Yates Hall Steam Tunnel

Pittsburg State University

Structural Assessment Report

Prepared For:
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PEC Project No.:
217063-001

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Date:
October 20, 2022

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Purpose

Professional Engineering Consultants, P.A. (PEC) was engaged by Pittsburg State University to perform an assessment of the steam tunnel lid located behind Yates Hall in Pittsburg, KS. The purpose of the assessment is to review the condition of the concrete lid after excessive spalling was observed and provide repair recommendations. The tunnel lid is used for pedestrian traffic and occasionally vehicle traffic.

The structural scope of services includes observations of the existing conditions, production of a written report documenting the observations, and to provide an assessment (conclusions and recommendations) based on the observations. Environmental assessment including, but not limited to, asbestos, lead based paint, mold and water intrusion is expressly excluded from the scope of work.

The evaluation of the property for elements routinely provided by other disciplines, not listed above, is excluded from the report.

Observations

The observations were performed on August 3, 2022. The observations were performed by Larissa Minihan, I.E. with University Architect Lindell Haverstic and Plumbing Supervisor John Foster.

The original construction of the tunnel consists of a six inch reinforced concrete slab bearing on two eight inch reinforced concrete retaining walls on either side of the tunnel. The slab spans five feet clear from inside face of tunnel wall to inside face of tunnel wall.

Areas of rust staining, concrete cracking, and concrete spalling were observed throughout the length of the steam tunnel lid.

EXTERIOR RUST SPOTS

Rust spots were visible throughout the length of the tunnel on the top side of the slab.

EXTERIOR CRACKING

Cracks were observed when viewing the top of the steam tunnel lid from outside Yates Hall. One crack in the concrete propagated the full width of the steam tunnel.



EXTERIOR SPALLING

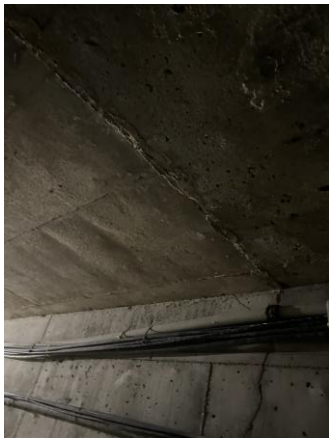
In multiple locations on the top side of the slab, the concrete spalled and the welded wire fabric reinforcing was exposed to the elements.


INTERIOR CRACKING - LID

Observed interior cracking propagated along the width of the tunnel. Some full width cracks may have been control joints from the original construction of the tunnel.




INTERIOR CRACKING – LID (CONT.)



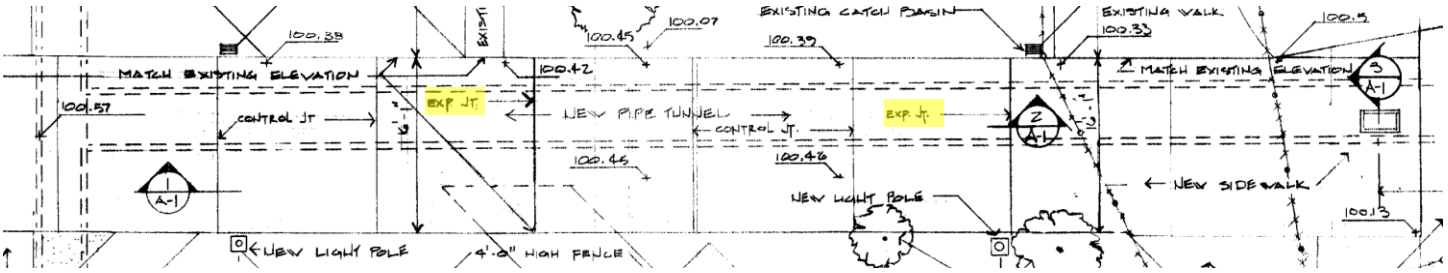
INTERIOR CRACKING - WALLS

At multiple locations throughout the length of the tunnel, cracking in the walls was observed. The cracks were located near the top of the wall adjacent to the connection to the tunnel lid.

