February 20, 2017

Municipality of the District of Argyle
27 Courthouse Road / PO Box 10
Tusket, Nova Scotia
B0W 3M0

Attn: Hans Pfeil, B.Sc., APALA, CSLA

Re: Report on Hipson Brook Bridge Site Investigation (Project No. 10-22010-038)

Background

Hipson Brook Bridge is a stone masonry arch bridge spanning the Hipson Brook in East Pubnico, Nova Scotia. The bridge was originally constructed as part of the original Nov Scotia Truck #3 Highway in the early 1900's. The bridge has only been subjected to pedestrian loading since 1936 when the original highway was realigned and a new bridge was constructed upstream from the existing.

SHM Canada Consulting (SHM) was retained by the Municipality of the District of Argyle to develop detailed design solutions to preserve the originality and value of the existing bridge. As part of the detailed design stage, SHM engineers performed a detailed site investigation to determine bridge defects and areas requiring restoration. The site investigation included visual and intrusive site inspections. The visual inspection was conducted on November 28, 2017 by Phil Vickers, P.Eng and Matt MacLeod, EIT with the assistance of KTM Services Group providing access support. The intrusive investigation was completed by exp Services on November 29, 2017. Sue Sirrs, APALA of Outside! Planning & Design Studio completed an inspection of the surrounding landscape and community park on November 29, 2017. This report presents the findings and recommendations from the site investigations.

Topographic Survey

A topographic survey of the bridge and surrounding area was completed on December 4, 2017, by Acker and Doucette Surveying Inc. Due to the lack of historical drawings and data of the site, the topographic survey is crucial for the development of tender drawings.

Visual Inspection

Bridge elements were inspected visually at an arm's length with the use of chipping hammers and nails used to determine the depth of deterioration and integrity of mortar. Rope access techniques were used to provide safe access during in-stream inspection due to heavy flow of

the brook. The portion of foundations below the water line were inspected using an underwater camera to determine the extent of mortar loss from joints and signs of undermining.


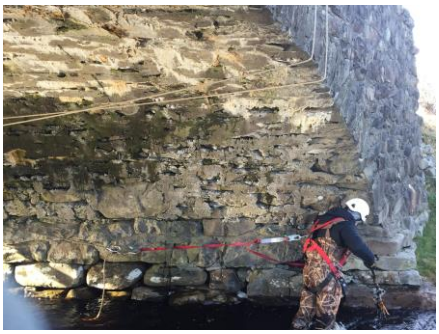

Figure 1: Testing of mortar deterioration (Left), Underwater video of arch foundations (Right)

The main findings from the visual inspection are as follows:

1. Undermining of foundations due to the brook flow;
2. Large fractured rock in north abutment/foundation;
3. Mortar at or below water line is badly deteriorated or absent due to the brook flow;
4. Previous patch repair of mortar on arch soffit is inconsistent with historic structure, covers the faces of stones, and is deteriorating;
5. Signs of widespread water seepage from top of arch is visible on arch soffit as evidenced by efflorescence;
6. Mortar on outer faces of bridge spandrel and parapet walls showing signs of deterioration;
7. Missing stones from parapet railings;
8. Stacked rock retaining walls on bridge approach are deteriorating, with rocks displaced or falling.


Figure 2: Loss of mortar in north foundation (Left), Condition of arch soffit (Right)

Figure 3: Deteriorating mortar on SE spandrel wall (Left), Presence of efflorescence on arch soffit (Right)

Figure 4: Partially tumbles south approach retaining wall (Left), Stones missing on west face of parapet railing (Right)

Intrusive Investigation

The intrusive investigation consisted of two boreholes at each bridge approach and the extraction of two cores from the top of the bridge arch. Both cores were fractured during extraction at the stone/mortar interface and could not be tested for compressive strength. The findings from the intrusive investigation are as follows:

1. Masonry Core Extraction:
    a. Fractures occurred at the interface of stone mortar/grout where surface water had seeped through, causing salt deposits and affecting the structural integrity of the arch;
    b. Vegetation root ingress through cracks into the top layer of mortar was observed;
    c. Presence of voids was noticed;

d. The arch appears to have been repaired in the past using cementitious material.

2. Boreholes:
    a. Strata underlying the bridge abutments is satisfactory and is not likely to lead to settlement of the foundation.

Figure 5: Masonry core extraction of arch (Left), Borehole drilling at north approach (Right)

Figure 6: Extracted core samples from arch.

