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Memorandum l May 26, 2020

Lake Park Arch Bridge over Ravine Road

Concrete Repair and Surface Treatment Alternatives

To: Karl Stave, PE
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Purpose

WJE assembled a memorandum on the Lake Park Arch Bridge concerning repair and surface treatment options of the original concrete. The final draft of the Memo is dated May 5, 2020. WJE's memorandum is attached. The purpose of this document is to provide additional considerations in the decision on how to proceed with repairs and protective coatings for the original concrete retained as part of the rehabilitation.

Introduction

As designers for the rehabilitation of historic bridges we are routinely faced with decisions on how older materials should be treated as part of projects. Extremely deteriorated materials, in poor condition, lead to simple choices; Reconstruction with appropriate materials is the choice. Materials in good condition are relatively simple choices too; Little or no additional change is often necessary to keep the material in service. Materials exhibiting some deterioration, and at best in fair condition, present the most difficult decisions. Retaining the materials that already exhibits deterioration often includes compromises. Do I simply reconstruct the material, or to provide a reasonable service life, do I need to coat the material with a protective coating? From a designer's perspective it is simple to reconstruct the component. From a historic preservation perspective, the retention of historic fabric is important and reasonable means should be used to preserve it. Therein lies the tension.

WJE considered chloride contamination levels, carbonation levels, and freeze thaw damage evidence. This led WJE to conclude that a protective finish is necessary for retained concrete elements. We agree with this conclusion. WJE continued and compared the characteristics of clear silane sealers and pigmented acrylic film forming coatings. From a historic preservation perspective, they found the clear silane sealers to be the preferred option. For several reasons, we disagree that a clear silane sealer is the preferred protective finish for the Lake Park Arch Bridge. We believe the thin build pigmented acrylic film forming coating is better suited for the retained concrete components of this bridge.

The WJE memo was intentionally written to be vague assuming that another entity would consider their memo in making recommendations for the project. It should also be noted that they did not consider cost implications, schedule implications, or maintenance measures such as graffiti removal in their memo. As the designers of record, we do not have the luxury of deferring conclusive concrete repair and surface treatment decisions to another entity.

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The WJE memo even suggests that past repairs that are sound but "inappropriate" according to the standard might be removed and replaced. We believe this standard of care to be appropriate for a National Historic Landmark. We also believe this standard of care is extremely expensive.

> **Relative importance in history.** Is the building nationally significant? Is it a rare survivor or the work of a master architect or craftsman? Did an important event take place in it? National Historic Landmarks, designated for their "exceptional significance in American history," or many buildings individually listed in the National Register often warrant Preservation or Restoration. Buildings that contribute to the significance of a historic district but are not individually listed in the National Register more frequently undergo Rehabilitation for a compatible new use.

Excerpt from the National Park Service's Website (https://www.nps.gov/tps/standards/four-treatments.htm)

The Lake Park Arch Bridge over Ravine Road is a beloved bridge. It is a contributing historic resource to a beloved National Register listed park. Our project is using the Rehabilitation Treatment found within the Secretary of the Interior's Standards for the Treatment of Historic properties. WJE recognizes that Rehabilitation is the appropriate treatment for this resource.

The Rehabilitation standard is less stringent than the Preservation or Restoration standards, in that more significant alterations can be accepted.

It should also be noted that pigmented protective coatings have been used on important concrete bridges for decades. Bridge engineers have simply understood it greatly extends the service life of old concrete and provides a more uniform color that the public expects to see when a bridge completes a rehabilitation project. We have worked on three Mississippi River concrete arch bridges in Minneapolis that are individually listed in the National Register. All three were rehabilitated in the 1970s prior to their national register nomination. All three were coated to protect the original concrete.

The pigmented coatings typically used on new concrete bridges are a relatively "thick" build product (0.1" thick) which is intended to cover blemishes in the original construction. Recognizing the historic importance of the Lake Park Arch Bridge – the pigmented coating is planned to be thin or low build with a thickness of just 0.030".

The WJE Memo recommendation for a clear silane also includes a recommendation to stain adjacent prior repairs that have a different color compared to the surrounding original concrete. They recognize that without some "treatment" of the prior repairs the resulting appearance will likely be unacceptable. One of our concerns with this approach is that we've seen concrete stains fade within a relatively short period of time. If fading occurs on this project, the current blotchy appearance will return in short order.

Looking at the project as a whole, we feel the best historic bang-for-the-buck is obtained by bringing back the historic railing. If an unusually large amount of the project's dollars are spent on concrete repairs and coatings (typically away from the arm's length of the public) we will be unable to bring back the historic railing and meet the fiscal constraints of the project.

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Impacts to the Historic Integrity of the Bridge Depicted in the 30% plans

SEVEN ASPECTS OF INTEGRITY

- Location
- Design
- Setting
- Materials
- Workmanship
- Feeling
- Association

The ***Location*** will be unchanged as part of the project – no reduction in historic integrity.

