

**April 2021 ABC-UTC Monthly Webinar:  
Precast Culverts Flood Mitigation & Pedestrian Safety Solution – Allen Creek Railroad Berm Project**

| # | Questions  | Responses  |
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|   | <b>Design</b>  |  |
| 1 | Which programs were used for the hydrology and hydraulic modeling to determine culvert size?                               | This was covered in the slides. The Storm Water Management Model (SWMM) was used because we could better model overland flow in combination with the enclosed drainage flow. The Soil Conservation Service (SCS) method was used for the hydrology.  |
| 2 | What kind of scour analysis was performed for the culverts?  | Scour analysis was not required as the stormwater at the inlet is entering the weir through a paved surface. At the outlet end, a cast-in-place concrete apron and riprap were provided along with left-in-place cofferdam sheeting in the Huron River.  |
| 3 | Was there an embedment requirement of the culvert bottom to provide for fish protection?                                   | This culvert is conveying stormwater only. There are no fish (hopefully).  |
| 4 | Were precast headwalls and wingwalls used?   | These were cast in place since they were done outside of impacting rail traffic.   |
| 5 | The replacement box structures appear fairly conventional. Were unconventional ABC structures or techniques also explored? | We tried to squeeze in another slide discussing briefly the temporary sheeting and tie backs. The complexity of designing and detailing the sheeting with tie backs presented many challenges related to the existing fiber optic utilities (3) and clearance with the Railroad who does not prefer to have the tie backs under their tracks. In this case, they allowed it, but the tie backs had to be removed and grouted after they were no longer needed. |
| 6 | Can you provide more design examples for this type of construction?  | Please take a look at the American Concrete Pipe Association (ACPA) website ( <a href="http://www.concretepipe.org">www.concretepipe.org</a> ). There is a plethora of examples to look through, located under news and project profiles.  |

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| 7                   | Will it be possible to link the presentation with the climate change issue?                          | This is a good idea. This project was funded through the Hazard Mitigation program partnering between the State of Michigan and Federal Emergency Management Agency (FEMA). Understanding that extreme events are more common and are more impactful with increased development, seeking ways to limit damage and necessary cleanup/response is important. |
| <b>Construction</b> |  |  |
| 8                   | How was the flow controlled upstream? Was diversion of the creek, pumping, or pooling required?      | The Allen Creek enclosure was not part of the project. The new culverts for this project were for local stormwater and were essentially built offline. There was a 42-inch-diameter pipe under the tracks which drained some of the local enclosed street drainage which was maintained through staging.   |
| 9                   | Were there any problems with points opening between precast segments due to differential settlement? | This was covered in the slide by Northern Concrete Pipe, Inc. (NCPI), regarding grouting between the boxes.  |
| 10                  | Can you comment on the joints and any waterproofing that was required for the pedestrian box?        | Joints consisted of male-female formed connections in the culvert sections. A gasket is applied around the connection internally during installation. Once connected, the exterior is treated with geotextile and joint waterproofing.   |
| 11                  | What would you have done differently in hindsight?   | This was covered more in Lessons Learned during the presentation. Would have limited the owner's exposure to the ground water risks. Also would have held the concept of the fiber optic cables being relocated ahead of the outage instead of working around them.  |
| 12                  | Can you address any Change Orders that were necessary during construction?                           | The biggest change order was discussed during the presentation and regarded groundwater control and treatment.   |
| <b>Cost</b>         |  |  |
| 13                  | What was the cost per foot for fabrication, shipping, and installation of the precast box culvert?   | The cost per foot for the culverts was covered in the presentation. See Slide #6 for this information.   |

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| 14                              | How did costs compare for this project compared to previous precast box projects, for the precast box sections and other items?  | It is difficult to compare total costs since there were many other components to this project other than just the box culverts. However, considerable dollars were spent on maintaining railroad traffic (around \$550,000 for sheeting, tiebacks, and flagging). Another \$100,000 was spent for fencing along the railroad tracks to keep pedestrians out after completion of the project.  |
| <b>Questions during Webinar</b> |  |   |
| 15                              | How was the post-tensioning done for the radius sections versus the straight sections?   | No post-tensioning was used for this project. Northern Concrete Pipe, Inc. (NCPI) has not used post-tensioning on any box projects that have been done going back to the late 1960's.   |
| 16                              | With the carbon steel reinforcement and the galvanized steel ties used on top of the precast segments, were the dielectric properties of the two materials considered for premature deterioration of the segments? | The threaded anchors that hold the tie plates in place are located in between the rows of circumferential reinforcing of the box sections, so they are not in contact.  |
| 17                              | There looked to be connectors between box sections at each end. What detail was used, if any? Is the detail used on the top and bottom and the sides?  | Nine each 5/8" x 4" x 2'-8" long galvanized tie plates were used at the end joint at each end for all three culvert crossings. For this project, all tie plates were placed on the top slab only.   |
| 18                              | What was the weight of a section of each size box?   | The 12'x7' box sections were approximately 26 tons each, and the 14'x12' box sections were approximately 31 tons each.  |
| 19                              | Were there any thoughts to using galvanized rebar?   | Northern Concrete Pipe, Inc. (NCPI) has used welded wire fabric (wwf) reinforcement since the early-to-mid 1970's. The added cost for galvanization would be very significant.  |
| 20                              | Was a study done to determine if it was more economical to build a small pedestrian bridge rather than a separate, larger box culvert?   | Yes, during the study phase several different options were investigated. Due to the large train loads, a pedestrian bridge option would have required significant piling foundations which would have been difficult to construct between trains which would have added even more cost. The maintenance of the bridge would also have been higher over its life compared to the box culvert option. The benefits of a bridge option, however, included more open space/feel for pedestrians. The overall estimate for the bridge option was about 25% higher than the box culvert option. |

