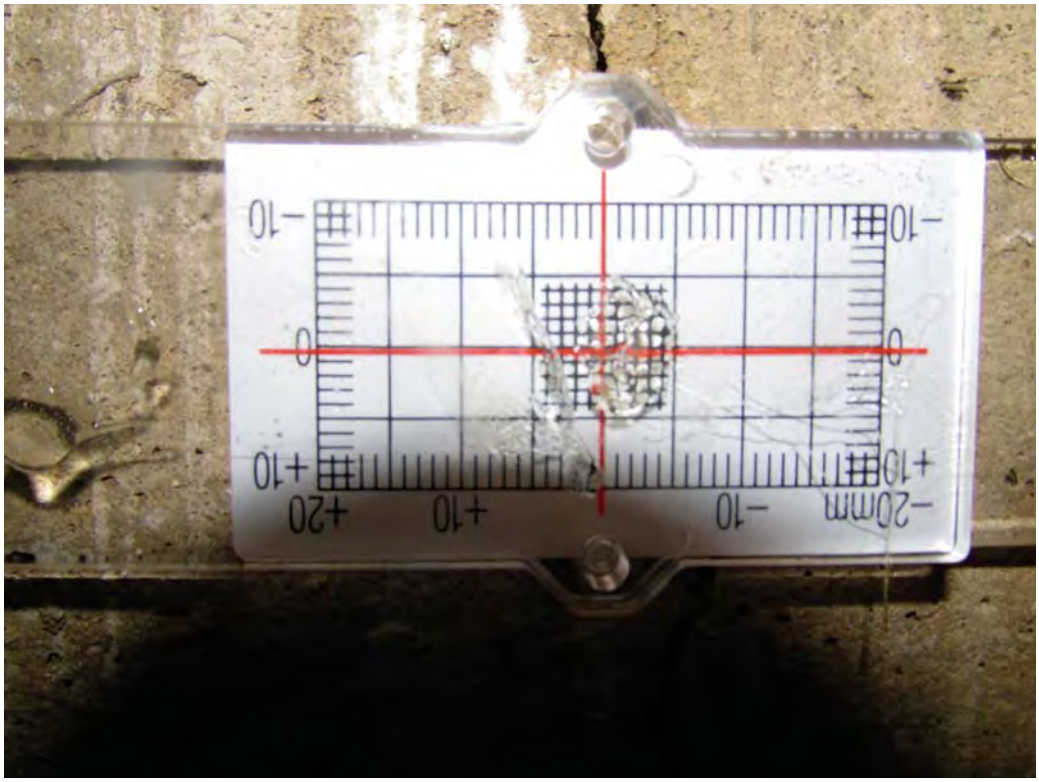
- Debris on Floor
- Location: Between Grid Line 2 and 3
- Comments: Concrete / rubble debris on floor at October, 2017 review.

PHOTOGRAPH NO.1

- Debris on Floor
- Location: Between Grid Line 2 and 3
- Comments: Concrete / rubble debris on floor at September, 2017 review.