The ***Design*** will be improved. The original balustrade railings will be returned to the bridge. While not original historic fabric – the historic integrity will be improved by conveying a design element from an earlier time. It is retaining its use as a pedestrian crossing in a park.

The ***Setting*** will be unchanged. It will continue to be nestled in a park setting. No new buildings or structures will be constructed near the bridge to diminish the setting.

The integrity of the ***Materials*** is mixed because of the project. Some historic materials will be lost because they are severely deteriorated. The reconstructed components (as permitted in preservation Brief 15) will be "uncoated" concrete components just as they were originally. Most users and visitors to the bridge will interact with the uncoated concrete components. The retained historic concrete elements will be coated with a thin-build acrylic coating to provide protection from accelerated deterioration and to provide a more uniform color to the components. Many have extensive patched regions that are not matched to the surrounding concrete color or texture.

We believe the integrity element of ***Workmanship*** will be unchanged or improved. The balustrade railing will exhibit the artisan elements from its original construction.

We believe the integrity element of ***Feeling*** will be improved. It will better convey its original construction date of 1905 and will better integrate with the nearby Grand Staircase details.

The integrity of the ***Association*** will be unchanged

Best Possible Match to the Color, Finish and Texture

The WJE memo identifies several tasks be undertaken to obtain "the best possible match to the color, finish, and texture of the original concrete". The "best possible" is a higher standard than a normal bridge rehabilitation project is held to. The "best possible" comes with additional cost and additional schedule.

Concrete Staining: Use of pigmental stains and semi-transparent coating to adjust the color of sound but non-matching prior repairs is endorsed within the WJE memo. The cost of an artisan level of concrete staining is believed to be on the order of $15,000. This task was not contemplated in the 30% cost estimate of probable bid price. Concrete staining is perceived to be on the critical path of the structural schedule. As such, it is likely this work would extend the duration of construction by up to one week. Application of a pigmented film-forming coating would eliminate the ostensible need for concrete staining.

Trial Concrete Mixes: The WJE memo encourages the development trial concrete mixes to obtain the best possible match to the color, finish, and texture of the original concrete. Development of specialized concrete mix to emulate the original concrete should be completed prior to the procurement stage of the project to eliminate variables in bidding and to mitigate the potential for claims. Development of the concrete mix would require hiring a testing laboratory and field work. It is anticipated the cost of developing the specialized concrete mix would be $10,000 or more. It is not clear that the specialized mix could be develop

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in time to meet the current design development schedule. Application of a pigmented film-forming coating would mitigate the perceived need to develop a specialized concrete mix to match the original concrete. It should be noted that concrete mock-ups are included in our 30% project.

Trial Forming Techniques: The WJE memo encourages exploration of forming techniques, again to achieve the best possible match to the color, finish, and texture of the original concrete. This is envisioned to entail experimental trials with shotcrete, form-and-pour methods, and form-and-pump methods. This level of experimentation is cost prohibitive and cannot be completed within the design schedule. Shotcrete was used to make concrete surface repairs circa 1974 and 1976 and likely constitutes over 10% of the surface of the bridge. Shotcrete finished to emulate the finish and texture of the original concrete was assumed in the 30% estimate of probable bid price. Requiring form-and-pour or form-and-pump methods of concrete surface repairs is anticipated to increase the cost of the repairs by more than $180,000.

Trial Crack and Surface Repairs: The WJE memo indicates trial concrete crack repairs should be undertaken. Like the other trial repairs, this exercise should ideally be accomplished prior to the procurement stage of the project. It is unlikely that trial crack repairs could be developed and evaluated within the design schedule. The current design budget is insufficient to undertake this experimentation. The current crack repairs and concrete surface repairs utilize an elastomeric compound beneath two layers of pigmented film-forming coating with elastomeric properties. The intention is to seal the cracks from moisture through the seasonal temperature variations to extend the remaining service life of the bridge. If a penetrating sealer is applied to the bridge, the elastomeric compound would need to be eliminated from the repair details. The crack and concrete surface repairs would not have flexible properties to accommodate seasonable temperature variations. The repairs would also be inherently prone to moisture infiltration due to sealers limited crack bridging capacity which would lead to deterioration at an accelerating rate with the passage of time. Crack repair details absent the elastomeric compound and elastic film-forming coated are inferior because they compromise the service life of the bridge. We believe there is no need, budget, or schedule to experiment with means and methods of crack repair.

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Interaction with the Original Concrete

In general, observers of the Lake Park Arch Bridge will not be within arm's length from the original concrete. That is, there limited opportunity to observe color, finish, texture, and details of the original concrete. At the south end of the bridge, spectators will have access only to uncoated concrete in the form of wing walls, railing, and deck. At the northwest corner of the bridge along the stone steps, original concrete will be within the viewshed of observers, but again not within arm's length. It is apparent that people have (will) congregated near the face of the north thrust block. The entire front face of the north thrust was repaired with shotcrete in circa 1974 and has been painted, presumably to mask graffiti. As such, there is limited original concrete is this area.

