### BEARING SCHEDULE

<table>
<thead>
<tr>
<th>Location</th>
<th>Order</th>
<th>Type</th>
<th>No. req'd.</th>
<th>Perpendicular loads</th>
<th>Horizontal loads</th>
<th>Total VS. loads</th>
<th>Design reaction (lb.)</th>
<th>Orientation angle (degrees)</th>
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### BEARING ORIENTATION PLAN

- **Orientation and Direction of Movement**
- **Girder Flange**
- **Sole Plate**
- **Upper Bearing Plate**
- **Polymer Urethane Disc**
- **Stainless Steel**
- **PTFE**
- **Bronze**

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**Notes:**
- PTFE: polytetrafluoroethylene
- Bronze: an alloy of copper and tin

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**Guidance:**
- All bearings shall be designed and fabricated to meet the requirements of Section 408.03(a) of the Specifications.
- Bearings shall be of the type shown in the BEARING ORIENTATION PLAN.
- All bearings shall be designed to accommodate the design load and rotation specified in the BEARING SCHEDULE.

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**Material:**
- Stainless steel, PTFE, and bronze surfaces shall be used as specified in the BEARING SCHEDULE.
- All bearings shall be designed and fabricated to meet the requirements of Section 408.03(a) of the Specifications.
BEARINGS SCHEDULE

<table>
<thead>
<tr>
<th>Location</th>
<th>Order</th>
<th>Type</th>
<th>No. recs.</th>
<th>Minimum design load kips</th>
<th>Horizontal design load kips</th>
<th>Vertical design load kips</th>
<th>Total design load kips</th>
<th>Design reaction capacity of masonry plates</th>
<th>Orientation angle degrees</th>
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Notes:

- S.A.S. designates socket head cap screws.
- Bearings shall conform to Section 408.01, High Load Multi-Rotational Bearings, of the Specifications.
- Standard bearing plates shall be ASTM A36 grade B.
- The Contractor may select from Appendix A, High Load Multi-Rotational Bearings, of the Specifications.
- The design load on the bearing shall not exceed 20% of the combined vertical load and rotation may not exceed 20%.
- The strain under total vertical load may not exceed 10%, the strain to prevent lift off during rotation.
- The instantaneous deflection under total load is limited to a maximum of 10% of the thickness of the unstressed disc.
- The strain under total vertical load is limited to a maximum of 10% of the thickness of the unstressed disc.
- The maximum design load for Non-Guided Bearings is given solely for the design of the fixed position and plate edge washers, stainless steel or sheet steel washers.
- Stainless steel PTFE and bronze surfaces, surfaces in contact with the elastomeric disc, the polyether urethane disc or the shear pin shall not be painted.
- The Horizontal Design Load for Non-Guided Bearings is given solely for the design of the fixed position and plate edge washers, stainless steel or sheet steel washers.
- Stainless steel PTFE and bronze surfaces, surfaces in contact with the elastomeric disc, the polyether urethane disc or the shear pin shall not be painted.
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NOTES TO DESIGNER:

1. The High Load Multi-Rotational Bearing Standard consists of three standard sheets:

   BBD-6 Fixed Bearings
   BBD-7A Guided Expansion Bearings
   BBD-7B Non-Guided Expansion Bearings

   Normally, a set of plans will have all three standards included. The type of bearing given in the Bearing Schedule shall be FF (Fixed), EF (Guided Expansion), or EE (Non-Guided Expansion).

2. Vertical Design Loads: The minimum vertical design load shall not be less than 20% of the maximum vertical design load. If this minimum load is not maintained on the bearing, it may not function properly and failure may occur.

3. Horizontal Design Loads: The total horizontal force on a row of bearings shall be the larger of:
   a. The total actual horizontal design loads from the superstructure.
      1. Seismic Performance Category A – a minimum horizontal capacity of 20% of the total vertical dead load of the superstructure.
      2. Seismic Performance Category B – the actual calculated seismic load divided by the response modification factor R.

   Because of the clearances between parts of bearings and the difficulty of aligning them in the field, each bearing shall be designed for the total horizontal load when there are only two bearings resisting the load. If more than two bearings resist the load, use the number of bearings divided by two and round down. The horizontal design load on an individual fixed or guided expansion bearing shall be computed as the total horizontal force in a direction on a row of bearings but not less than 10% of the maximum vertical design load of the bearing. Frictional resistance shall be neglected when calculating the horizontal design load. If a row of bearings consists of two guided bearings which allow longitudinal movement and all the rest are unguided expansion bearings, then each of the two guided bearings would be designed to resist the total transverse horizontal load (wind, centrifugal, thermal, seismic etc.) from the superstructure. If a row of bearings consists of two fixed bearings and all the rest are guided bearings which allow transverse movement, then each of the two fixed bearings would resist the total transverse horizontal force and the total longitudinal force would be resisted by the number bearings divided by two and rounded down. The minimum horizontal design load for an unguided expansion bearing shall be equal to 10% of the maximum vertical design load of the bearing. This provides the design load for the pot and piston. It does not mean that the sliding surface must be able to transmit this much force or that stops have to be provided to limit movement.

