

Demolition Observations/Findings of the City of Houghton's "Big Deck"



Prepared By:

U.P. Engineers & Architects, Inc.

100 Portage Street, Houghton, Michigan 49931



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Brief History

The former parking deck located between Huron Street and Quincey Street, was constructed in 1978. The parking structure itself was an elevated post tensioned slab floor system on a COR-TEN structural steel frame. There have been several evaluations and reports done on this structure which identified issues with the structure and provided recommendations to address those issues.

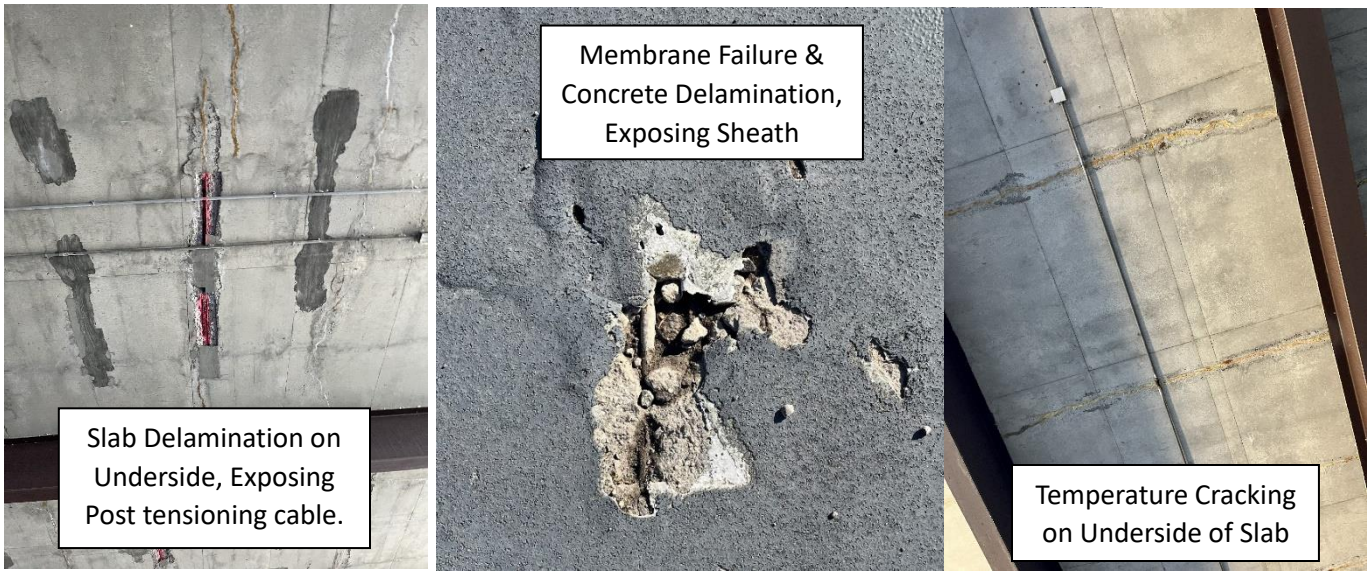
In 2011-2012 the City hired Comprehensive Engineering & Restoration Engineering Tech to conduct a Structure Condition Assessment of "The Big Deck". Based on the evaluation the firm provided two possible project scopes to maintain safe operation of the parking deck; one which was termed a "10-year fix" and the other a "20-year fix" which denotes the expected service life of the proposed work before more extensive and expensive repairs would be required to maintain safe operation of the deck. The 20-year fix was estimated to cost twice as much as the 10-year fix. Due to budgetary constraints the City voted to implement the less expensive "10-year fix".

The last major repair sequence (approx. \$1.1 million to complete) took place between 2012-2014 and addressed the loss of strength in post tensioning cables due to corrosion, concrete patching, and placement of an elastomeric coating. The corrosion was attributed to exposure to deicing salts used on the deck and that transported in by vehicles occupying the deck. The corrosion caused the strands of the cables to break and the seasonal freeze thaw cycles, with expansion of the corroding cables, caused spalls in the concrete surface which further increased exposure to the corrosive materials. The work also included spot repairs of some of the concrete surfaces and the addition of a thin high-strength concrete layer intended to slow the intrusion of moisture and chlorides. The elastomeric coating was placed on the deck surface to further inhibit migration of moisture and chlorides.