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| 21 | What was done during design to review and potentially mitigate the condition of the subgrade under the proposed box culverts?   | Borings were obtained both in the rail corridor and on the approaches. Standard testing was completed to assess the soils, and they were found to be competent for the proposed box culvert. However, groundwater was near the excavation limits for installing the bedding material.  |
| 22 | For the concrete cover, did you set the same concrete cover for both sides of the walls (two inches), or did you increase the concrete cover to three inches for the side of the wall that is permanently in contact with the backfill? | Cooper E-80 loading requires two inches of cover for all reinforcement, both inside and out. ASTM C-1577 requires one inch of cover both inside and out, except with less than two foot of cover over the top of the box, two inches is required for the top outside reinforcing mat.  |
| 23 | Can you expand on the comment "Long lasting effect on the construction staff" on the last content slide?  | This was a comment from the Contractor related to the difficult working conditions. There were no injuries or anything, but the crews had to have time to recover which impacted the rest of the work ongoing for the Contractor. Also as noted, this was during the Covid crisis where numerous people were unsure of what impacts there would be from that. No Covid outbreaks occurred on the project, but the spread of it was a concern by all.                     |
| 24 | Was hydraulic pushing of the culvert under the tracks considered instead of open-cut excavating?  | Yes. We also considered tunnel liner plates. The condition of the rail berm materials along with the proximity of the tracks to where the top of the structure had to be was far too close for these options. There is not enough room to perform this function without taking trains out of service for an extended time. We also looked into ground freezing technologies but again, there is not enough room between the tracks and the work to be considered stable. |
| 25 | It looks like the invert of the pedestrian tunnel is the same as the culvert. Were there any precautionary measures to prevent water leaking into the pedestrian tunnel?  | While the box culverts maintain the same invert, the pedestrian side had aggregate and a concrete surface installed which brought the grade up higher than the hydraulic invert. With the pedestrian culvert being raised one foot during construction, it was about three foot above the hydraulic invert.  |
| 26 | There is no reinforcement shown on the 12" haunch at the inside corners of the culvert. It is not a major component, but is there a reason for this?  | Generally, reinforcing the haunch is not required for ASTM designs. It was not required for either of the three designs that were used for this project.   |

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| 27 | What is the maximum dimension of the boxes that can be precast monolithically?   | Northern Concrete Pipe, Inc. (NCPI) has manufactured from 4-ft up to 26-ft spans and from 3-ft up to 14-ft rises (internal dimensions). This will vary by manufacturer. A 20-ft span is pushing the limits for a Cooper E-80 design.  |
| 28 | Was a form of a "Load Distribution Slab" used above the culverts carrying train loads and truck loads, to span the culvert joints? | No load distribution slab was used to carry the Cooper E-80 loading over the culvert joints. The reinforcement is included in the joints per ASTM 1577, Section 9.2.  |
| 29 | How wide was the gap between the box culvert installations?  | It is generally recommended to use two to three inches minimum between runs. That dimension varied, especially at radial sections, with grouting satisfying the differences.  |
| 30 | What was the benefit-to-cost ratio based on the original estimate?   | This was an item of debate during the funding application. FEMA's benefit/cost program seemed to be in error and was yielding about 1.5, although we believe it should have been around 3.0. The issue was that the software counted a negative benefit/cost ratio for a few properties for no reason, and you could not make those a zero in the system which lowered the overall result. Support from the software developer of FEMA's program could not figure it out, and so FEMA required us to go with the lower value. Had those properties even just showed zero, the benefit/cost ratio would have been 3.0 and would even have been more if you considered a benefit to those properties. In no case would lowering a floodplain on a property bring its value down, but the software did this. |
| 31 | Was fiber-reinforced polymer (FRP) reinforcement considered for the project?   | We have investigated this product over the past several years, but have never used it for a project.  |
| 32 | How were the 10'x14' sections transported to the site?   | One piece per load was transported. In Michigan, we can ship up to 16-ft wide with an escort vehicle in front of and behind our trucks.   |
| 33 | Is the invert level of all three boxes the same as at the inlet?   | While the box culverts maintain the same invert, the pedestrian side had aggregate and a concrete surface installed, which brought the grade up higher than the hydraulic invert. With the pedestrian culvert being raised one foot during construction, it was about three foot above the hydraulic invert.  |

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| 34 | Could you share the joint details for the waterstop?   | Butyl Rope (ASTM C-990) was used in the joints, and a membrane joint waterproofing exterior wrap (Mel-Dek) was used on the top and sides.  |
| 35 | When would post-tensioning ducts be implemented?<br>There is no evidence that this method was used for this culvert run.             | Northern Concrete Pipe, Inc. (NCPI) has never used post-tensioning for a box culvert. We do furnish joint ties for the two or three joints at each end of the box runs when called for (often when the section is taller than the lay length of the section).  |
| 36 | Was there any concern for public safety in providing a tunnel for pedestrian passage? Is lighting provided in the pedestrian tunnel? | Lighting is provided within the tunnel and on the approaches to "transition" at each end (try to avoid coming out of a bright tunnel late at night into a dark area). The project also included solar lighting on the approaches with ability to wire them in the future if the panels fail. Concerns for pedestrian safety were a big discussion throughout design. The 90-degree turn into the tunnel was one concern which we did our best to mitigate with signage and a convex mirror in the corner. Cameras were not added but could be in the future. The path is expected to have high usage which itself gives a feeling of safety. |