Engineering Manual Preamble

This manual provides guidance to administrative, engineering, and technical staff. Engineering practice requires that professionals use a combination of technical skills and judgment in decision making. Engineering judgment is necessary to allow decisions to account for unique site-specific conditions and considerations to provide high quality products, within budget, and to protect the public health, safety, and welfare. This manual provides the general operational guidelines; however, it is understood that adaptation, adjustments, and deviations are sometimes necessary. Innovation is a key foundational element to advance the state of engineering practice and develop more effective and efficient engineering solutions and materials. As such, it is essential that our engineering manuals provide a vehicle to promote, pilot, or implement technologies or practices that provide efficiencies and quality products, while maintaining the safety, health, and welfare of the public. It is expected when making significant or impactful deviations from the technical information from these guidance materials, that reasonable consultations with experts, technical committees, and/or policy setting bodies occur prior to actions within the timeframes allowed. It is also expected that these consultations will eliminate any potential conflicts of interest, perceived or otherwise. MDOT Leadership is committed to a culture of innovation to optimize engineering solutions.

The National Society of Professional Engineers Code of Ethics for Engineering is founded on six fundamental canons. Those canons are provided below.

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
2. Perform Services only in areas of their competence.
3. Issue public statement only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, reasonably, ethically and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Preservation and Rehabilitation Guidelines for Continuous Span Variable Depth Concrete T-Beams

MDOT owns 160 Continuous Span Variable Depth Concrete T-Beam Structures. Of these, 7 are in Good Condition, 140 are in Fair Condition and 13 are in Poor Condition. 29 Structures are located in the Bay Region, while 30 are in Grand, 1 is in Metro, 9 are in North, 55 in Southwest and 36 are in the University Region.

89 of the T-Beam Structures have had PM projects and 102 have had rehabilitation projects – with the majority of the Structures having had both types of projects throughout their service life.

126 of the T-Beam Structures have had shallow concrete overlays and 40 of these Structures have had multiple overlays throughout their service life.

6 of the Structures have had partial deck replacements, with 1 Structure having had a full deck replacement [Partello]. Below is a brief outline of the work that was completed on the 6 Structures with partial deck replacements:

Structure No. 2503: The work on this structure was completed in 2010 and consisted of removing a 24'-0" by 28'-0" portion of the bridge deck. The removal began at the south abutment and proceeded north, 28' along the centerline, within the 55' of Span 1. This project also called for a ¾" hydrodemolition of the bridge deck and a 2 ¼" [min.] concrete overlay.

Structure No. 4424: The work on this structure was completed in 2015 and consisted of removing 1'-10" of the deck on either side of the centerline, resulting in a total deck removal of 3'-8" along the entire