Figure 1: North Thrust Block Shotcrete Face

Rustications, Reveals and Spandrel Walls Voids

Regardless of chosen repair and surface treatment methods, the original rustications, finials, reveals and voids in the spandrel walls from the circa 1906 construction will remain intact. This ensures preservation of the of some of the major features of this historic structure.

Figure 2: Arch Rib Finial

Figure 3: Rustication and Reveals

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Original Concrete Surface

The Lake Park Arch Bridge has been existence for nearly 115 years. Those concrete surfaces exposed to sun, wind and rain have eroded significantly.

Form Board Demarcations: The horizontal lines demarking the interface of boards used to form the concrete are barely visible on the concrete surfaces exposed to the elements. The form board lines on the exposed surfaces of the concrete are obscure for two reasons: 1) The designers would attempt align the form boards on the prominent faces of the bridge to mitigate the visual distraction of form board lines and 2) Whatever lines of demarcation existed have largely been eroded away. Board form finish is often found in obscure locations where the original designers were less concerned about the texture of the concrete element. Evidence of form boards are a clue as to the age of a component, not a design feature.

Exposed Aggregate: The concrete cream on the exposed surfaces of the bridge have also eroded to the point it appears to be some form of exposed aggregate. The pseudo exposed aggregate is a byproduct of deterioration, it is not an original design detail. Point being that application of a pigmented film forming coating would not obscure what may be perceived as design features.

Figure 4: Existing Original Concrete Surface

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Parge Coating: It appears that the exposed faces of both the east and west arch ribs and spandrel walls have been coated with some form of cementitious parge material. Loose parge will be moved during the rehabilitation efforts. The fact that majority of the original concrete surface of prominent features of the bridge has already been concealed lessens the argument pigmented film forming coating should not be applied because it will conceal the color, finish, and texture of the original concrete

Figure 5: East Arch Rib and Spandrel Face w/ Parge Coat

Figure 6: West Arch Rib & Spandrel Wall Face w/ Parge Coating

Graffiti Removal

Those portions of the bridge near the face of the thrust blocks and within arm's reach from the ground are prone to graffiti vandalism. Removal of graffiti is perceived to be different when a penetrating sealer and when a pigmented film forming coating is applied.

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Penetrating Sealer: A penetrating sealer fills the voids in a concrete surface. It does not provide a uniform coating over the surface of the concrete. Therefore, paint will adhere to the concrete and will need to be removed, or painted over, in the instance of vandalism. Painting over graffiti will obfuscate or otherwise destroy the color, finish, and texture of the sealed original concrete. Use of a graffiti remover would likely ameliorate the graffiti but is not likely to remove it. Water or medium blasting will likely remove graffiti. However, the blast cleaning will negatively impact the color, finish, and texture of the concrete surface. It is likely that the remedy to graffiti of a sealed concrete surface it to blast clean the concrete, reseal the concrete and live with the alteration to the color, finish, and texture.

Pigmented Film Forming Coating: The coating will develop an opaque acrylic film over the concrete surface. Removal of graffiti from the coated concrete is envisioned to include removal of the graffiti to the extent possible with low pressure water blasting and/or solvents. If the film is disturbed during the process, or the color is changed, the coating could simply be re-applied over the graffitied area. Alternatively, the coating could be applied over the graffiti as if painting over the graffiti. Removal of graffiti from a coating surface is believed to be less labor intensive than removal graffiti from a sealed concrete surface.

Conclusions and Recommendations

Financial Constraints: There are financial limits to complete the project. The 30% estimate of probable bid price exceeds the available funds for the project. It is entirely possible that the 60% estimate of probable bid price will exceed the 30% estimate as the quantities, scope of work, and level of effort are refined. Adding trials for concrete mixes, crack repair, forming techniques, surface treatments will without doubt push the design and estimated probable bid price further beyond the available funds.

Conceivably planned design features such as the balustrade railing, could be sacrificed to make more funds available for trial mixes, etc. From ONE's perspective, it is much more important to bring back the railing than conducting trial repairs.

Schedule: The existing design schedule requires final documents to be completed by the end of December 2020. It is unlikely that trial mixes, crack, and surface repair techniques could be conducted and evaluated, and findings incorporated into the construction documents within the existing design schedule.

Preservation of Historic Fabric: Use of an elastomeric compound beneath layers of pigmented film forming coating with elastomeric properties will provide superior protection of the original concrete than a penetrating sealer with rigid repair materials. The farther one looks into the future, the more important this becomes. It is possible that use of and proper maintenance of a pigmented film forming coating in combination with elastomeric compounds will led to a service life of more than 50 years.

Remaining Original Concrete Surface: There is very little, if any, of the original concrete surface color, texture finish remaining on prominent east and west faces of the arch ribs and spandrel walls.

Graffiti Removal: Removal and repair of graffiti is believed to less laborious if a pigmented film forming coating is applied to the original concrete.

Recommendation: ONE recommends advancing the design with details as depicted in the 30% design submittal.