In the years since the last repairs were completed, the deck concrete experienced several additional failures, such as:

- Spalling/popping under the coating of previously repaired and newly repaired areas.
- Spalling of bottom-side repair patches which resulted in concrete falling to the pavement below and occasionally parked vehicles.
- Spalling of "new" bottom side sections.

- Spalling of post-tension cable locations and exposure of the cables.



Slab Delamination on Underside, Exposing Post tensioning cable.

Membrane Failure & Concrete Delamination, Exposing Sheath

Temperature Cracking on Underside of Slab

After much discussion, consideration, structural evaluations, and several public input meetings the City of Houghton council approved moving forward with the demolition of the parking structure in July of 2021 and obtained a \$1,500,000 general obligation bond to finance the demolition and associated surface repairs. The City of Houghton was later awarded a \$1,000,000 grant from the Michigan Economic Development Corporation (MEDC) in the Fall of 2022 through their Revitalization and Placemaking Program. The “Lakeshore Drive Corridor Rehabilitation” project was later awarded to MJO Contracting, Inc of Hancock, MI near the end of April in 2023 to demolish the parking structure and restore the area previously encompassed by the parking structure.

Demolition Summary

MJO Contracting, Inc. subcontracted with Veit & Company, Inc. out of Rogers, MN to complete the demolition of the parking deck. Demolition crews utilized several larger excavators with specialized attachments for demolition including a concrete “jaw cracker” for demolition of the post tensioned concrete deck, and steel shears for cutting beams and columns. Building protections were installed and deployed prior to any demolition occurring, the building facades were primarily protected with large timber matting that were mounted to the parking structures steel beams. All exterior doors, windows, gas meters, air conditioning units and other fixed objects within the demolition influence were



Concrete Jaw Cracker



Steel Shears

protected through boarding and shielding. Seismic monitors were installed in strategic locations throughout the duration of demolition to ensure/verify that the demolition operations were not causing excessive vibrations adjacent to the buildings that would cause damage to any of the historic buildings near the work.

Temporary Timber Mats Protecting Building Facades During Demolition



Steel Shoring During Demolition

Photo of the Eastern Deck Demolition

Excavator Processing the Concrete Deck

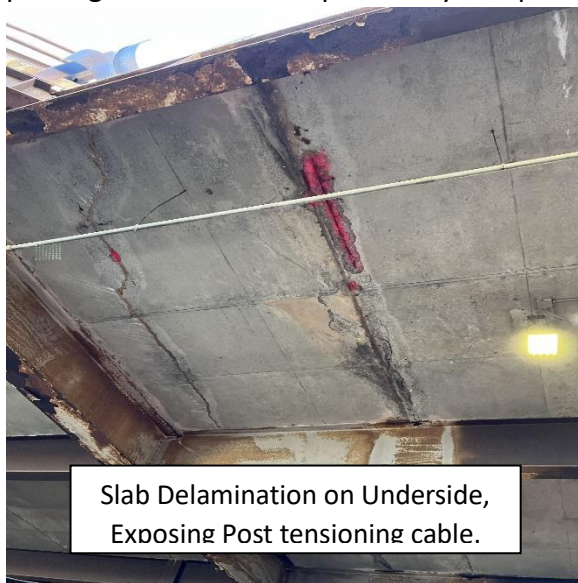


Photo of the Eastern Deck Demolition

The actual demolition of the “Big Deck” began on June 20, 2023, and was substantially completed on July 20, 2023, so it took about one month to take down and haul away. Throughout the demolition there was a wide array of observations made by MJO Contracting, Veit & Company and U.P. Engineers and Architects that made one really question how much longer this structure would have safely lasted had it not been taken down or had extensive and expensive repairs completed, which will be briefly discussed throughout this demolition observation summary.

