NOTES FOR DESIGNING AND DETAILING DIAPHRAGMS

1. DESIGN SPECIFICATIONS
   a) ASME/LRFD BRIDGE DESIGN SPECIFICATIONS (ASME/LRFD).
   b) FDOT DESIGN MANUAL, PART 4 (FDOT OWN).
   c) FDOT SPECIFICATIONS, PUBLICATION FOR 2018.

2. REFERENCES
   a) AISC SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS, AISC360-10, JUNE 22, 2010 (AISC SPEC).
   b) FDOT MORTAR MASONRY DESIGN MANUAL, VOLUME 1: BRICK DESIGN, MORTAR DESIGN, STRUCTURAL DESIGN, MORTAR DESIGN, MORTAR, MORTAR MASONRY, MORTAR, MORTAR MASONRY, MORTAR, MORTAR MASONRY, MORTAR.

3. DETAILED REQUIREMENTS
   a) GIRDERS SMALLER THAN 150 M (600 FT) SHOULD BE DETAIL AND TERMINATE SUCH THAT THE COLUMN HEADS ARE VERTICAL (PLUMB) AS SPECIFIED IN THE TABLES BELOW.
   b) NON-SKEWED AND SKEWED DIAPHRAGMS WITH SPF > 1.025 M (40 FT) ARE NOT ACCEPTABLE.
   c) NON-SKEWED BRIDGES WITH SPF > 1.025 M (40 FT) ARE NOT ACCEPTABLE.
   d) FOR STRAIGHT BRIDGES, PLACE INTERMEDIATE DIAPHRAGMS PARALLEL TO THE SKEW AND IN CONTIGUOUS LINES.
   e) FOR NON-SKEWED BRIDGES, PLACE DIAPHRAGMS PERPENDICULAR TO THE SKEW.
   f) FOR CURVED BRIDGES, PLACE DIAPHRAGMS PARALLEL TO THE CURVE.
   g) FOR SKEWED BRIDGES, PLACE DIAPHRAGMS PERPENDICULAR TO THE SKEW.
   h) FOR CURVED SKEWED BRIDGES, PLACE DIAPHRAGMS PERPENDICULAR TO THE SKEW.
   i) FOR CURVED SKEWED BRIDGES, PLACE DIAPHRAGMS PARALLEL TO THE CURVE.
   j) COORDINATE BEARING STIFFENER AND CONNECTION PLATE LOCATIONS WITH DETAILS OF BEARING TO GIRDER CONNECTIONS.
   k) PLACE PIER DIAPHRAGMS PARALLEL TO THE SKEW FOR SKEW ANGLES OF 70° TO 90°, OR NORMAL TO THE GIRDER FOR SKEWS LESS THAN 70°.
   l) END DIAPHRAGMS ARE REQUIRED AT THE ENDS OF GIRDERS TO SUPPORT THE EDGE OF DECK AND THE EXPANSION JOINTS.
   m) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   n) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.

4. USAGE AND ORIENTATION OF DIAPHRAGMS
   a) DIAPHRAGMS SHOULD BE USED TO TRANSFER HORIZONTAL SUPERSTRUCTURE FORCES INTO THE BEARINGS.
   b) DIAPHRAGMS SHOULD BE PLACED PERPENDICULAR TO THE SKEW.
   c) DIAPHRAGMS SHOULD BE PLACED PARALLEL TO THE SKEW.
   d) DIAPHRAGMS SHOULD BE PLACED IN CONTIGUOUS LINES.
   e) DIAPHRAGMS SHOULD BE PLACED IN STAGGERED ARRANGEMENT.
   f) DIAPHRAGMS SHOULD BE PLACED PERPENDICULAR TO THE SKEW.
   g) DIAPHRAGMS SHOULD BE PLACED PARALLEL TO THE SKEW.
   h) DIAPHRAGMS SHOULD BE PLACED IN CONTIGUOUS LINES.
   i) DIAPHRAGMS SHOULD BE PLACED IN STAGGERED ARRANGEMENT.

5. SELECTION OF DIAPHRAGM TYPE
   a) DIAPHRAGM TYPES SHOULD BE SELECTED BASED ON THE FOLLOWING GUIDELINES:
   b) FOR STRAIGHT BRIDGES, PLACE DIAPHRAGMS PARALLEL TO THE SKEW AND IN CONTIGUOUS LINES.
   c) FOR NON-SKEWED BRIDGES, PLACE DIAPHRAGMS PERPENDICULAR TO THE SKEW.
   d) FOR CURVED BRIDGES, PLACE DIAPHRAGMS PARALLEL TO THE CURVE.
   e) FOR SKEWED BRIDGES, PLACE DIAPHRAGMS PERPENDICULAR TO THE SKEW.
   f) FOR CURVED SKEWED BRIDGES, PLACE DIAPHRAGMS PARALLEL TO THE CURVE.
   g) FOR CURVED SKEWED BRIDGES, PLACE DIAPHRAGMS PERPENDICULAR TO THE SKEW.
   h) FOR CURVED SKEWED BRIDGES, PLACE DIAPHRAGMS PARALLEL TO THE CURVE.
   i) PLACE PIER DIAPHRAGMS PARALLEL TO THE CURVE FOR SKEW ANGLES OF 70° TO 90°, OR NORMAL TO THE GIRDER FOR SKEWS LESS THAN 70°.

