STANDING STONE LLC

Brookline Stone Arch Bridge Assessment Report and Repair Cost Guide

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ASSESSMENT:

A basic visual assessment of the current conditions was performed by Brian Post on Feb 7th 2025.

Based on this assessment the bridge was built in 3 segments.

1) The original portion

This is on the downstream end and is 14 ft long. The stonework was well built and it appears that an early Portland mortar, or a Portland/lime mix was used. There has been some settling and shifting over time. A far bit of the mortar has fallen out of the lower portion of most joints. It is typical of the work done by James Otis Follet on similar bridges in Southern VT.

On the southern side, the foundation appears to be getting undercut by the stream to some degree and the foundation and springer stones appear to have tilted inward. This should be carefully monitored for future movement and reassessed after snow melt when it can be more carefully looked at. It may need rebuilding in the not too distant future. Snow and Ice prevented a detailed inspection.

The north side appears reasonably unmoved and stable, A few stones have cracked but this does not appear to affect the stability.

Overall there does not appear to be much in the way of loose or missing stones or stones falling through the top of the arch. This section can be viewed as likely to be reasonably sound.

2) The middle portion.

This section appears to be an add on to increase the width of the bridge. It was built with stone and mortar or concrete. It was poorly constructed and relied on the mortar to “glue” it together.

Despite being relatively poorly constructed, the north side appears reasonably unmoved and stable, There are some cracks and missing mortar but this does not appear to affect the stability.

The south side of this section is near to collapsing, a large poorly placed stone at the bottom of the arch has been pushed forward out of the wall. It is precariously balanced on other stones and is holding up the arch above, Once this stone shifts a little further, it will likely lead to the collapse of this section of the arch. This collapse may happen a little at a time or all at once.

There are numerous other poorly placed stones on the south side that may lead to the section failing quickly once that one large stone shifts. Nearly all the mortar on this section has fallen out of the wall. It also appears that water is likely flowing through the upstream wing wall and washing back out through this section, further destabilizing it. It was observed that there were substantial gabs behind and above stones in this section.

This section needs attention very soon.

3) The concrete section
This section appears to be a further addition to widen the road to its present width. It is a monolithic cast in place concrete arch. The concrete appears to be in good sound condition. Without knowing if or how much steel is in the concrete it is not possible to determine the strength of the arch, however it appears to be sound and quite sturdy.

The south side and possibly both sides do appear to be getting undercut by flowing water. The concrete does not appear to extend deeper than the stream bottom. It appears that on the south side in particular water is flowing under and behind the concrete. There appear to be enough stones below the concrete that the concrete itself has not noticeably shifted.

Headers and wing walls:
Much of the header walls and wing walls were buried in snow. What could be seen appeared to be in poor condition.

On the upstream side the stonework on either side of the concrete appeared to be poorly constructed and affected by erosion, flood water, and pressure from the road infill behind it. These walls should be rebuilt in the not too distant future. Care should be taken to address flood water going through the wall.

On the downstream side the walls also appeared to be deteriorating. Erosion, pressure from the road infill, the installation of the guardrail posts, and stones deteriorating seem to be the main culprits. This header and wing walls should be rebuilt relatively soon.

Photos of the conditions observed are in Appendix B

RECOMMENDATIONS:

Monitor:

The most important thing to do at the moment is closely monitor the center section of the arch for further deterioration. Visually inspecting it after every storm and at least every two weeks. If there is further displacement of stones in this section or stone starts to come out of the arch, it is recommended that the bridge be closed to traffic until it can be closely assessed and at a minimum temporary reinforcement can be added.

Repair and Restoration

There are a variety of ways to address the restoration of this bridge: Rough order of magnitude costs are provided in Appendix A.

1) Do patch repairs to the sections most in need:

This would entail specific targeted rebuilding of sections as they get near to collapse. At present this would be addressing the south wall of the center section, and probably also the wing walls. The south side of the southern section needs a more detailed inspection after snow melt. It may also need rebuilding, or may be ok.