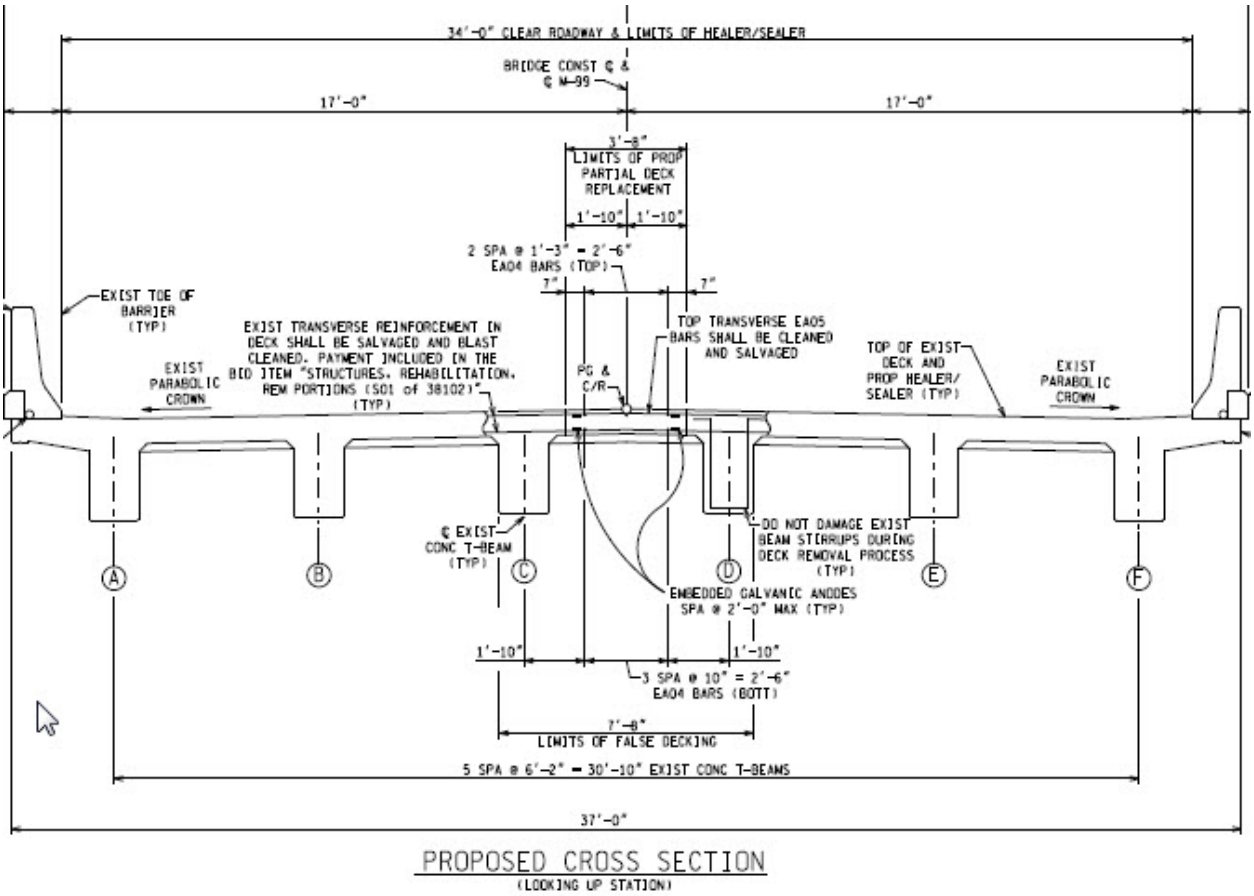
length of the structure. This removal was located between the third and fourth beam, out of six total beams. It was required to salvage and blast clean all existing steel reinforcement, with the exception of the longitudinal reinforcement. The project also consisted of hand-chipping the deck to remove unsound material and the patching of these areas, along with a healer sealer of the entire deck.

Structure No. 4425: The work on this structure was completed in 2015 and consisted of removing 2'-0" of the deck on either side of the centerline, resulting in a total deck removal of 4'-0" along the entire length of the structure. This removal was located between the third and fourth beam, out of six total beams. It was required to salvage and blast clean all existing steel reinforcement, with the exception of the longitudinal reinforcement. The project also consisted of a ¼" scarify and a ¾" hydrodemolition of the entire bridge deck, along with a 1 ½" [min.] concrete overlay.

Structure No. 4428: The work on this structure was completed in 2015 and consisted of removing 1'-6" of the deck on either side of the centerline, resulting in a total deck removal of 3'-0" along the entire length of the structure. This removal was located between the third and fourth beam, out of six total beams. It was required to salvage and blast clean all existing steel reinforcement, with the exception of the longitudinal reinforcement. The project also consisted of hand-chipping the deck to remove unsound material and the patching of these areas, along with an epoxy overlay of the entire deck.

Structure No. 6914: The work on this structure was completed in 1993 and consisted of removing, and replacing, the expansion joint at each end of the bridge, which required full depth removal of the adjoining deck concrete. This project also consisted of a ¼" scarify and a ¾" hydrodemolition of the entire bridge deck, along with a 1 ½" [min.] concrete overlay.