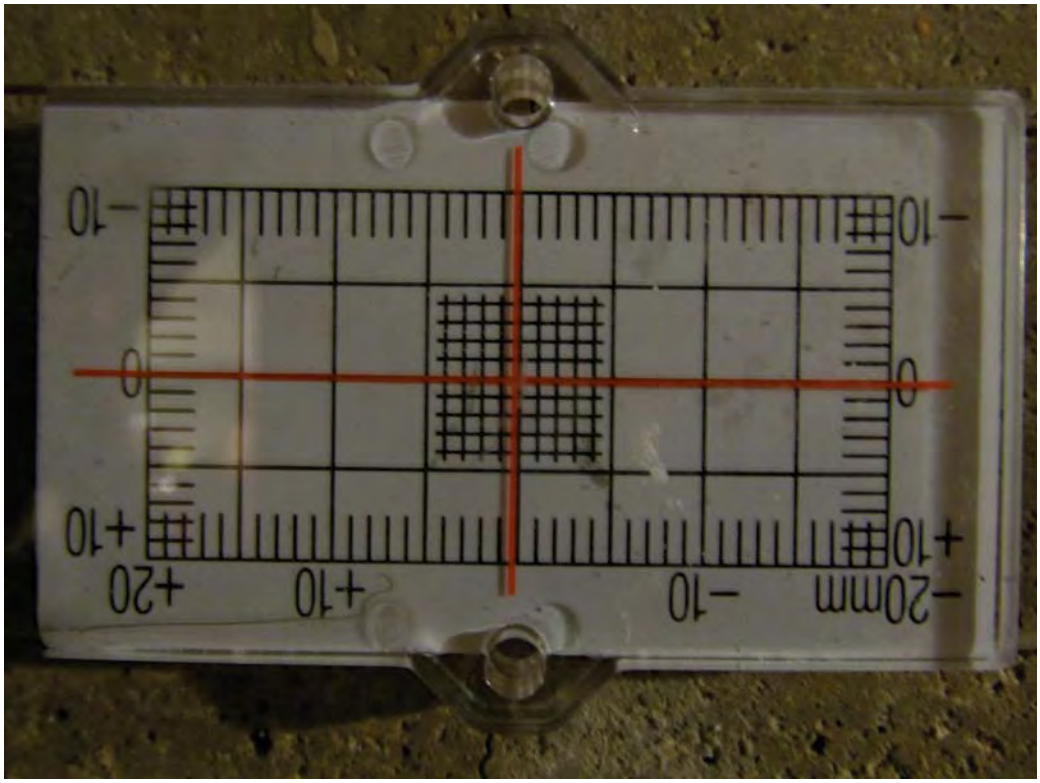
PHOTOGRAPH NO.2

- Tell-Tale Marker 1
- Location: Grid Line 10
- Comments: No additional movement



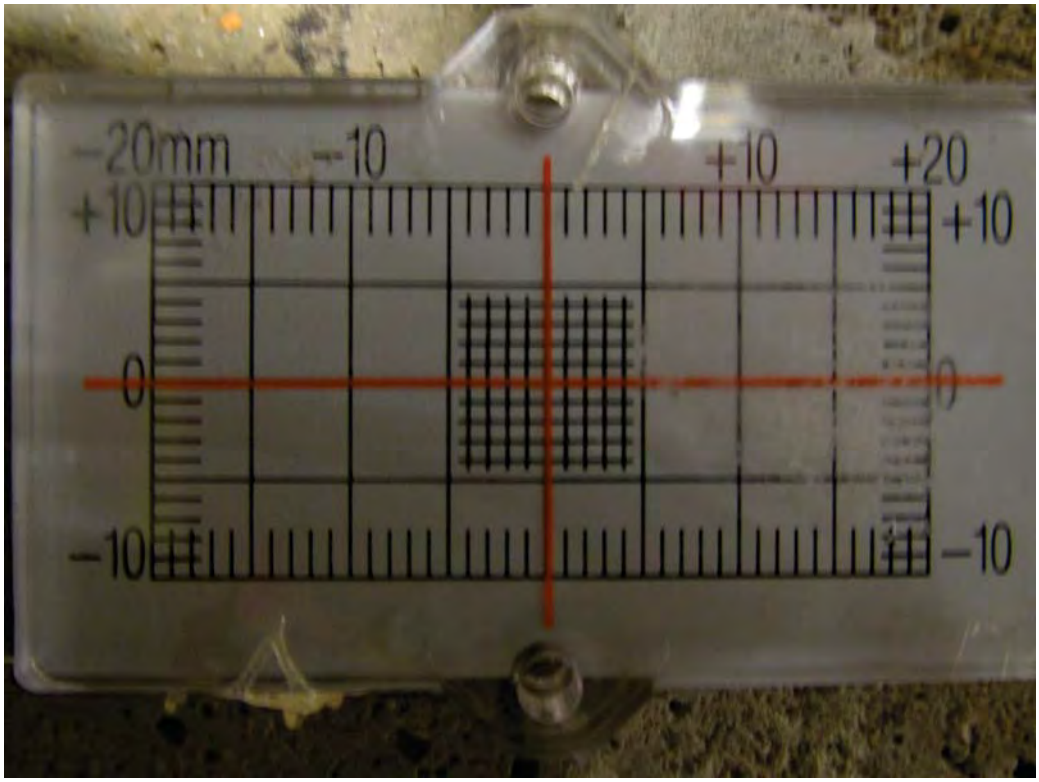
PHOTOGRAPH NO.3

- Tell-Tale Marker 2
- Location: Between Grid Line 14 & 15
- Comments: No movement



PHOTOGRAPH NO.4

- Tell-Tale Marker 3
- Location: Grid Line 19
- Comments: No movement



PHOTOGRAPH NO.5

CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

GENERAL CONFORMANCE REVIEW

DATE OF REPORT	DATE OF FIELD REVIEW	TIME OF FIELD REVIEW
Nov 24, 2017	Nov 24, 2017	10:30 AM

PROJECT	PROJECT No.	WEATHER CONDITIONS
TS Wall Monitoring	1897	6 Degrees C

TITLE	REPORT No.	PAGE No.
Memorial Arena Wall Monitoring - Review No.6	006	1 of 1

PURPOSE OF SITE REVIEW & ATTENDANCE

The above captioned site was visited for the purpose of performing the November monthly review of the structural assessment of the existing South Wall. Representatives from CSE were present.

CURRENT ACTIVITY

At the time of our site visit, no activity was taking place.

PARTS REVIEWED

- Crack Growth
- Delamination Survey
- Debris on Floors

COMMENTS

1. The tell-tale crack monitors were reviewed to see if there had been any movement and/or crack growth. No changes in the readings taken at our previous site visit were noted. We will continue to monitor the tell-tales for crack growth at the subsequent monthly reviews.

2. A hammer tap was conducted around the perimeter of the previously noted delaminated areas on the south face of the wall. In general, there has been no significant increase in the area of delaminated concrete since the initial investigation on June 23, 2017. We shall continue to perform this test at the following monthly reviews to determine if the area of delaminated concrete is increasing.

3. The amount of debris on the ground in both the header trench and the first bay underneath the ice rink slab was documented using photographs and compared to the photographs archived from the previous monthly reviews. Based on our review, there was a small increase in the amount of debris in the header trench tunnel at the west end of the tunnel, as a few additional concrete spalls were observed. As well, a small piece of cork had fallen from the roof of the first bay, which is not of any concern at this time. We will continue to monitor this condition at the following reviews.

At this time, no structural concerns are expressed, but the recommended additional shoring below the Zamboni Path and Localized locations for the Trench Header Pipes should be installed as a precaution.

We trust the above is to your satisfaction, should you have any further questions please do not hesitate to contact the undersigned.

SIGNATURE C.Miller

CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

GENERAL CONFORMANCE REVIEW

DATE OF REPORT	DATE OF FIELD REVIEW	TIME OF FIELD REVIEW
Dec 20, 2017	Dec 20, 2017	10:00 AM

PROJECT	PROJECT No.	WEATHER CONDITIONS
TS Wall Monitoring	1897	-1 Degrees C

TITLE	REPORT No.	PAGE No.
Memorial Arena Wall Monitoring - Review No.7	007	1 of 1

PURPOSE OF SITE REVIEW & ATTENDANCE

The above captioned site was visited for the purpose of performing the December monthly review of the structural assessment of the existing South Wall. Representative from CSE was present.

CURRENT ACTIVITY

At the time of our site visit, no activity was taking place.

PARTS REVIEWED

- Crack Growth
- Delamination Survey
- Debris on Floors

COMMENTS

1. The tell-tale crack monitors were reviewed to see if there had been any movement and/or crack growth. No changes in the readings taken at our previous site visit were noted. We will continue to monitor the tell-tales for crack growth at the subsequent monthly reviews.

2. A hammer tap was conducted around the perimeter of the previously noted delaminated areas on the south face of the wall. In general, there has been no significant increase in the area of delaminated concrete since the initial investigation on June 23, 2017. We shall continue to perform this test at the following monthly reviews to determine if the area of delaminated concrete is increasing.