6. NOTES FOR DESIGNING AND DETAILING DIAPHRAGMS
   a) FOR STRAIGHT BRIDGES, PLACE INTERMEDIATE DIAPHRAGMS PARALLEL TO THE SKEW AND IN CONTIGUOUS LINES.
   b) FOR NON-SKEWED BRIDGES, PLACE DIAPHRAGMS PERPENDICULAR TO THE SKEW.
   c) FOR CURVED BRIDGES, PLACE DIAPHRAGMS PARALLEL TO THE CURVE.
   d) FOR SKEWED BRIDGES, PLACE DIAPHRAGMS PERPENDICULAR TO THE SKEW.
   e) FOR CURVED SKEWED BRIDGES, PLACE DIAPHRAGMS PARALLEL TO THE CURVE.
   f) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   g) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   h) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   i) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   j) COORDINATE BEARING STIFFENER AND CONNECTION PLATE LOCATIONS WITH DETAILS OF BEARING TO GIRDER CONNECTIONS.
   k) PLACE PIER DIAPHRAGMS PARALLEL TO THE SKEW FOR SKEW ANGLES OF 70° TO 90°, OR NORMAL TO THE GIRDER FOR SKEWS LESS THAN 70°.
   l) END DIAPHRAGMS ARE REQUIRED AT THE ENDS OF GIRDERS TO SUPPORT THE EDGE OF DECK AND THE EXPANSION JOINTS.
   m) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   n) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   o) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   p) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   q) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   r) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   s) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   t) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   u) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   v) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   w) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   x) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   y) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   z) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
   A) PLACE END DIAPHRAGMS APPROPRIATELY PARALLEL TO THE CENTERLINE OF THE GIRDER.
NOTES FOR DESIGNING AND DETAILING DIAPHRAGMS (CONTINUED FROM SHEET 1)

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

Type of Diaphragm

Type of Type X Diaphragms are typically the most economical design and should be used in cases where gravity loading is predominant. They can be used in cases where the diaphragm is subjected to a single load or a combination of loads. The type of Type X diaphragms does not require a detailed analysis of the diaphragm.

Type of Type Y Diaphragms should be used in cases where the diaphragm is subjected to a single load or a combination of loads. The use of Type Y diaphragms facilitates the passage of utilities through the diaphragm.

Type of Type Z Diaphragms should be used in cases where the diaphragm is subjected to a single load or a combination of loads. The use of Type Z diaphragms facilitates the passage of utilities through the diaphragm.

Selection of Diaphragm Members

Select the most economical diaphragm members that meet design and detailing requirements. The selection of diaphragm members is based on the type of diaphragm and the type of loading. The most common types of diaphragm members are listed below.

- **Type X Diaphragms**
  - Solid Plate Diaphragms
  - Welded Plate Diaphragms

- **Type Y Diaphragms**
  - Solid Plate Diaphragms
  - Welded Plate Diaphragms

- **Type Z Diaphragms**
  - Solid Plate Diaphragms
  - Welded Plate Diaphragms

Selection of Diaphragm Type

The most economical diaphragm members are typically single angle sections. Equal leg angles should be used. Solid plate diaphragms should be used only in cases where the diaphragm is subjected to a single load.

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

Type of Diaphragm

Type of Type X Diaphragms are typically the most economical design and should be used in cases where gravity loading is predominant. They can be used in cases where the diaphragm is subjected to a single load or a combination of loads. The type of Type X diaphragms does not require a detailed analysis of the diaphragm.

Type of Type Y Diaphragms should be used in cases where the diaphragm is subjected to a single load or a combination of loads. The use of Type Y diaphragms facilitates the passage of utilities through the diaphragm.

Type of Type Z Diaphragms should be used in cases where the diaphragm is subjected to a single load or a combination of loads. The use of Type Z diaphragms facilitates the passage of utilities through the diaphragm.

Selection of Diaphragm Members

Select the most economical diaphragm members that meet design and detailing requirements. The selection of diaphragm members is based on the type of diaphragm and the type of loading. The most common types of diaphragm members are listed below.