4. Loads given in the Bearing Schedule shall be the maximum loads resulting from the various group load combinations divided by the percentage of the basic unit stress allowed for that group load combination. Therefore, if the Horizontal Design Load is from a Group III loading, the load would be divided by 1.25 before entering it into the Bearing Schedule. Seismic loads are divided by 1.5.
NOTES TO DESIGNER (cont’d):

5. The minimum design rotational capacity of the bearing \((R_b)\) is the actual design rotation of the structure \((R_s)\) plus 0.02 radians construction tolerance \((R_c)\). The actual design rotation of the structure \((R_s)\) shall not be less than 0.01 radians. Therefore, \(R_b \geq 0.03\) radians.

6. The installed alignment of bearing guiding systems relative to the anticipated movement direction of the structure should be carefully considered to avoid bearing guide system failure. Special studies or designs may be required on curved or skewed structures to ensure correct installation. The STAAD-III/ISDS finite element computer program may be used with its thermal load case for this purpose. Generally, movements radiate away from points of fixity. The proper alignment of the guided bearings shall be shown in the plans.

7. Transverse rows of bearings should have two fixed bearings with the remainder guided expansion or two guided expansion bearings with the remainder unguided expansion. The two fixed or guided expansion bearings should be adjacent to each other. On curved structures with steel pier caps supported by two HLMR bearings, the fixed bearing at the pier cap should be on the outside of the curve.

8. The standard drawings are not to be used without referring to Specifications Section 408.03(a), High Load Multi-Rotational Bearings, for design criteria.

9. For large diameter bearings or for bearings with large movements, multiple pairs of bearing stiffeners may be required to insure uniform distribution of the load to the bearing.

10. When setting sole plate width, do not set minimum width based entirely on girder flange. The sole plate is set perpendicular to the direction of movement and may not be perpendicular to the girder. The sole plate width needs to be checked for this case.

11. Heights of bearings given in manufacturers’ literature may not be accurate since they are generally designed for less than 0.03 radians rotation. Adjust the manufacturer’s height by the difference in its rotation capacity and your rotation capacity times the radius of the elastomer.

12. A copy of any design calculations for HLMR bearings furnished by a fabricator should be provided to Structure and Bridge Division to the attention of the project designer. The design calculations should include an example of the formulas and theories used and not merely computer output listing final dimensions.

13. Always provide bridge seat reinforcement beneath High Load Multi-Rotational Bearings.

14. Anchor bolts must be located so that the nuts may be put on with the whole bearing (including sole plate) in place. The specifications do not allow the Contractor to disassemble the bearing in order to put the nuts on the bolts.

15. On expansion bearings, the dimension SA is always perpendicular to the direction of movement and dimension SB is always parallel to the direction of movement.
HIGH LOAD MULTI-ROTATIONAL BEARINGS

NOTES TO DESIGNER (cont’d):

16. Refer to the top figure on Sheet 7 and the following instructions as an example for determining the horizontal design loads for the bearings:

\[ V = \text{maximum vertical design load on the bearing being designed} \]
\[ HT = \text{total normal transverse loads (wind, centrifugal, etc.)} \]
\[ HL = \text{total normal longitudinal loads (wind, traction, etc.)} \]
\[ ST = \text{total transverse seismic load defined in 3b.} \]
\[ SL = \text{total longitudinal seismic load defined in 3b.} \]
\[ N = \text{number of bearings capable of resisting the horizontal force in a given direction} \]
\[ INT = \text{integer} \]

a. At the abutments, each NE bearing would be designed for a horizontal force of:

\[ O.IV \]

b. At the abutments, each GEL bearing would be designed for a horizontal force equal to the larger of:

\[ O.IV \text{ or } HT \text{ or } ST \]

c. At the pier, each GET bearing would be designed for a horizontal force equal to the larger of:

\[ O.IV \text{ or } HL/INT(N/2) \text{ or } SL/INT(N/2) \]

d. At the pier, each F bearing would be designed for a horizontal force equal to the larger of:

\[ \sqrt{((HL/INT(N/2))^2 + HT^2)} \text{ or } SL/INT(N/2) + 0.3ST \text{ or } 0.3SL/INT(N/2) + ST \]

NOTES:

When comparing loads to determine the maximum, make the proper reduction for group load combinations.

Longitudinal horizontal loads not resisted by bearings at one substructure element will be carried by the bearings at other substructure elements.
- Bearing Location
  F - Fixed Bearing
  GET - Guided Expansion Transverse
  GEL - Guided Expansion Longitudinal
  NE - Nonguided Expansion
  → - Direction of Movement

Notes: Individual orientation of guided bearings to be shown in the plans.
Details only apply to bridges with radial supports

EXPANSION OF CURVED GIRDER BRIDGES
USING HLMR BEARINGS