NOTES FOR DESIGNING AND DETAILING DIAPHRAGMS

1. DESIGN SPECIFICATIONS
a. ASME STANDARD BRIDGE DESIGN SPECIFICATIONS (ASME LBD 1).

2. REFERENCES
a. AISC SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS, ANSI A36-10, JUNE 2010 (AISC SPEC).

3. DETAILING REQUIREMENTS
a. Diaphragms shall be selected and sized such that the girder webs are vertical (plumb) as specified in the tables below.

4. USAGE AND ORIENTATION OF DIAPHRAGMS
a. For personnel with access to the girder webs in the bridge design, place intermediate diafragms parallel to the girder webs in the bridge design. Place intermediate diafragms parallel to the girder webs in the bridge design.

5. DETAILING SPECIFICATIONS
a. Weight of steel, weight of deck slab and weight of superimposed dead loads, but not including weight of superimposed dead loads.

6. USAGE AND ORIENTATION OF DIAPHRAGMS
a. Referred to the ASME LBD 1 recommendations for load conditions.

7. DETAILING SPECIFICATIONS
a. Weight of Steel, weight of deck slab and weight of superimposed dead loads, but not including weight of superimposed dead loads.

8. USAGE AND ORIENTATION OF DIAPHRAGMS
a. For personnel with access to the girder webs in the bridge design, place intermediate diafragms parallel to the girder webs in the bridge design. Place intermediate diafragms parallel to the girder webs in the bridge design.

9. DETAILING SPECIFICATIONS
a. Weight of steel, weight of deck slab and weight of superimposed dead loads, but not including weight of superimposed dead loads.

10. USAGE AND ORIENTATION OF DIAPHRAGMS
a. For personnel with access to the girder webs in the bridge design, place intermediate diafragms parallel to the girder webs in the bridge design. Place intermediate diafragms parallel to the girder webs in the bridge design.

11. DETAILING SPECIFICATIONS
a. Weight of steel, weight of deck slab and weight of superimposed dead loads, but not including weight of superimposed dead loads.

12. USAGE AND ORIENTATION OF DIAPHRAGMS
a. For personnel with access to the girder webs in the bridge design, place intermediate diafragms parallel to the girder webs in the bridge design. Place intermediate diafragms parallel to the girder webs in the bridge design.

13. DETAILING SPECIFICATIONS
a. Weight of steel, weight of deck slab and weight of superimposed dead loads, but not including weight of superimposed dead loads.
NOTES FOR DESIGNING AND DETAILING DIAPHRAGMS (CONTINUED FROM SHEET 1)

5. SELECTION OF DIAPHRAGM TYPE (CONTINUED FROM SHEET 1)

**Type B**
- All applicable limit states, as identified in Section 3 of the AASHTO LRFD, shall be investigated as part of the design process. The design for each limit state shall be as presented in Section 3 of the LRFD, following the same assumptions as noted.

- Both the strength and stiffness requirements for stability bracing as specified in the ASCE Spec. 6.3 and/or the FHA Spec. Vol. 13 shall be satisfied.

- The stiffness requirement as presented in the FHA Spec. Vol. 13 shall be satisfied:

$$\frac{L}{L_{eff}} = 1.25$$

- See previous note for definition of all variables. See below for additional definition of the ultimate loads.

**Type K**
- The ultimate loads used for stability and strength analyses shall be consistent with the provisions of the AASHTO LRFD. The ultimate loads used for these analyses shall be based on the following load combinations for the given limit state:

- **Type K, Final Condition, Composite, No Negative Moment Regions**: 1.25 $L_{eff}$ + 1.5 $D_{max}$ + 1.75 $L_{fr}$

- **Type K, Final Condition, Composite, Positive Negative Moment Regions**: 1.25 $L_{eff}$ + 1.5 $D_{max}$ + 1.25 $L_{fr}$

- **Type K, Final Condition, Noncomposite, Positive Negative Moment Regions**: 1.25 $L_{eff}$ + 1.5 $D_{max}$ + 1.25 $L_{fr}$

**Type K, Final Condition, Noncomposite, Positive Negative Moment Regions**: 1.25 $L_{eff}$ + 1.5 $D_{max}$ + 1.25 $L_{fr}$

**RECOMMENDED APPEARANCES, SECTION 6.3 FOR BASIC DEFINITION OF ALL VARIABLES. SEE BELOW FOR ADDITIONAL DEFINITION OF THE ULTIMATE LOADS.**

**Type X**
- The ultimate loads used for stability and strength analyses shall be consistent with the provisions of the AASHTO LRFD. The ultimate loads used for these analyses shall be based on the following load combinations for the given limit state:

- **Type X, Final Condition, Composite, No Negative Moment Regions**: 1.25 $L_{eff}$ + 1.5 $D_{max}$ + 1.75 $L_{fr}$

- **Type X, Final Condition, Composite, Positive Negative Moment Regions**: 1.25 $L_{eff}$ + 1.5 $D_{max}$ + 1.25 $L_{fr}$

- **Type X, Final Condition, Noncomposite, Positive Negative Moment Regions**: 1.25 $L_{eff}$ + 1.5 $D_{max}$ + 1.25 $L_{fr}$

**Type X, Final Condition, Noncomposite, Positive Negative Moment Regions**: 1.25 $L_{eff}$ + 1.5 $D_{max}$ + 1.25 $L_{fr}$