Please note that no hammer tap was conducted along the inside (north) face of the wall.

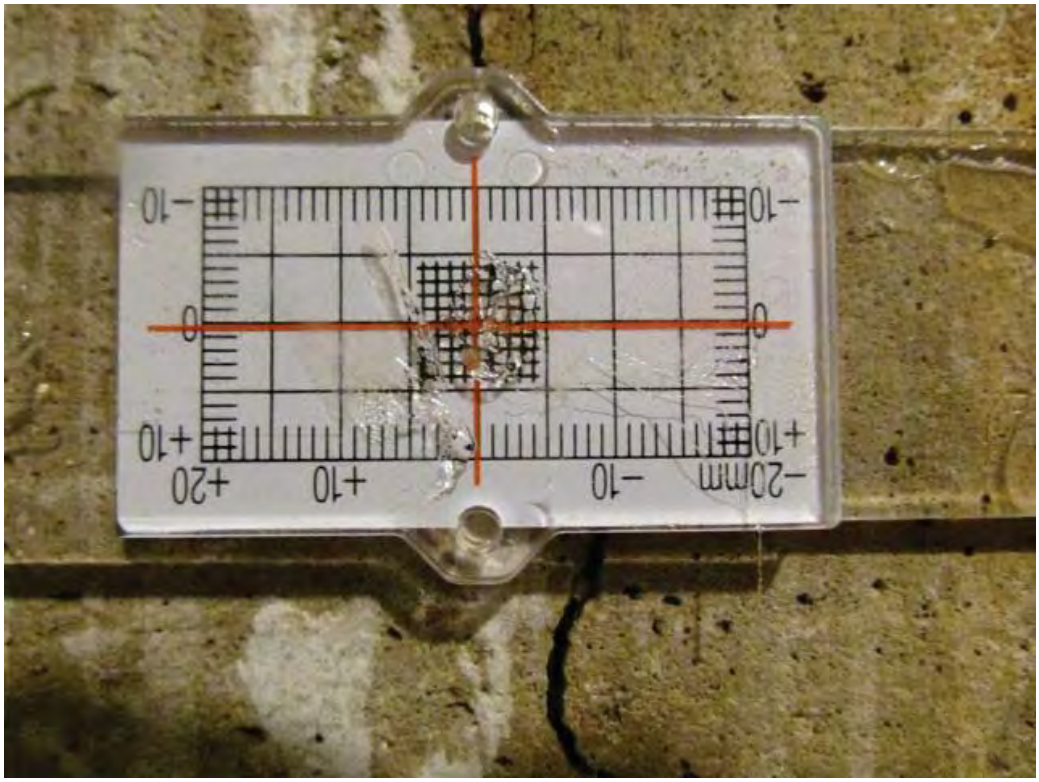
3. The amount of debris on the ground in the header trench was documented using photographs which were compared to the photographs archived from the previous monthly reviews. Based on our review, there has been a small increase in the amount of concrete debris in the header trench tunnel since the previous review. It should be noted that since these monthly reviews have commenced, a significant amount of debris has accumulated in the header trench tunnel. We will continue to monitor this condition at the following reviews.

We would recommend that the steel shoring design provided by CSE be installed in the header trench at the earliest convenience as a precautionary measure.

We trust the above is to your satisfaction, should you have any further questions please do not hesitate to contact the undersigned.