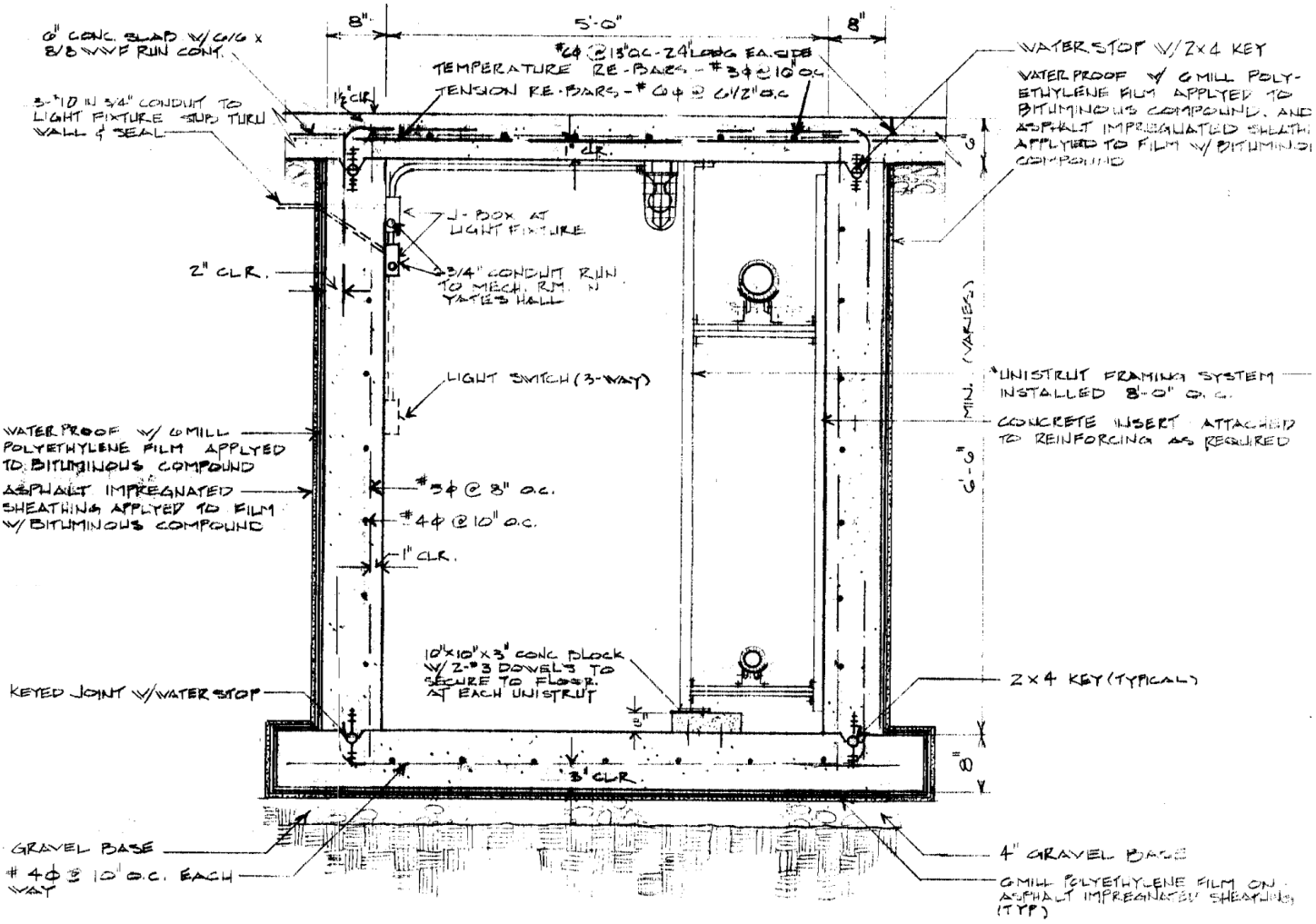
INTERIOR SPALLING

Large pieces of spalled concrete were observed within the tunnel in various locations. The impacted areas had been shored to try to mitigate further movement of the concrete so not all damage was able to be observed.

The original construction documents, dated August 11, 1980, were reviewed as part of this assessment. The drawings indicate two expansion joint locations in the tunnel lid. The drawings also note that control joints are to be at 16'-0" o.c. maximum.



The section through the tunnel indicates there are to be waterstops and keys between the top of the tunnel walls and the concrete lid. The concrete slab is to be reinforced with welded wire fabric, #6 tension bars at 6½" on center, and #3 temperature reinforcement at 10" on center. The strength of the concrete was not called out. A concrete strength of 3,000 psi was assumed for calculation purposes. The detail is included below for reference.



Conclusions

Based on the observations, it is our professional opinion spalling concrete exposed the reinforcing and has allowed water to infiltrate the slab and degrade the interface between the concrete and reinforcing. Reinforcing that is exposed to water, de-icing agents, etc. will rust. As the rebar within the slab corrodes and expands, the surrounding concrete will begin to spall.