Concrete Deck Delamination and Cracking

The first deficiencies of the parking deck we will discuss is concrete slab delamination and temperature cracking. This should come as no surprise as they have been identified in every parking deck evaluation previously completed, and rightfully so as you didn’t need to look very



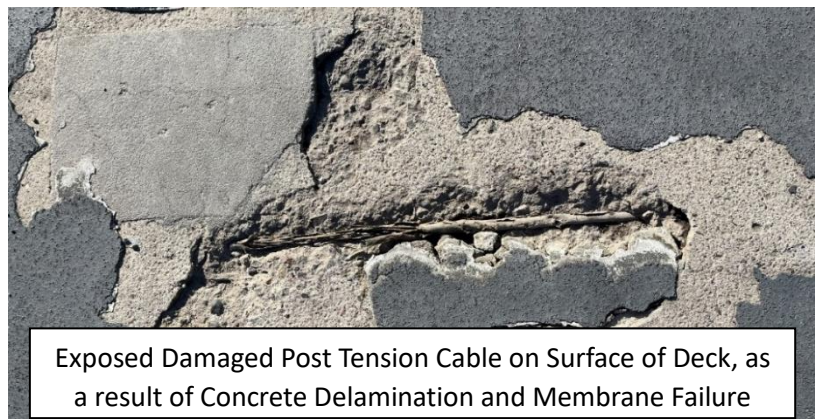
Slab Delamination on Underside, Exposing Post tensioning cable.

hard or far at the underside of the parking decks concrete slab or the concrete deck to locate them. On several occasions throughout the demolition and even during the demolition preparation, there were substantial sections of concrete that had fallen from the underside of the structures slab in areas that no work was even being conducted in. When mentioning this to several City staff members after the fact, it was noted that they had occasionally needed to remove sections of concrete that had fallen from the underside of the slab from Lakeshore Drive in the past and that they routinely inspected the underside of the concrete with a lift and a pike

pole to identify and remove loose concrete. While that may not be of concern to some, this is certainly a major safety hazard when you consider that the concrete is falling approximately 15 feet to the ground with enough force to seriously injure or even kill someone depending on the size of the falling debris.

Post Tensioning Strands

As mentioned in previous evaluations for the parking deck, it was believed that some of post tensioning strands had been compromised due to corrosion from penetrating chlorides. Isolated instances of this were visible from the underside of the



Exposed Damaged Post Tension Cable on Surface of Deck, as a result of Concrete Delamination and Membrane Failure

deck where cracks were evenly spaced out parallel to the spans which is a direct result of inadequate compressive forces from the post tensioning strands. However, this was confirmed throughout the demolition of the parking structure as many of the strands/cables had little to no tension left in them, it is estimated that approximately 50% of the strands were compromised completely or partially, as there was very little or no tension to release when cutting the strands.



Slab Delamination on Underside, Exposing Post tensioning cable.

Chloride and Moisture Penetration

In 1999 during a Comprehensive Parking Structure Analysis completed by Carl Walker Parking Consultants the deck surface was tested for chloride penetration and was found to have



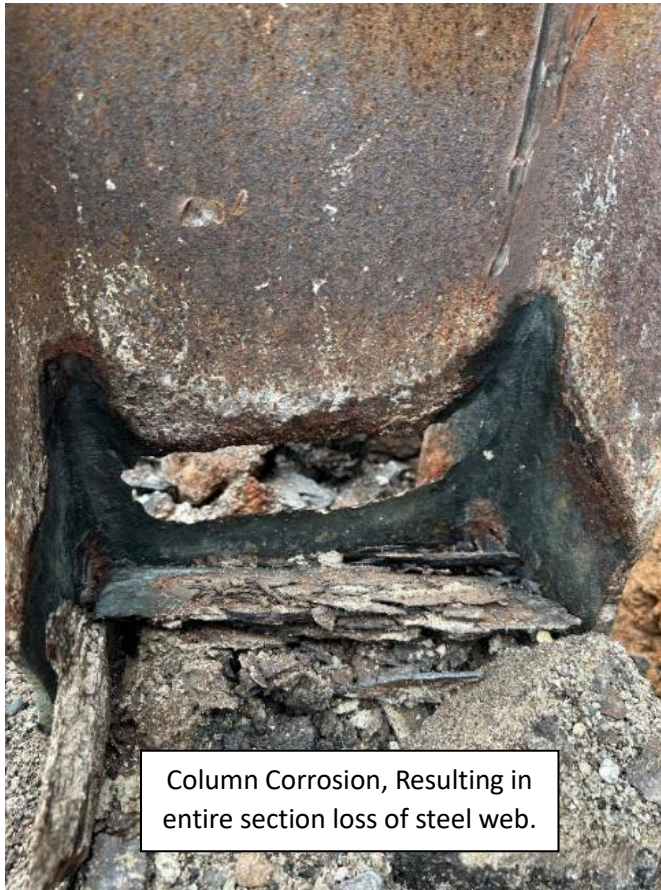
Membrane Failure & Concrete Delamination, Exposing Sheath