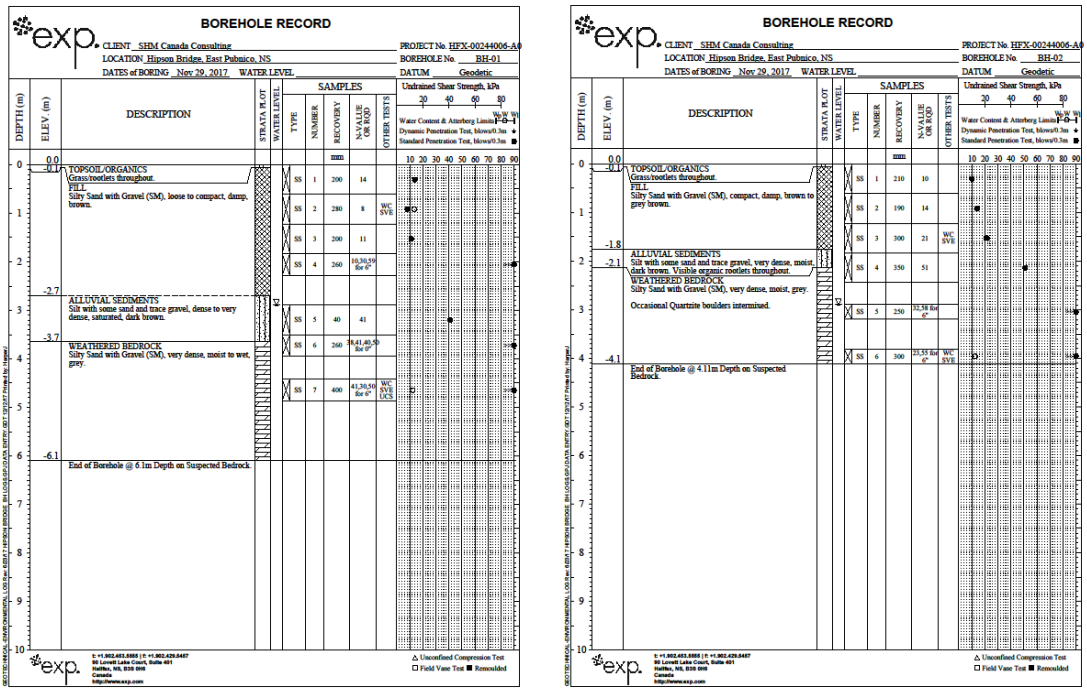

Figure 7: Borehole logs.

Landscape Investigation

The findings from the landscape site investigation are as follows:

1. Existing trees improve appearance of the bridge and the Community Park;
2. No vegetative protection at bridge abutments;
3. Stones added in brook by local anglers for kayak run in spring.

Recommended Repairs

Hipson Brook Bridge can be rehabilitated and preserved by implementing the following recommended remedial measures:

1. Foundation:
    a. Replace fractured/fragmented stones;
    b. Pressure grout foundations below water line using appropriate grout material;
    c. Point masonry joints.
2. Foundation Above Water and Arch:
    a. Remove previous mortar patch repairs and original mortar to 50 mm depth and repoint;
    b. Excavate existing backfill to expose arch extrados and pressure grout from top of arch to fill voids created by loss of mortar and water seepage;

   c. Cover arch extrados with liquid waterproofing membrane and drainage board to prevent future water seepage and root ingress.
3. Spandrel Walls and Parapets:
   a. Remove existing mortar to the depth of 50 mm from exposed and covered faces and repoint;
   b. Replace missing railing stones.
4. Approach:
   a. Reconstruct stacked rock retaining walls.
5. Landscaping:
   a. Keep all community amenities as they are;
   b. Reinstate any sod damaged by bridge repair work;
   c. Add vegetation in front of bridge abutments to deflect water away from foundations (soil bioengineering measures);
   d. Keep a grassy path to the water from the community park.

Cost Estimate

The estimated cost to perform the recommended repairs and restoration measures is $301,000 plus taxes. This estimated cost excludes fees for project management, administration, and inspection costs during construction.

Conclusion/Closing Comments

Instream work will be required to perform the recommended repairs outlined in this report. It is recommended that the municipality initiate contact with the Nova Scotia Environment and/or Department of Fisheries and Oceans Canada to coordinate construction of work to avoid any potential delays.

Please do not hesitate to contact me should you have any questions or require additional information.

Sincerely,

Vidya Limaye, Ph. D, P. Eng.

President,
SHM Canada