Based on visual observations, all the locations with excessive spalling also have rusted reinforcing visible. Water penetrating the slab appears to be a long standing issue based on the stalactites forming at crack locations. There is also sealant visible in locations that should be control joints instead of expansion joints as viewed from the top of the slab. This could indicate an attempt to remedy the water infiltration issues.

It was difficult to align the observed damage within the tunnel to the tunnel lid as observed from above in the exterior photos. It is possible some of the interior cracks observed that were straight across the width of the tunnel were due to control joint locations on the surface of the tunnel lid. The control joints provide a location for the concrete to crack in a controlled manner. These cracks are caused by concrete movement due to temperature changes and shrinkage while drying. They are expected as the concrete ages and are not cause for concern. It is recommended to seal these cracks against water infiltration.

The spalled concrete on top of the slab reveals that the welded wire fabric reinforcing does not have the concrete cover of 1½"to the surface of the slab as indicated in the detail. To protect the reinforcing from water infiltration and subsequent damage, the reinforcing should have been placed to maintain the indicated clear distance between it and the top of the slab. The American Concrete Institute (ACI) requires a cover of 1" minimum between top of concrete and reinforcing for exposed slabs. From the images provided in the exterior spalling section, it is shown that the depth between the top of concrete and the welded wire reinforcing is less than required.

An analysis was performed for a unit width of the tunnel lid. The slab was checked for a pedestrian load of 100 pounds per square foot. It was also checked for a vehicular load of 640 pounds per lineal foot based on AASHTO loading requirements. The results of the calculations indicate that the construction of the slab should be adequate for pedestrian loading as well as maintenance vehicles.

However, if the slab is subjected to extreme loading in excess of the loads analyzed or cyclical heavy loading, the slab could become overstressed. It was determined from the calculations that the slab would be at its maximum capacity with a load of approximately 3,100 lbs located at the center of the tunnel. This result is based on the original design of the tunnel lid and does not account for the degradation that has already occurred. It is unclear what caused the initial spalling of the tunnel lid. However, periodic heavy loads cause changes in the deflection of the slab which can exacerbate the spalling issue.

Due to the spalled concrete, the slab then has reduced capacity from the loss of concrete section and the degradation of the reinforcing. An inch of concrete section loss (5" slab instead of 6") reduces the capacity of the existing slab by 27%. Degraded rebar experiencing more than 15% section loss (reduced to 5/8" diameter) reduce the capacity of the slab by 14%. Where there is spalled concrete, there is also likely to be degraded reinforcing. The combined effects of these two factors reduce the capacity of the slab by a third.

Concern was expressed that the north side of the tunnel slab appeared to be lower than the rest of the slab. The elevations provided on the original construction drawings indicate the elevations on either side of the tunnel differ. The slab may have been formed with a slope for drainage purposes. Some slab settlement is normal and expected to occur but there were no indications of excessive slab settlement on one side of the tunnel.

It was also noted in the report that there were cracks visible in the wall of the tunnel past the hatch, where the tunnel lid drops in elevation. The cracks in the walls are not cause for structural concerns at this time.

Recommendations

Based on the observations, PEC recommends repairing the impacted areas as indicated in the construction documents prepared by PEC dated October 20, 2022. The exposed rebar will need to cleaned of all rust and the concrete replaced to avoid continued degradation.

While repairing the notable areas of concern, it is also recommended to patch minor cracks or spalling in the tunnel lid and walls with the repair grout.

PEC would appreciate the opportunity to assist in implementing the recommendations in this report. Please do not hesitate to contact us if we can be of further service.

Disclaimer

This assessment was based on the conditions readily observable at the time of the assessment and any related inspection. Subsequent deterioration of the property may have occurred since the time of any such inspection. There may be unforeseen or hidden damage that was not observed at the time of the observation due to a number of possible issues. No subsurface or other intrusive investigation was made.

No survey was performed to determine any dimensions or boundaries.

PEC does not have any beneficial interest in the subject property. This report is a qualitative assessment of the property. Construction and/or renovation of the property based on the conclusions or recommendations should not begin until a full set of construction documents are prepared by a licensed professional. The report is written solely for the use of the client listed above and no other party shall have the right to rely on the information contained in the report. This report is not transferable to a third party without written permission of PEC. Reproductions of this report, not bearing the original engineer's signature, are invalid. This Assessment was limited to the items specifically included in the scope of work. Nothing in this report shall be deemed to imply or suggest anything beyond what is specifically stated.