- **Type X Diaphragms**
  - Solid Plate Diaphragms
  - Welded Plate Diaphragms

- **Type Y Diaphragms**
  - Solid Plate Diaphragms
  - Welded Plate Diaphragms

- **Type Z Diaphragms**
  - Solid Plate Diaphragms
  - Welded Plate Diaphragms

Selection of Diaphragm Type

The most economical diaphragm members are typically single angle sections. Equal leg angles should be used. Solid plate diaphragms should be used only in cases where the diaphragm is subjected to a single load.

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

Type of Diaphragm

Type of Type X Diaphragms are typically the most economical design and should be used in cases where gravity loading is predominant. They can be used in cases where the diaphragm is subjected to a single load or a combination of loads. The type of Type X diaphragms does not require a detailed analysis of the diaphragm.

Type of Type Y Diaphragms should be used in cases where the diaphragm is subjected to a single load or a combination of loads. The use of Type Y diaphragms facilitates the passage of utilities through the diaphragm.

Type of Type Z Diaphragms should be used in cases where the diaphragm is subjected to a single load or a combination of loads. The use of Type Z diaphragms facilitates the passage of utilities through the diaphragm.
NOTES FOR DESIGNING AND DETAILING DIAPHRAGMS (CONTINUED FROM SHEET 2)

6. DETERMINATION OF DESIGN LOADS (CONTINUED FROM SHEET 2)

b) IN SITUATIONS WHERE TYPE K INVERTED END DIAPHRAGMS ARE USED AND THE TOP CHORD ACTS TO STRENGTHEN AND STABILIZE THE END DIAPHRAGM, THE STRENGTH OF THE WELDED CONNECTIONS IN ACCORDANCE WITH THE PROVISIONS OF THE AASHTO LRFD (SECTION 6).

7. DETAILED DESIGN PROCEDURES FOR TYPE K AND TYPE K INVERTED END DIAPHRAGMS

a) IN GENERAL, DESIGN TYPE K AND TYPE K INVERTED END DIAPHRAGMS FOLLOWING THE GUIDANCE PRESENTED IN SECTION 6.13.3.5 OF THE AASHTO LRFD.

b) IN GENERAL, THE WELDED CONNECTIONS SHALL BE DESIGNED IN ACCORDANCE WITH THE PROVISIONS OF THE AASHTO LRFD (SECTION 6).

8. DETAILED DESIGN PROCEDURES FOR TYPE X AND TYPE K INTERMEDIATE DIAPHRAGMS

a) DESIGN OF TOP CHORD, BOTTOM CHORD, AND DIAGONALS IN TYPE X AND TYPE K DIAPHRAGMS

b) DESIGN OF BOLTED CONNECTIONS OF GUSSET PLATES TO DECK, BEARING STIFFENERS, AND CONNECTION PLATES

9. DETERMINATION OF DESIGN LOADS (CONTINUED FROM SHEET 2)

b) IN SITUATIONS WHERE TYPE K INVERTED END DIAPHRAGMS ARE USED AND THE TOP CHORD ACTS TO STRENGTHEN AND STABILIZE THE END DIAPHRAGM, THE STRENGTH OF THE WELDED CONNECTIONS IN ACCORDANCE WITH THE PROVISIONS OF THE AASHTO LRFD (SECTION 6).

10. DETAILED DESIGN PROCEDURE FOR SOLID PLATE INTERMEDIATE DIAPHRAGMS

a) SOLID PLATE INTERMEDIATE DIAPHRAGMS ARE DESIGNED FOR THEIR APPROPRIATE STRENGTH LIMIT DESIGN LOAD EFFECTS IN A MANNER SIMILAR TO THE DESIGN OF OTHER STEEL GIRDERS OR BEAMS, IN ACCORDANCE WITH THE APPROPRIATE PROVISIONS OF THE AASHTO LRFD (SECTIONS 6.9.2.1, 6.10.11.2 AND 6.13.3.2).

b) SOLID PLATE INTERMEDIATE DIAPHRAGMS ARE DESIGNED FOR THEIR APPROPRIATE STRENGTH LIMIT DESIGN LOAD EFFECTS IN A MANNER SIMILAR TO THE DESIGN OF OTHER STEEL GIRDERS OR BEAMS, IN ACCORDANCE WITH THE APPROPRIATE PROVISIONS OF THE AASHTO LRFD (SECTIONS 6.9.2.1, 6.10.11.2 AND 6.13.3.2).
SKewed supports with contiguous cross-frame lines parallel to the skew (skew ≥ 70°)

Severely skewed supports with staggered cross-frame lines

Contiguous cross-frame lines (within the span) normal to the girder tangents (skew < 70°)

Discontinuous (staggered) cross-frame lines along the entire span normal to the girder tangents (skew < 70°)

Note:

These framing plans are conceptual only and are provided only to illustrate potential framing arrangements for various cross sections designing specific geometries. These plans are not intended for construction and shall not be replaced on plans.

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