Structure No. 7579: The work on this structure was completed in 2016 and consisted of removing the fascia concrete, in full, and 4" of the deck over the fascia beam and extending 1'-10 ½" towards the second beam. This work was done on both sides of the bridge. The project also consisted of a ¼" scarify and a ¾" hydrodemolition of the entire bridge deck, along with a 2 ½" [min.] concrete overlay.



PROPOSED CROSS SECTION
(LOOKING UP STATION)

Of MDOT's 18 posted structures, 5 of the structures are Variable Depth Concrete T-Beam Structures. It has been the trend that it is becoming increasingly difficult to get the analysis calculations to support the capacity of the structure and not indicate that posting is necessary. This is why it is imperative to contact the Load Rating Unit prior to programming any rehabilitation projects for these structures. Current capacity of the respective structure will need to be discussed, along with whether the proposed project will contribute to the structure's capacity, or if there is any concern over any addition of deadload due to the proposed project.

Research

Several research projects have been done to learn more about the behavior of Variable Depth T-Beam Structures:

https://www.michigan.gov/documents/mdot_c&t_r-1374_67459_7.pdf

MDOT Bridge Development
2017

This report summarized research completed on T-Beam structures that included visual inspection of multiple T-Beam structures in order to observe the different types of deterioration common to these types of structures, and a physical load testing of one T-Beam structure. In conclusion, it was found that, generally, T-Beam structures are in better condition, with less reinforcement deterioration, than is estimated by inspection, and that these structures typically have greater load carrying capacity than is predicted by analysis.

http://www.michigan.gov/documents/mdot_c&t_r-1349_67446_7.pdf

This report summarized the monitoring of a T-Beam structure as it underwent a deck replacement and widening. As a part of the deck replacement, the deck directly over the beams was left in place to preserve negative moment reinforcement. It was found that the casting of a new deck, and the operations required to form and pour the deck, did not over stress the beams. Instead, it was found that the resulting strain from the newly applied loads was less than the strain that was relieved when the original deck, sidewalk and parapet rail were removed. It was also found that there was minimal deflection and minimal locked-in stress, as a result of the deck replacement.

Preservation Guidelines

Decks in good or fair condition should receive cyclic and preventive maintenance in order to preserve the good or fair condition as long as possible. Cyclic activities include joint repair, concrete sealing, minor concrete patching and repair, and concrete crack sealing. Preventative Maintenance activities include joint replacement, epoxy overlay, and deck patching. Healer Sealers have also proven to be an effective Preventative Maintenance activity in helping to retain the deck condition. Preservation of a good or fair deck condition is more important for this structure type because procedures, such as a deck replacement, can be intricate and costly. Special procedures for deck removal are required since the deck of a Variable Depth T-Beam Structure contributes to the load carrying capacity of the beams; i.e. – negative moment reinforcing steel in the deck over the piers provides support for dead load and live load. Placing Rigid Overlays on these structures can also be challenging. While hydrodemolition still seems to be in wide use for this type of structure, it is not generally advised as it can be difficult to control the depth of the concrete removal. Also, the additional weight of the overlay material may cause issues with the load rating capacity of the structure.

Rehabilitation Guidelines

Decks of these types of structures should be rehabilitated earlier and shallow concrete overlays are preferred, and should be performed, over deep overlays. Though hydrodemolition is still regularly used on these structures, it is suggested that it should be avoided as the depth of concrete removal can be difficult to control and this raises concerns in the negative moment areas.

Isolated areas of full depth repair can be done under the guidance of an experienced bridge design engineer who has done analysis to confirm removal limits. These removal areas can be done using staging if needed.

When removing concrete on T-Beam Structures:

1. Analyze how much negative moment reinforcement of the piers is needed to support dead loads and construction loads. For example, a bridge may only need the negative reinforcement over the stem of the beam to support dead loads and construction loads. The concrete in these areas must not be removed to expose more than 20 percent of the negative moment reinforcement surface area viewed from above.
2. The concrete outside of these negative moment areas, in the positive moment region and in the deck between the stems for negative moment regions, can be removed below the top row of rebar to remove delaminated and deteriorated concrete.