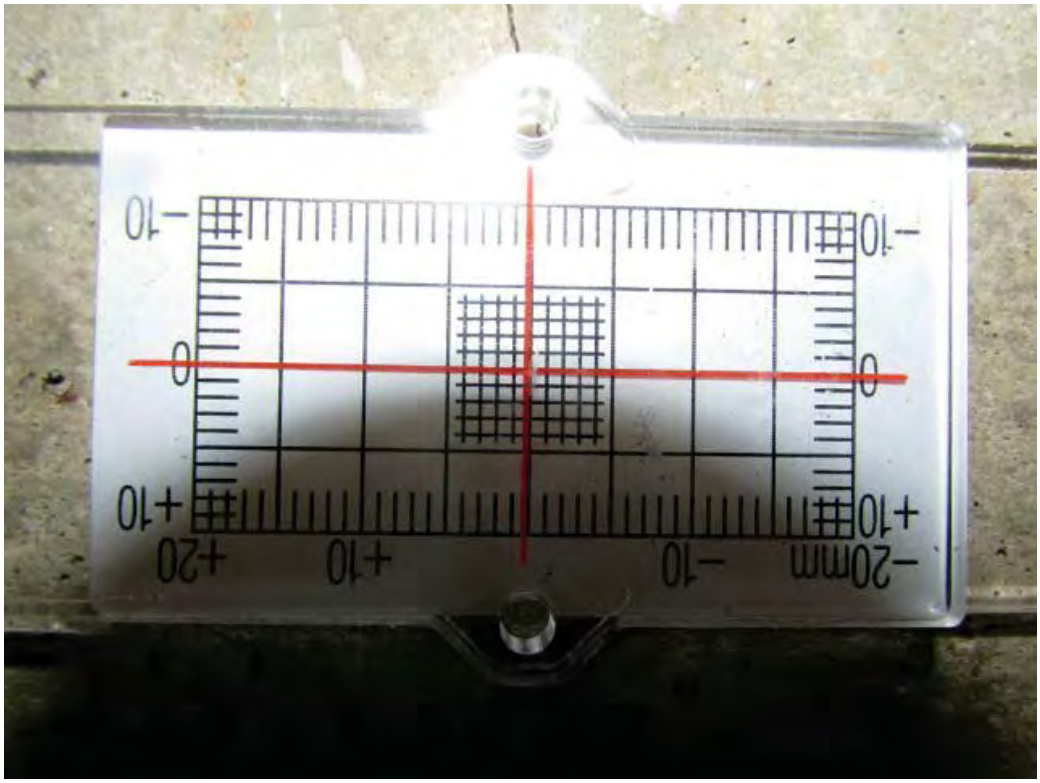
SIGNATURE C.Miller

- Tell-Tale Marker 1
- Location: Grid Line 10
- Comments: No additional movement



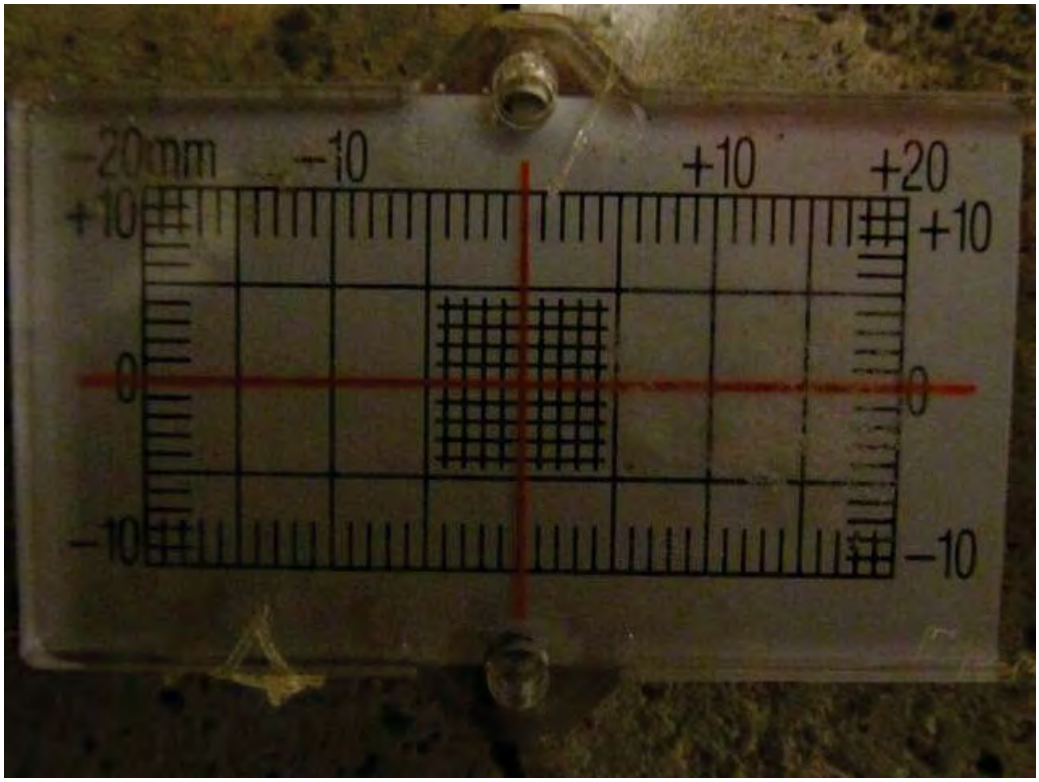
PHOTOGRAPH NO.1

- Tell-Tale Marker 2
- Location: Between Grid Line 14 & 15
- Comments: No movement



PHOTOGRAPH NO.2

- Tell-Tale Marker 3
- Location: Grid Line 19
- Comments: No movement



PHOTOGRAPH NO.3

CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

GENERAL CONFORMANCE REVIEW

DATE OF REPORT	DATE OF FIELD REVIEW	TIME OF FIELD REVIEW
Jan 25, 2018	Jan 24, 2017	2:30 PM

PROJECT	PROJECT No.	WEATHER CONDITIONS
TS Wall Monitoring	1897	-5 Degrees C

TITLE	REPORT No.	PAGE No.
Memorial Arena Wall Monitoring - Review No.8	008	1 of 1

PURPOSE OF SITE REVIEW & ATTENDANCE

The above captioned site was visited for the purpose of performing the January, 2018 monthly review of the existing South Wall at the Memorial Centre Arena. Representatives from CSE were present.

CURRENT ACTIVITY

At the time of our site visit, no activity was taking place.

PARTS REVIEWED

- Crack Growth
- Delamination Survey
- Debris on Floors

COMMENTS

1. The tell-tale crack monitors were reviewed to see if there had been any movement and/or crack growth. No changes in the readings taken at our previous site visit were noted. We will continue to monitor the tell-tales for crack growth at the subsequent monthly reviews.

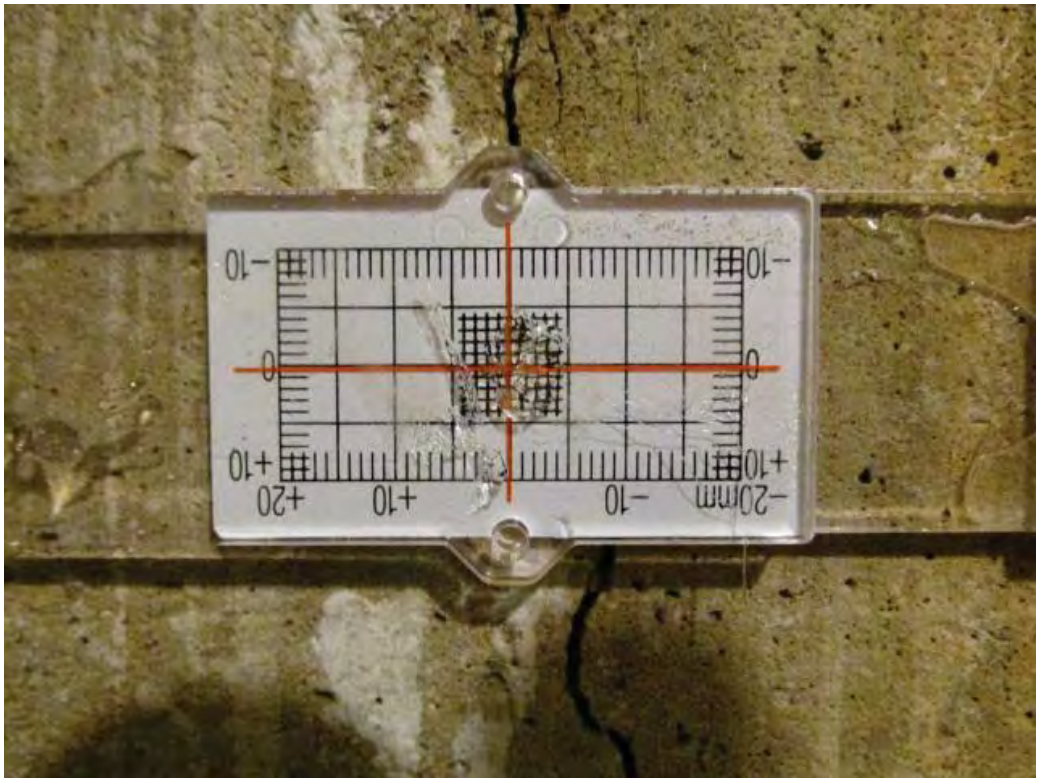
2. A hammer tap was conducted around the perimeter of the previously noted delaminated areas on both the north and the south faces of the wall. In general, there has been a slight increase in the area of delaminated concrete, since the initial investigation on June 23, 2017. However, this increase is only minor and does not pose any concerns at this time. CSE will continue to perform this test at the following monthly reviews.