infiltrated the concrete up to 3 inches, the original post tensioned slab was only 5 inches thick in most areas, other areas being 7 inches thick. Despite the City of Houghton's efforts over the years to limit chloride and moisture infiltration to the concrete, the chlorides and moisture that had already penetrated the slab continued to diffuse through the slab to the reinforcing steel in the post tensioned slab and compromise the concrete through the repeated freeze-thaw cycles. The membrane installed in 2013 has since been compromised and is missing or deteriorated in various locations throughout the surface of the elevated slab allowing chlorine laden water to soak through the concrete slab further compromising reinforcing steel, deteriorating the

concrete and compromising post tensioning cables/strands and the sheaths protecting them. Even after the elastomeric membrane was installed concrete underneath the membrane was continuously spalling each winter further degrading the slab and the membrane could only be repaired during summer months due to temperature application limitations.

Structural Steel Corrosion

One of the larger more concerning observations made during the demolition of the Big Deck was the condition of some of the connection plates between the concrete footings and the vertical steel columns supporting the deck and the subsurface condition of the H-Piles/columns, which were completely corroded including the anchor bolts in some instances. The column pictured below had completely rusted through and was located approximately six inches below grade. These connections and structural members were not previously thoroughly evaluated as it would have required destructive investigations but has been noted that columns were corroded at grade in several previous evaluations. In the most recent evaluation for the parking deck completed by Pierce Engineers in 2020 it was mentioned that there were bracing beams spanning north/south under the Eastern half of the deck that had minor buckling from twisting out of plane, and the failed subsurface connection plates and section loss of columns are likely the result of this due or at a minimum a contributing factor to the loss in horizontal movement resistance.



Structure Stability during Demolition

Throughout demolition shoring and bracing was required to prevent excessive lateral movement or swaying when processing the concrete deck, while this can be attributed to several factors, it was primarily only an issue in areas that were found to have corroded or compromised connections/anchor points as described and pictured previously. In order to safely take down the structure large beams were welded as cross bracing to stabilize the frame, as shown to the right.



Parapet Wall Condition

The parapet wall/masonry wall bordering the North Side of the eastern half of the deck had severe freeze thaw damage from extensive water infiltration over the years. Sections of this wall were to the point that one could remove bricks by hand, this area was closed for several years leading up to the demolition for that reason.



Stair Tower Condition

The eastern stair tower had extensive corrosion of the stair pan risers and treads as well as multiple failed welds, leading to the closure of the eastern stair tower several years ago. Even



with the closure of the stair tower and minimal use, on several occasions there were sections of the stair pan that had fallen due to the extensive corrosion. In addition to the above three of four exterior walls were compromised due to freeze/thaw damage essentially meaning the stairwell needed to either be torn down or completely rebuilt.

Conclusion

Parking structures in northern climates such as ours, if properly designed, constructed, and maintained have a typical service life of 40-50 years. This structure was constructed in 1978 and it is now 2023 and the “Big Deck” was in service for 45 years. While it had COR-TEN structural steel framing, which is more resistant to atmospheric weathering than other steels, this structure had far outlived its service life when considering the decks direct exposure to de-icing chemicals, primarily salt which further reduces the expected service life mentioned above.

