Methodology

Analysis Method

Bridge 01562B is modeled and rated using AASHTOWare BrR line girder analysis.

Assumptions

1. The unknown steel strength and dimensions of the metal bridge planking is to be consistent with the 1978 Bethlehem Bridge Flooring product sheet, provided in the Appendix section, which is consistent with the built date and details as shown in the inspection report.
2. The dimensions of the connection plates were assumed as web depth (22.546”) x half the flange width (4.53”) x 0.5” based on the 2017 Bridge Inspection Report photos. An additional 20% was added to the calculated diaphragm weight to consider the attachment hardware and the uncertainty of the members.
3. The members and member sizes for the bridge railing were assumed based on the 2017 Bridge Inspection Report photos. An additional 20% was added to the calculated weight to consider the attachment hardware and the uncertainty of the members.
4. Due to the lack of beam end details, all section loss was assumed between the centerline of bearings and thus included in the BrR model.
5. The top flanges of the exterior members were assumed to be not laterally braced due to the significant top flange and corrugated metal deck deterioration noted in the 2017 Bridge Inspection Report. Alternatively, the interior members were assumed to be laterally braced by the corrugated metal deck.

Comments

1. There are no applicable projects associated with this structure.
2. The diaphragm locations were based on the framing plan field measurements contained in the 2000 Bridge Load Rating.
3. The Railing definition in BrR is for defining the appropriate travelway on the structure and does not apply rail load to the model. The load for the railing is applied via Member Loads to the exterior girders.
4. The fatigue life for the controlling fatigue detail was determined as finite but the remaining life has not been exceeded. Therefore, the finite fatigue life does not require recalculation since the fatigue detail has a calculated year of exhaustion of 2285, which will exceed the life of the structure. Refer to the Appendix for the applicable Spec Check output from BrR for additional information.
5. In the Deck module of BrR, the unit weight of the bituminous concrete was adjusted to consider a DW load factor rather than a DC load factor.
6. The bituminous concrete thickness was applied in the Deck module to consider the weight of the wearing surface above the top of the planking for the deck rating. Additionally, the bituminous concrete thickness was applied in the Structure Typical Section module to consider the weight of the wearing surface for the girder rating.

Rated Members

G1 through G7
Corrugated Metal Deck

Methodology

Analysis Method

The rating for this structure was performed using BrR 6.8.1.3001 line girder analysis engine.

Assumptions

1. Unknown prestressed concrete strength taken as 3.125 ksi based on MBE Table 6A.5.2.1-1 for year of construction, initial compressive strength is 80% of the assumed 28 day compressive strength.
2. Unknown reinforcing steel material taken as grade 40 based on MBE table 6A.5.2.2-1 for year of construction.
3. Unknown prestressing Steel Ultimate strength taken as 250 ksi strand based on jacking force of the strand. Note that the MBE unknown value based on year of construction would be 232 ksi.
4. Unknown material of utility conduits was assumed to be steel.
5. All strands in all girders, except two strands in Girder 8, are assumed to be full section, and the rust described in the BIR is only surface rust with no section loss.

Comments

1. Due to the missing anchor plates and chucks on the first and third transverse post-tensioning anchorages on the west fascia, gap between units, and deteriorated joints between girders, the rating is based on controlling of two cases of joint connectivity. Case I is based on the assumption that the joints between units cannot transfer load, and Case II considers that some transverse load sharing is occurring between G1 and G2. See the Load Distribution section in the Calculations for more detail.
2. A second BrR superstructure definition was required to check Case II for G1 and G2.
3. The existing deck shown on the rehab drawings refers to latex modified concrete applied in 1999 apart of a maintenance operation, see appendix for project 0128-0143 correspondence.
4. The strand layout was determined by counting 15 strands in the bottom row by the visible rust staining in BIR photo 16. The bottom row was assumed to be located at the clear cover plus one half of the nominal strand diameter. The remaining strands were assumed to be in a single layer and their location was computed based on the bottom row location and centroid of the complete strand pattern.
5. Severe environmental conditions were considered because of evidence of leakage and active leakage mentioned in the BIR.

BrR Bug Workarounds

- **Service III** - Jira Ticket ID: BRDRSUP-1052

BrR is applying a 0.80 live load factor for legal loads at the Service III limit state. The workaround for this bug is to multiply the final rating factor by the ratio of the wrong live load factor to the correct live load factor = 0.80/1.0 = 0.80. The controlling legal Service III rating factor was multiplied by 0.80 prior to recording in the CTDOT Load Rating Summary Tables.

- **Service I** - Jira Ticket ID: BRDRSUP-1361

BrR does not perform a Service I rating, therefore a rating was performed externally using section properties and loads computed by BrR. Note that Service I did not governing any permit ratings, however the CT-P200(10) produced ratings less than 1.0, see Permit less than 1 table.

Rated Members

- Girder 1
- Girders 2 through 7 and Girders 9 through 12 represented by Girder 2
- Girder 8
- Girders 13
- Girders 14 through 16 represented by Girder 14

Methodology

Analysis Method

The structure was analyzed using AASHTOWare 6.7.0.3001 as a line girder in a girder system.

Assumptions

Unknown girder haunches were assumed to be 2 inches for the entire length of each girder, which is reasonable based on BIR photos 6, 7 and 10.

Comments

The granite curb was modeled as a parapet appurtenance separate from the concrete parapets to account for the difference in density of concrete and granite.

Rated Members

- Rolled Steel Girders
    - Span 1: G1-G6 (girders individually rated)
    - Span 2: G1-G6 (represented by span 1)

Rating Methodology

Analysis Method

The structure was analyzed using 3D FEM techniques with LARSA4D version 7.09.02 staged construction analysis method.

Reason

Due to the high skew of the girders and truss-style floorbeams supports, a 3D FEM is required to capture the effects of the skew and forces in truss-style floorbeams.

Choice of Elements

- Girders webs were modeled with plate elements and each flange was modeled with beam elements to capture the effects of warping of the cross-section.
- Floorbeams and stringers cross-sections were modeled as beam elements.
- Deck were modeled as plate elements.

The vertical eccentricities of members were considered in the model.

Utilization of Links

- Floorbeam end nodes share the mid-web node of the girder webs to reflect the moment connection as detailed in contract drawings.
- Stingers connected to floorbeam via rigid springs which fixed translation and free rotations. Stringers were modeled as continuous over 2 panels as shown in the contract drawings.
- The non-composite deck was connected to the stringers and girders with rigid springs which fixed vertical translation, all other degrees of freedom were freed.

Support Degrees of Freedom

Bottom nodes of girders at support locations were fixed in the vertical and transverse translation degrees of freedom. The supports at Pier 1 were additional restricted from longitudinal translation. All supports were made with a 6x6 spring definition.

Artificial Elements

None

Sequence of Construction Stages Modeled

Stage	Elements Erected	Loads Applied
1	Girders & Floorbeams	Selfweight
2	Stringers and Diaphragms	Selfweight & Wet Concrete
3	Deck	Superimposed dead loads

Placement of Lanes

LARSA's influenced based travel surface was used to apply the live load cases to the structure. Lanes were not permitted to be split between the median barriers

Assumptions

1. Section loss note *"Random locations of floorbeam top flange section loss up to ¼ inch"* was applied to full length of all floorbeams since the exact locations of these losses were not annotated in the BIR.

Comments

1. Top flanges of girders and stringers were analyzed as continuously braced by the deck.

Rated Members

- G1 through G4
- All Floorbeams
- All Stringers
- Girder field splices