3. The amount of debris on the ground in the header trench was documented using photographs which were compared to the photographs archived from the previous monthly reviews. Based on our review, there has been no noticable increase in the amount of concrete debris in the header trench tunnel since the previous review. However, it should be noted that since these monthly reviews have commenced, a significant amount of debris has accumulated in the header trench tunnel. We will continue to monitor this condition at the following reviews.

We trust the above is to your satisfaction, should you have any further questions please do not hesitate to contact the undersigned.

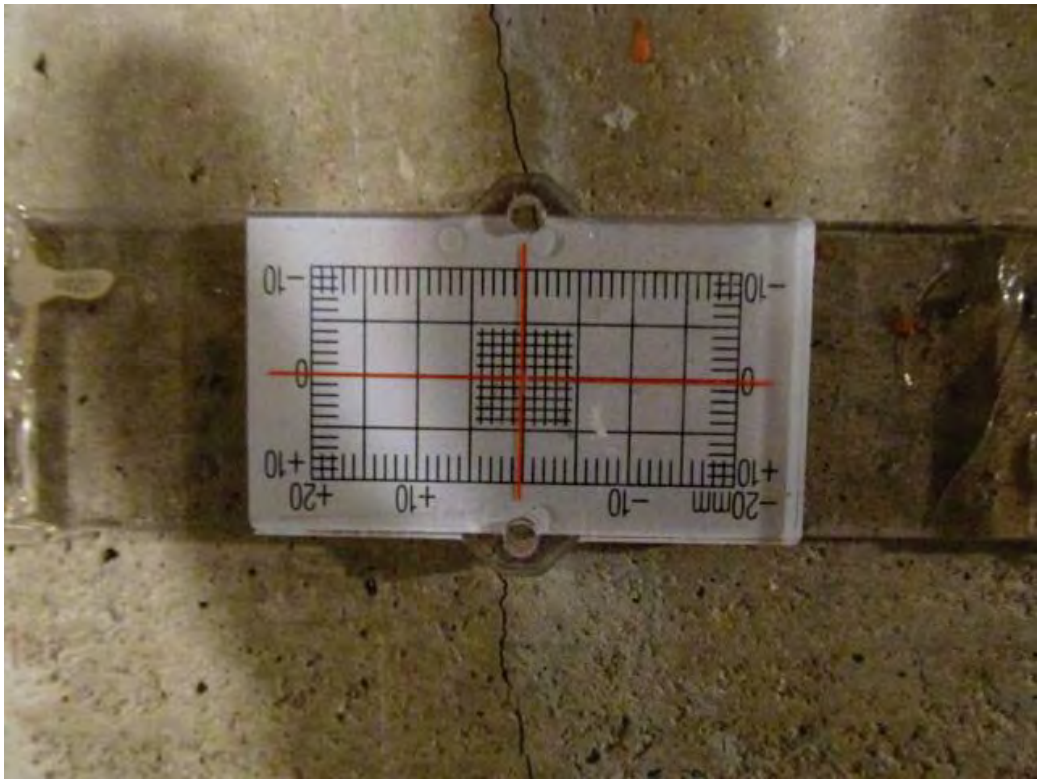
SIGNATURE C.Miller / G.Carvajal

- ▶Tell-Tale Marker 1
- ▶Location: Grid Line 10
- ▶Comments: No additional movement



