From: Myers, Glenn <Glenn.Myers@atkinsglobal.com>
Sent: Friday, July 29, 2011 4:09 PM
To: Hernandez, Albert A. (MDT)
Subject: MDT Guideway Analysis of FPL High Voltage Conduits Attached to Guideway

Albert:

We performed an analysis and design check on the Type I double tee. These are the 80' girders supporting tangent track that make up the majority of the South Corridor, and the most prevalent girder in the entire system. These Type I double tees are also the most sensitive girders affected by additional loading. These are not the girders that you want to start taking risks with. We have not reviewed the effects of the additional loading on the other girder types.

The previous evaluation performed to justify the heavier vehicle currently under procurement (120,000 pounds, including passengers), resulted in stresses equal to the maximum tension allowed (actually 4 psi overstress, but this was deemed acceptable). Note that we used every ounce of reserve in these girders to allow the 120 kips for the new vehicle procurement.

The 100 plf identified by FPL for the weight of the conduits, cables and mounting hardware applied as a vertical load offset 4 feet from the center of the guideway has been analyzed. The offset is important in that it adds tension to the bottom flange of the double tee due to warping torsion. The analysis now shows an additional 66 psi of tension resulting in a 70 psi overstress. I would not recommend accepting it.

The analysis assumes full superimposed dead load (SDL) is applied to the double tee girders per the Stage I guideway structures design criteria. This SDL consists of component dead weight for running rails, rail fasteners, concrete rail supports, power distribution system components, wireways, MDT utilities, handrails and acoustical barrier. While every girder is not necessarily subjected to all of these loads, most likely, there may be cases where the girders are subjected to all of these loads. In general, MDT has made decisions related to additional guideway appurtenances added to the system subject to the total load not exceeding the SDL. Using part of the SDL allowance for FPL will limit options for MDT in the future.

In reviewing the FPL report dated July 5, 2011, I have the following additional concerns:

1.) MDT has a prohibition on attachments to the guideway, specifically to the areas of the web subjected to tension under live load. You can confirm this with Isabel. Drilling expansion anchors into a precompressed area that will be subjected to large tension strains from the passage of vehicles may loosen the attachment. This method of attachment is a significant concern and is not recommended. While epoxy-secured anchors might address some of this particular concern, the shortest Hilti HVA Adhesive anchor is embedded 3½ inches. This will conflict with the stirrups/strands in the girder webs.
2.) Samples of similar attachments to bridges were shown in the report. The Metrorail guideway is not a highway bridge. The LRFD Bridge Design Specifications were calibrated in a manner where the maximum design load for a highway bridge may occur once every two months. From the studies we performed on past and future patronage and its impact on the design life of the guideway, the maximum design load for the guideway may occur 7 times a day on average. Therefore, comparison of typical attachment details to highway bridges should not be viewed as a justification of acceptable performance.
3.) The guideway generally consists of simple span girders that are separated at every pier by an expansion joint that allows the girders to deflect independently. With a vehicle length of 75 feet and a typical span of 80 feet, the two girders supported by a single pier will be subjected to its maximum load and deflection simultaneously. With a ¾" deflection of each girder, the rotation at the joint will be more than 0.006 radians, which is substantial. FPL did not provide as to how deflections, rotations and expansion/contraction will be accommodated.
4.) The FPL Report acknowledges that inspection and access for repairs will be more difficult, but cites that there are cases where there are similar obstructions that the inspection staff currently work around today. While this statement is true, it does not reflect on the scope of the increased difficulty of the inspection, its effect on the inspection staff's productivity and the budget requirements for these increased efforts.
5.) The guideway is designed for catastrophic derailment. During this type of event, the outside stem of the double tee deflects approximately 5 inches and rotates approximately 4 degrees (verified through full scale testing of the guideway girders). These deformations, as a minimum, should be accounted for in the conduit and connection

design. The effects on having a high voltage line mounted on the guideway should also be evaluated from an emergency response perspective. For example, what delay will there be before the all-clear is given indicating that the power line has not been compromised, or has been de-energized, and is safe to work around. And if it has been compromised, is there additional risk in having this compromised power line near a metal vehicle filled with passengers hanging over the edge of the guideway. The derailment scenario anticipated in the original design criteria is a valid concern given the recent bullet train derailment in China.

6.) As documented in the FPL report, there will be numerous conflicts with guideway appurtenances that will need to be resolved, such as with existing traction power conduits and junction boxes.

Albert, these are my initial thoughts on the subject. Call me if you have any additional questions.

Regards

Glenn

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