Key Advantages:

- This would best preserve what is there now, in that only the sections near to collapse would be rebuilt.
- It would also have the lowest initial cost, and perhaps the lowest cost overall for many decades

Key Disadvantages:

- There is no way to determine an engineered strength to the bridge
- It is more likely to need repairs in the future as additional sections deteriorate. This could result in some rework of previously repaired sections
- Small bridge opening size means increased likelihood of damage from future flooding

2) Installing a bypass culvert:

By installing a large culvert to the north of the bridge it would relieve flood water pressure on the bridge. This would mean water would flow through the bridge at a reduced speed and would be less likely to further damage the bridge.

Key Advantages:

- Allows for the preservation of the existing bridge while reducing flooding concerns
- Less expensive than a full rebuild and expansion of the stone bridge

Key Disadvantages:

- Only recommended in addition to patch repairs as above. It will not repair current damage.

- Increases the complexity of the stream channel, and may require additional maintenance after major flooding to maintain both channels.
- Would require work to be done outside of the road right of way. Neighboring land owners would need to allow this.
- Creates additional infrastructure that will need repair or replacement at some point.

3) A complete rebuild and expansion of a stone arch bridge

This approach would entail completely dismantling the existing bridge and building a new stone arch bridge in its place. This includes increasing the span to the recommendations of the state. All three sections of the bridge would be removed and rebuilt as a larger single span stone arch bridge. For the greatest strength and lowest cost, the arch barrel would be built with granite and the local ledge stone from the existing bridge would be repurposed for the spandrels and wing walls. The road surface would likely need to be raised a bit to accommodate the larger arch.

Key Advantages:

- Less costly than the proposed concrete box culvert
- Preserves the history of a stone arch bridge in this location
- Reuses the existing stone
- Much better longevity than a concrete structure in this climate
- Can be built to a known engineered strength and design load
- Significant reduction in project CO2 emissions by avoiding the use of concrete

Key Disadvantages:

- Does not leave any part of the existing historic structure intact
- Higher cost than doing patch repairs

Conclusions:

Based on this initial assessment there does not seem to be any benefits to the standard modern engineered approach of using a concrete structure in this location. It is costly and does not preserve the history of the bridge in any way. The decision between the strategies outlined above can best be determined by the available funding, long term durability, and desired preservation goals. Standing Stone can provide additional consulting to assist with determination process as needed.

APPENDIX A:

Rough Order of Magnitude (ROM) Costs

The costs outlined below are based on numerous assumptions of the scope of work and conditions. These are provided as a guide for decision making on the direction to move forward with the bridge. The costs shown here are not bid prices. Once a direction to move forward has been identified a work proposal and bid price or time and materials proposal can be prepared and submitted.

Project Element	Notes	ROM Cost
Repair to the south side of the center portion of the bridge	Includes temporarily supporting areas to remain, digging through the roadbed, placing large footing stones and rebuilding the failing section using existing stone which will be supplemented with additional similar stone. Hydraulic Lime mortar will be used in the repaired section. The area dug will be refilled and compacted and the road bed replaced. Repaving is not included.	$20,000 to $35,000
Rebuild the wing walls	Rebuild all 4 wing walls using existing stone supplemented by additional similar stone. Address erosion and water infiltration issues.	$25,000 to $35,000
Rebuild the south side of the original portion of the bridge.	If necessary, rebuilding this portion would include the same process as rebuilding the center section. Repaving is not included.	$25,000 to $40,000
Install an additional 4ft diameter culvert	Includes the excavation, and installation of the culvert as well as digging a the inlet and outlet channels needed, building stone header walls for the culvert and rip-rap armoring for stream channels and steep slopes. Repaving is not included.	$50,000 to $65,000
	Total if all the work above is done	*$120,000 to $175,000*
Complete rebuild of a new expanded stone arch bridge	As described above a complete rebuild of a new stone arch bridge to modern load capacities, and the needed size to accommodate flood waters. Guard rails and repaving are not included.	$220,000 to $260,000

APPENDIX B:

Photos of existing conditions:

Above and below: Middle section of bridge south side. Large stone precariously balanced and holding the bridge above.

North side of middle section. Shows poor building technique, but it appears to be relatively stable

North side, downstream portion, shows some cracked stone and mortar loss, but is generally in good condition.

Downstream end. Note the stones on the south side (left) at the bottom of the arch appear to be sloped downward. This may indicate a problem with this section. Both wing walls are in poor condition.

Upstream end. Concrete seems stable but the stone wing walls are deteriorating.