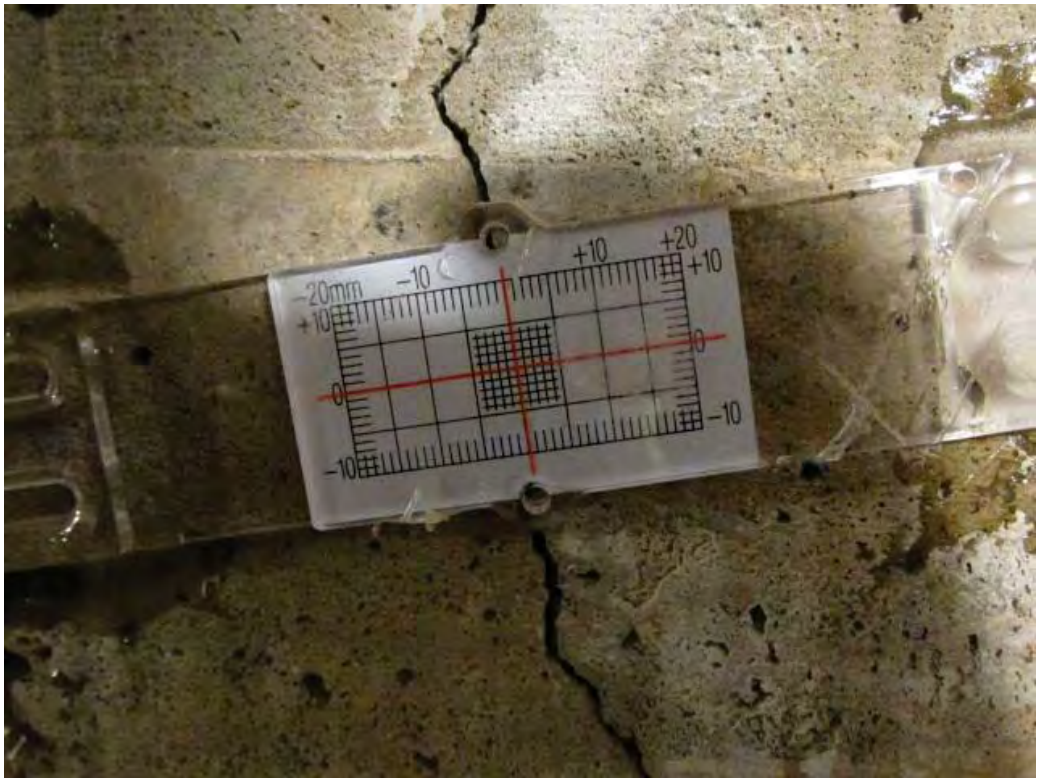
PHOTOGRAPH NO.1

- ▶Tell-Tale Marker 2
- ▶Location: Between Grid Line 14 & 15
- ▶Comments: No movement



PHOTOGRAPH NO.2

- Tell-Tale Marker 3
- Location: Grid Line 19
- Comments: No movement



PHOTOGRAPH NO.3

CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

GENERAL CONFORMANCE REVIEW

DATE OF REPORT	DATE OF FIELD REVIEW	TIME OF FIELD REVIEW
Mar, 9 2018,	Mar, 8 2018,	12:00 PM

PROJECT	PROJECT No.	WEATHER CONDITIONS
TS Wall Monitoring	1897	0 Degrees C

TITLE	REPORT No.	PAGE No.
Memorial Arena Wall Monitoring - Review No.9	009	1 of 1

PURPOSE OF SITE REVIEW & ATTENDANCE

The above captioned site was visited for the purpose of performing the monthly review of the existing South Wall at the Memorial Centre Arena. Representatives from CSE were present.

CURRENT ACTIVITY

At the time of our site visit, no activity was taking place.

PARTS REVIEWED

- Crack Growth
- Delamination Survey
- Debris on Floors

COMMENTS

1. The tell-tale crack monitors were reviewed to see if there had been any movement and/or crack growth. No changes in the readings taken at our previous site visit were noted. We will continue to monitor the tell-tales for crack growth at the subsequent monthly reviews.

2. A hammer tap was conducted around the perimeter of the previously noted delaminated areas on both the north and the south faces of the wall. Our review revealed that there has been a increase in the area of delaminated concrete since the initial investigation.

3. The amount of debris on the ground in the header trench was documented using photographs which were compared to the photographs archived from the previous monthly reviews. Based on our review, the amount of fallen debris is continuing to grow. Since these monthly reviews have commenced, a significant amount of debris has accumulated in the header trench tunnel. The source of the debris is the original slab that has been overlaid by the newer slab on top. We will continue to monitor this condition at the following reviews.

Overall, our reviews have revealed that the deterioration of the wall is progressing .

Some shoring has been schedule to take place once the ice is removed. A meeting to discuss the extent of shoring and possible alternatives is being suggested.

At this time, not safety concerns with the usage of the ice rinks is being expressed.

We trust the above is to your satisfaction, should you have any further questions please do not hesitate to contact the undersigned.

SIGNATURE C.Miller / G.Carvajal

CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

GENERAL CONFORMANCE REVIEW

DATE OF REPORT	DATE OF FIELD REVIEW	TIME OF FIELD REVIEW
Mar, 26 2018,	Mar, 23 2018,	11:00 AM

PROJECT	PROJECT No.	WEATHER CONDITIONS
TS Wall Monitoring	1897	3 Degrees C

TITLE	REPORT No.	PAGE No.
Memorial Arena Wall Monitoring - Review No.10	010	1 of 1

PURPOSE OF SITE REVIEW & ATTENDANCE

The above captioned site was visited for the purpose of performing the March 2018 monthly review of the existing South Wall at the Memorial Centre Arena. Representatives from CSE were present.

CURRENT ACTIVITY

At the time of our site visit, no activity was taking place.

PARTS REVIEWED

- Crack Growth
- Delamination Survey
- Debris on Floors

COMMENTS

1. The tell-tale crack monitors were reviewed to see if there had been any movement and/or crack growth. No changes in the readings taken at our previous site visit were noted. We will continue to monitor the tell-tales for crack growth at the subsequent monthly reviews.

2. A hammer tap was conducted around the perimeter of the previously noted delaminated areas on both the north and the south faces of the wall. Our review revealed that there has been an overall increase in the area of delaminated concrete since the initial investigation.

