**Given:**

1. All 3 supports are considered fixed.
2. The existing pier bearing anchorage is not adequate to resist 25% of the permanent tributary deadload (EQ load) (half of span 1 and half of span 2) as a horizontal extreme event load (BDM 303.1.4.1.b).
3. Is the abutment anchorage adequate to resist EQ load?
    a. If yes, do we need an analyze the abutment for Extreme I under elastic conditions?
    b. If no, then the connection loading at the pier will not be 25% of the permanent tributary deadload, but 25% of the entire superstructure deadload. Additionally, there is nothing to restrain the superstructure from falling off of the abutments (no transverse constraints on the abutments once the fixed bearing anchorage at the abutments fails during a seismic event).
4. We have adequate support length at the abutments (LRFD 4.7.4.4).

**Potential Solutions:**

**ALTERNATIVE A - REPLACE ALL BEARINGS AND CONVERT ABUTMENTS TO SEMI-INTEGRAL**

1. Replace all bearings with elastomeric and convert abutments to semi-integral. Add diaphragm guides and design to resist 25% of half of the total superstructure weight (since wingwalls are turned back). All bearings would be EXP.
    a. Pros
        i. Would eliminate the need for bearing anchorage for all substructures.
        ii. Would change all supports from FIX-FIX-FIX to EXP-EXP-EXP. Longitudinal load distribution should remain the same under service and strength limit states (Compliance to BDM C401.4.C).
    b. Cons
        i. Additional weight from diaphragm will cause the proposed DL Rx to exceed 115% of existing (roughly > 140% increase) (results in Non-Compliance with BDM 401.4.B).
            1. Abutment analysis would be required for service and strength limit states (utilizing applicable service and strength load and resistance factors).
            2. Additionally, as part of the abutment analysis, the forces transferred to the abutments by the diaphragm guides during seismic event would need to be evaluated due to high skew (nearly 56 degrees). This portion of thew abutment analysis would be required for extreme limit state (utilizing applicable extreme load and resistance factors).

**ALTERNATIVE B - REPLACE ALL BEARINGS WITH BI-DIRECTIONAL (LONGITUDINAL AND TRANSVERSE) SEISMIC ISOLATION BEARINGS**

1. Replace all bearings with bi-directional seismic isolation bearings. All bearings would be FIX in the service and strength limit states, and EXP in extreme limit state.
    a. Pros
        i. Would significantly reduce the Extreme Limit State design force for bearing masonry plate anchorage.
        ii. All supports would remain FIX-FIX-FIX. (Compliance to BDM C401.4.C).
        iii. Proposed service dead load would be less than 115% of existing at all substructures (Compliance with BDM 401.4.B).
        iv. Would not require seismic pedestals.
    b. Cons
        i. Potentially space constraints at the abutment seats (high skew contributing to this) limiting the size of the bi-directional seismic isolation bearings at the abutments.
        ii. Potentially collision between ends of girder and/or end of deck with backwall during a seismic event.

**ALTERNATIVE C - REPLACE ABUTMENT BEARINGS WITH UNI-DIRECTIONAL (LONGITUDINAL) SEISMIC ISOLATION BEARINGS, AND REPLACE THE PIER BEARINGS WITH BI-DIRECTIONAL (LONGITUDINAL AND TRANSVERSE) SEISMIC ISOLATION BEARINGS**

1. Replace abutment bearings with uni-directional seismic isolation bearings, and replace the pier bearings with bi-directional seismic isolation bearings. All bearings would be FIX in the service and strength limit states, and EXP in extreme limit state.
    a. Pros
        i. Would significantly reduce the Extreme Limit State design force for bearing masonry plate anchorage.
        ii. All supports would remain FIX-FIX-FIX. (Compliance to BDM C401.4.C).
        iii. Proposed service dead load would be less than 115% of existing at all substructures (Compliance with BDM 401.4.B).
        iv. Uni-directional bearings at the abutments would be smaller in the transverse directions (than bi-directional), potentially increasing the feasibility of placement at the abutment seats with a high skew.
    b. Cons
        i. Would require seismic pedestals at the abutments to mitigate the transverse component of the EQ load from the superstructure during an Extreme Event.
        ii. Potentially collision between ends of girder and/or end of deck with backwall during a seismic event.