**Type K, Final Condition, Noncomposite, Positive Negative Moment Regions**: 1.25 $L_{eff}$ + 1.5 $D_{max}$ + 1.25 $L_{fr}$

**STANDARD CROSS FRAME AND SOLID PLATE BRIDGES DESIGNED WITH REFINED METHODS OF ANALYSIS**

- **Type B**
- **Type K**
- **Type X**

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**BD-619M**
NOTES FOR DESIGNING AND DETAILING DIAPHRAGMS

6. Determination of Design Loads (continued from Sheet 2)

a) Fatigue Loading Effects

A detailed analysis of fatigue loading is not required for the design of diaphragms. This guidance provides the commentary of the AASHTO LRFD (C6.6.1.2.1), regarding the determination of fatigue loading when hangers have been computed using a refined analysis.

b) Stability Stiffening Forces

Bridge stability checks and stability requirements should be satisfied in accordance with the appropriate ASD/LRFD provisions. However, for other sections such as X, and channel sections, if necessary. The design should be checked using a refined analysis in the case of compression loading. The effective longitudinal length in the ASD/LRFD (Section 6.4.2.7) should be checked, but for other sections such as X, and channel sections. The design should be checked using a refined analysis in the case of compression loading. The effective longitudinal length in the ASD/LRFD (Section 6.4.2.7) should be checked, but for other sections such as X, and channel sections.

6. Design of Top Chord, Bottom Chord, and Diagonal Members

The weld connection of diaphragm top chord, bottom chord, and diagonal members shall be designed in accordance with the provisions of the ASD/LRFD. Design of bolted connection of gusset plates to connection plates shall be designed in accordance with the provisions of the ASD/LRFD (Section 6.4.4.1).

10. Detailed Design Procedures for Type X and Type K Intermediate Diaphragms

a) Design of Top Chord, Bottom Chord, and Diagonal Members

The effective length of top chord, bottom chord, and diagonal members shall be determined in accordance with the provisions of the ASD/LRFD. The connection plates for pier and end diaphragms typically also function as bearing stiffeners and should be designed for both fatigue loads and bearing reactions. The appropriate provisions of the ASD/LRFD (6.4.3.7.1-6) should be used.

b) Stiffening the Edge of the Deck at Expansion Joints

The diaphragm top chord should be designed to carry a portion of the dead load of the concrete deck. The use of a continuous top chord is recommended, but for situations where expansion joints are used, the diaphragm top chord is typically a channel or a wide flange. The stiffeners for the channel should be continuous over the full length of the channel and be designed to act in a composite fashion with the beam via the use of shear connectors.

11. Detailed Design Procedures for Solid Plate Diaphragms

TYPICALLY, SOLID PLATE DIAPHRAGMS ARE DESIGNED FOR THEIR APPROPRIATE STRENGTH LIMIT STATE (DESIGN LOAD EFFECTS IN A MANNER SIMILAR TO THE DESIGN OF OTHER STEEL GIRDERS OR BEAMS, IN ACCORDANCE WITH THE PROVISIONS OF EACH SECTION 6 ). IN-PLANE ECCENTRICITY OF LOADING FOR OTHER SECTIONS SUCH AS WT, W, AND CHANNEL SECTIONS (CONTINUED FROM SHEET 2)

12. Detailed Design Procedures for Solid Plate Diaphragms (continued from Sheet 2)

b) In Situations Where Type K Intermediate Diaphragms Are Used...

The diaphragm top chord should be designed to carry a portion of the dead load of the concrete deck. The use of a continuous top chord is recommended, but for situations where expansion joints are used, the diaphragm top chord is typically a channel or a wide flange. The stiffeners for the channel should be continuous over the full length of the channel and be designed to act in a composite fashion with the beam via the use of shear connectors.
CONCEPTUAL FRAMING PLANS

NOTE: THESE FRAMING PLANS ARE CONCEPTUAL ONLY AND ARE PROVIDED ONLY TO ILLUSTRATE POTENTIAL FRAMING ARRANGEMENTS FOR CONTINUOUS CROSSES AND/OR CURVED CROSSES GEOMETRIES.

- FOR SKEWS ≤ 70°, CROSS-FRAMES ALONG THE SKEWED INTERIOR SUPPORT LINE ARE NOT NECESSARILY RECOMMENDED.
- DETAILING AT INTERSECTIONS WITH CROSS-FRAMES NORMAL TO GIRDER IS COMPLEX.
- A CROSS-FRAMING SYSTEM NORMAL TO GIRDER AND AT BEARINGS THAT RESIST LATERAL FORCES AND FLANGE ARE RECOMMENDED.
- WHERE DISCONTINUOUS CROSS-FRAMES ARE UTILIZED, MANY INTERIOR SUPPORTS, DESIGNED TO
- A CROSS-FRAME IS ATTACHED WITH EACH BEARING THAT RESISTS LATERAL FORCE.
- WHERE A BEARING DOES NOT RESIST LATERAL FORCE, SUPER BOLTED PLATE IS ADEQUATELY BRACED.

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STANDARD CROSS FRAME AND SOLID PLATE DIAPHRAGMS FOR STEEL BEAM/GIRDER BRIDGES DESIGNED WITH REFINED METHODS OF ANALYSIS

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