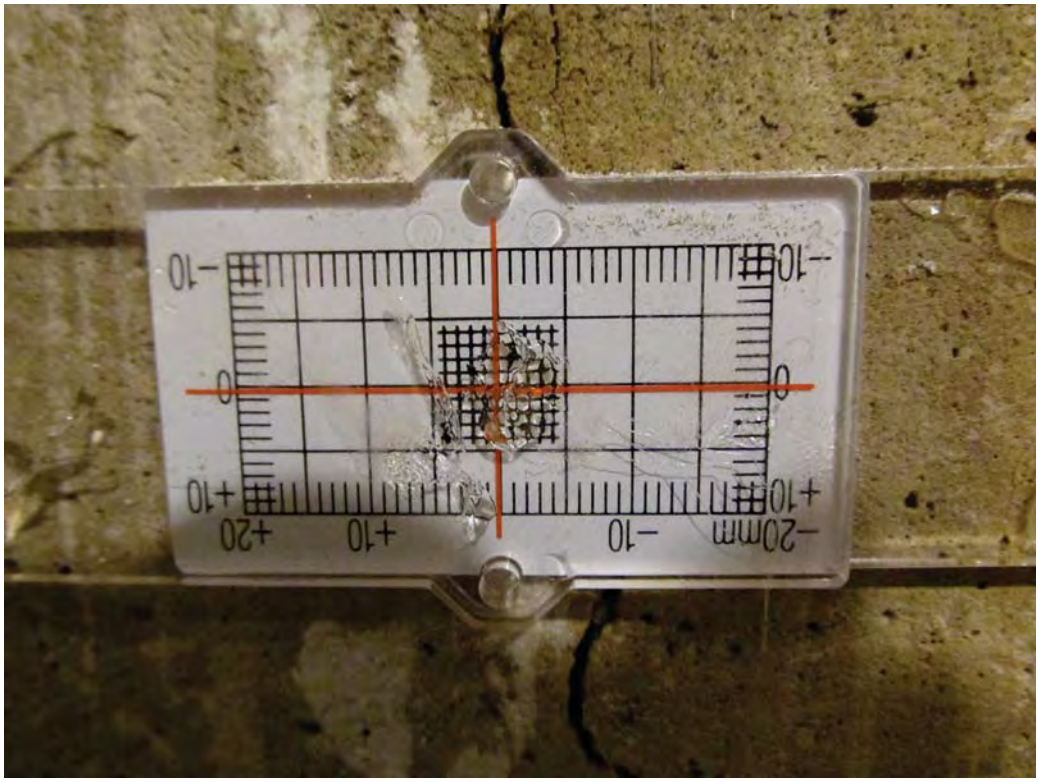
3. The amount of debris on the ground in the header trench was documented using photographs which were compared to the photographs archived from the previous monthly reviews. Based on our review, the amount of loose fallen debris is continuing to grow. The source of the debris is the original slab that has been overlaid by the newer structural slab on top. We will continue to monitor this condition at the following reviews.

Overall, our reviews have revealed that the deterioration of the wall is progressing. However, at this present time no safety concerns with the usage of the ice rink is being expressed.

We trust the above is to your satisfaction, should you have any further questions please do not hesitate to contact the undersigned.