While in the later years of the deck the city did not use salt to de-ice the deck, there is still a substantial amount transported in by vehicles occupying the deck. As previously mentioned in this report chloride had penetrated up to half of the slab back in 1999 which was essentially half of the deck’s service life and likely penetrated further over the last 24 years it was in service. This further stressed the need to complete a major investigation requiring destructive investigations and further leading to extensive rehabilitation projects to keep the deck in service, however the cost to conduct these investigations and subsequent repairs far outweighs the cost to remove and relieve the taxpayers of the financial burden that would be imposed to keep it operational or replace it.

While the convenience of the deck will certainly be missed, the decision made by the City Council to demolish it was certainly supported by the observations made during the demolition of the structure. While one cannot speculate if a catastrophic failure was imminent, the past documented safety hazards and structural deterioration witnessed during demolition provided clear evidence that failure was eventual without extensive rehabilitation of the parking deck structure.

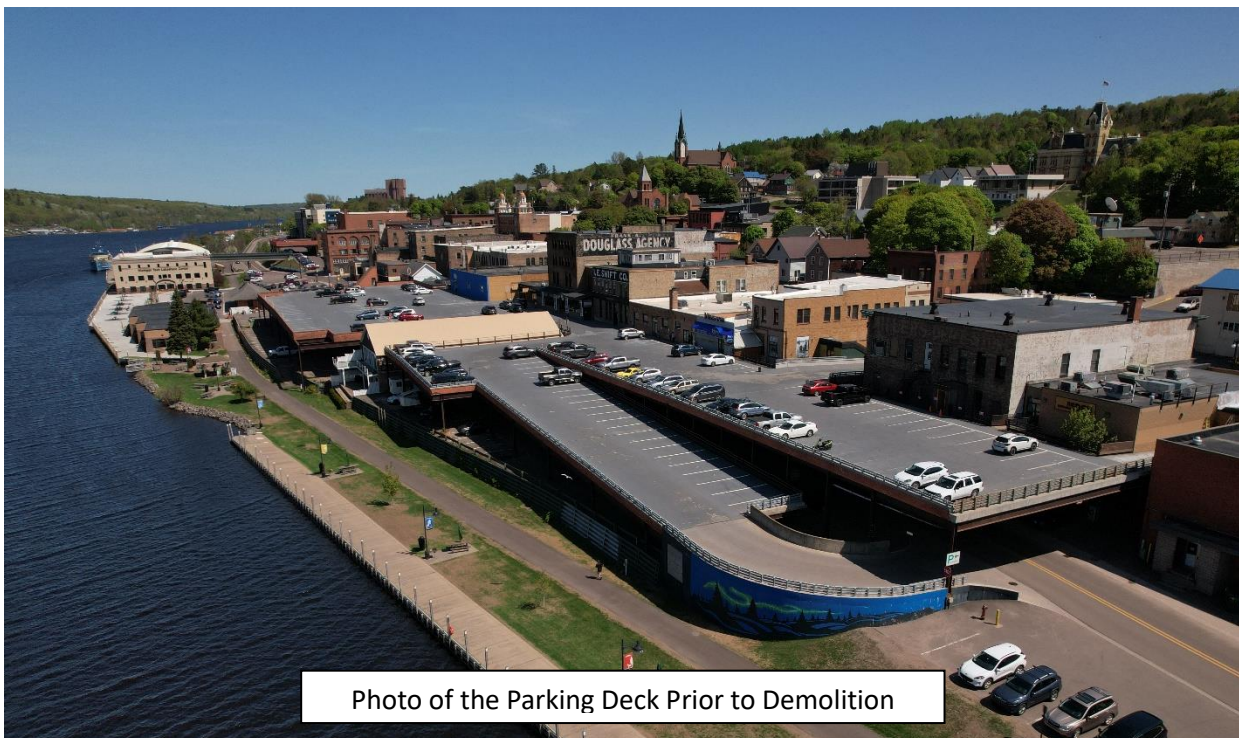


Photo of the Parking Deck Prior to Demolition