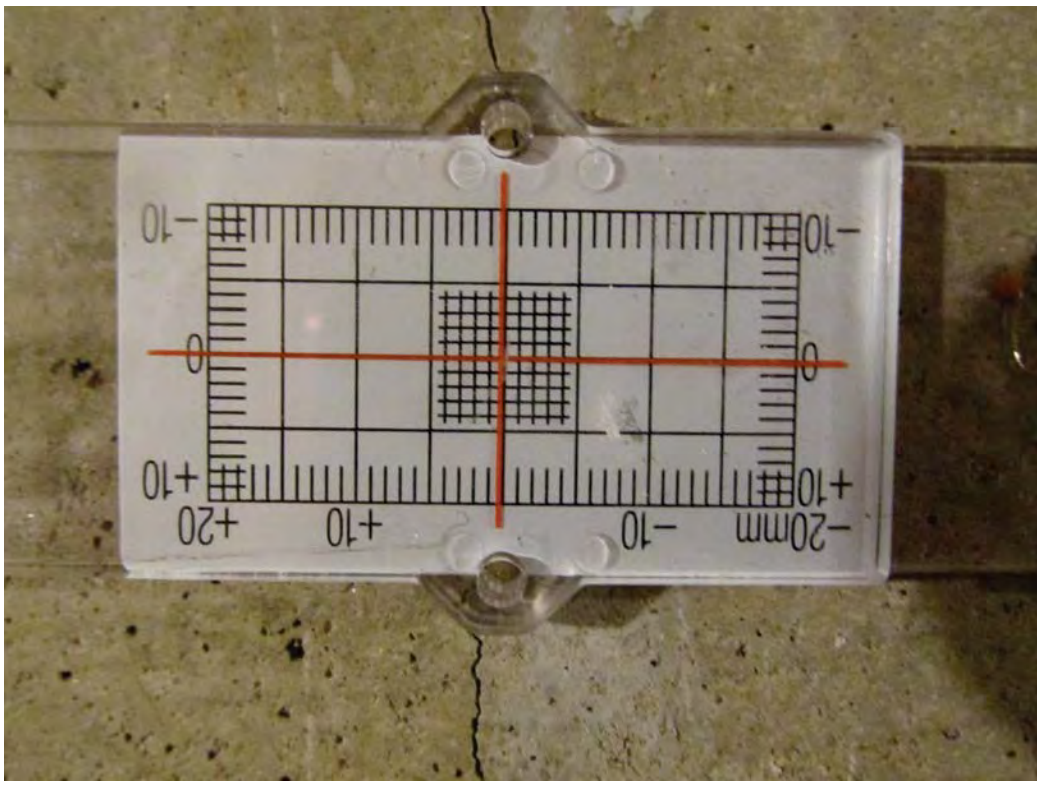
SIGNATURE C.Miller / G.Carvajal

- Tell-Tale Marker 1
- Location: Grid Line 10
- Comments: No additional movement



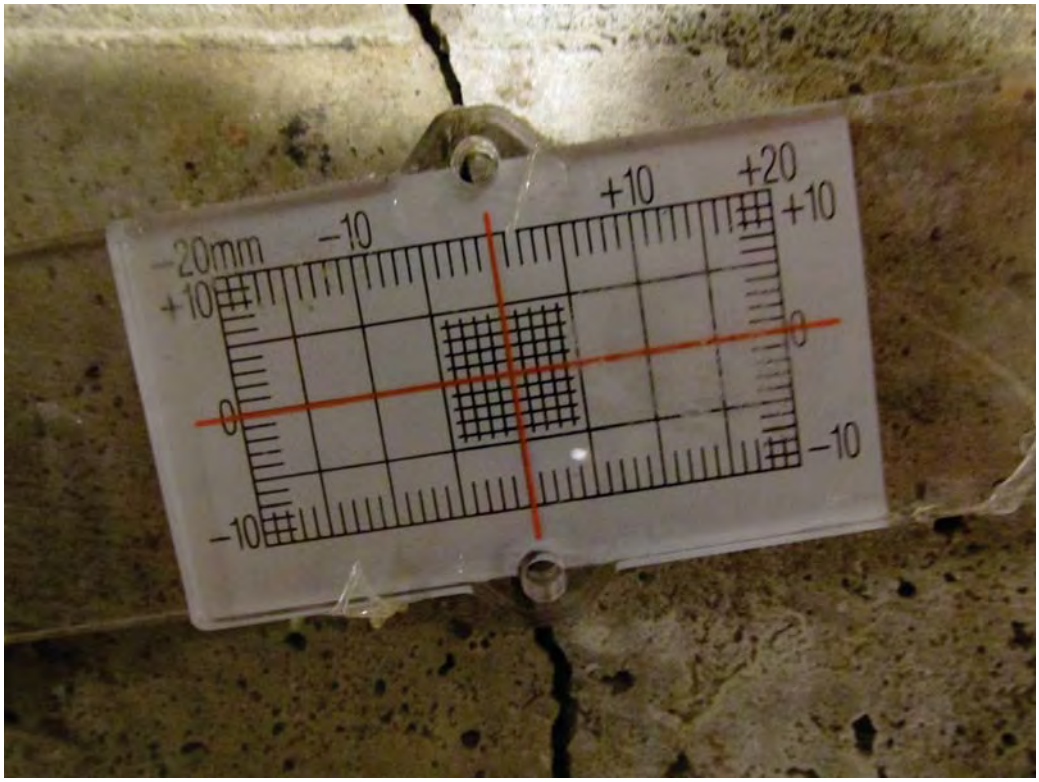
PHOTOGRAPH NO.1

- Tell-Tale Marker 2
- Location: Between Grid Line 14 & 15
- Comments: No movement



PHOTOGRAPH NO.2

- Tell-Tale Marker 3
- Location: Grid Line 19
- Comments: No movement



PHOTOGRAPH NO.3

CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

GENERAL CONFORMANCE REVIEW

DATE OF REPORT	DATE OF FIELD REVIEW	TIME OF FIELD REVIEW
May, 9 2018,	May, 3 2018,	1:00 PM

PROJECT	PROJECT No.	WEATHER CONDITIONS
TS Wall Monitoring	1897	15 Degrees C

TITLE	REPORT No.	PAGE No.
Memorial Arena Wall Monitoring - Review No.11	011	1 of 1

PURPOSE OF SITE REVIEW & ATTENDANCE

The above captioned site was visited for the purpose of performing the monthly review of the existing South Wall at the Memorial Centre Arena. Representatives from CSE were present.

CURRENT ACTIVITY

At the time of our site visit, no activity was taking place.
The ice rink had been removed at this time and therefore the header and brine pipes were no longer covered in ice build-up.

PARTS REVIEWED

- Crack Growth
- Delamination Survey
- Debris on Floors

COMMENTS

1. The tell-tale crack monitors were reviewed to see if there had been any movement and/or crack growth. No changes in the readings taken at our previous site visit were noted. We will continue to monitor the tell-tales for crack growth at the subsequent monthly reviews.

2. A hammer tap was conducted around the perimeter of the previously noted delaminated areas on the south (outside) face of the wall. Based on our review, there has been a significant increase in the area of delaminations since the initial investigation in June 2017.

3. The amount of debris on the ground in the header trench was documented using photographs which were compared to the photographs archived from the previous monthly reviews. Since the previous site review on March 23, 2018, there has been a notable increase in the accumulation of debris on the header trench floor.

4. The top of the concrete wall was reviewed since the previous build-up of ice is gone and it revealed that there is significant deterioration and loose concrete at the top of the wall. We believe this to be the result of frost damage.

CSE has scheduled a more detailed review of the south wall to determine the extent of frost damage and appropriate remedial measures.

We trust the above is to your satisfaction, should you have any further questions please do not hesitate to contact the undersigned.

SIGNATURE C.Miller / G.Carvajal

CSE STRUCTURAL FORENSIC & REHABILITATION SERVICES

GENERAL CONFORMANCE REVIEW

DATE OF REPORT	DATE OF FIELD REVIEW	TIME OF FIELD REVIEW
Jun 1, 2018	May 30, 2018	1:00 PM

PROJECT	PROJECT No.	WEATHER CONDITIONS
TS Wall Monitoring	1897	25 Degrees C

TITLE	REPORT No.	PAGE No.
Memorial Arena Wall Monitoring - Review No.12	012	1 of 1

PURPOSE OF SITE REVIEW & ATTENDANCE

The above captioned site was visited for the purpose of performing the May, 2018 monthly review of the existing South Wall at the Memorial Centre Arena. Representatives from CSE were present.

CURRENT ACTIVITY

At the time of our site visit, no activity was taking place.

PARTS REVIEWED

- Crack Growth
- Delamination Survey
- Frost Damaged Concrete

COMMENTS

1. The tell-tale crack monitors were reviewed to see if there had been any movement and/or crack growth. No changes in the readings taken at our previous site visit were noted. We will continue to monitor the tell-tales for crack growth at the subsequent monthly reviews. See attached photos of tell-tale markers.

2. A hammer tap was conducted around the perimeter of the previously noted delaminated areas on the south (outside) face of the wall. Since CSE's monthly reviews have commenced there has been continuous growth of the area of delaminated concrete.

3. A chipping hammer was used to determine the thickness of frost damaged concrete on both the inside and outside face of the wall. CSE's investigation revealed that in general there is 2-3 inches of damaged concrete on either face of the 8 inch thick wall (top of wall). The damaged concrete was observed to be loose and disintegrated easily.

Based on the results of our review and the safety concern of the continued use of the rink slab, CSE is recommending that the first bay north of the header trench be completely backfilled with a blown aggregate material to stabilize the ice rink slab. CSE will develop the plan, specifications & procedure.

We trust the above is to your satisfaction, should you have any further questions please do not hesitate to contact the undersigned.

SIGNATURE C.Miller / G.Carvajal