AASHTO/NSBA Steel Bridge Collaboration

G 9.1 - 2004

Steel Bridge Bearing Design and Detailing Guidelines

AASHTO/NSBA Steel Bridge Collaboration

Preface

This document is a standard developed by the AASHTO/ NSBA Steel Bridge Collaboration. The primary goal of the Collaboration is to achieve steel bridges of the highest quality and value through standardization of the design, fabrication, and erection processes. Each standard represents the consensus of a diverse group of professionals.

As consensus documents, the Collaboration standards represent the best available current approach to the processes they cover. It is intended that Owners adopt and implement Collaboration standards in their entirety to facilitate the achievement of standardization, but it is understood that local statutes or preferences may prevent full adoption of the document. In such cases, Owners should adopt these documents with the exceptions they feel are necessary.

The following guidelines and details are for typical steel bridges. The Collaboration recognizes that most states currently have standards for bearings, however it is the intent that states will adopt or modify their standards for steel bridge bearings to conform to this guideline. In many cases, options for economical bearings are offered to facilitate the acceptance and use of this document.

Disclaimer

AASHTO Document No: SBB-1

EXECUTIVE COMMITTEE
2003–2004

Voting Members

Officers:

President: John R. Njord, Utah

Vice President: J. Bryan Nicol, Indiana

Secretary-Treasurer: Larry M. King, Pennsylvania

Regional Representatives:

REGION I: James Byrnes, Connecticut, One-Year Term
Allen Biehler, Pennsylvania, Two-Year Term

REGION II: Whittington W. Clement, Virginia, One-Year Term
Fernando Fagundo, Puerto Rico, Two-Year Term

REGION III: Mark F. Wandro, Iowa, One-Year Term
Gloria Jeff, Michigan, Two-Year Term

REGION IV: Michael W. Behrens, Texas, One-Year Term
Tom Norton, Colorado, Two-Year Term

Non-Voting Members

Immediate Past President: Dan Flowers, Arkansas

AASHTO Executive Director: John Horsley, Washington, D.C.

HIGHWAY SUBCOMMITTEE ON BRIDGES AND STRUCTURES 2004

Malcolm T. Kerley, Virginia, *Chairman*
Sandra Q. Larson, Iowa, *Vice Chairman*
Myint Lwin, Federal Highway Administration, *Secretary*

ALABAMA, William F. Conway, George H. Conner
ALASKA, Richard A. Pratt
ARIZONA, Jean A. Nehme
ARKANSAS, Phil Brand
CALIFORNIA, Richard Land, Susan Hida, Barton J. Newton
COLORADO, Mark A. Leonard
CONNECTICUT, vacant
DELAWARE, Jiten K. Soneji, Barry A. Benton
DISTRICT of COLUMBIA, L. Donald Cooney
FLORIDA, William N. Nickas, Jack O. Evans
GEORGIA, Paul Liles, Brian Summers
HAWAII, Paul Santo
IDAHO, Matthew M. Farrar
ILLINOIS, Ralph E. Anderson, Thomas J. Domagalski
INDIANA, John J. Jordan
IOWA, Norman L. McDonald
KANSAS, Kenneth F. Hurst, Loren R. Risch
KENTUCKY, vacant
LOUISIANA, Hossein Ghara, Tony M. Ducote
MAINE, James E. Tukey, Jeffrey S. Folsom
MARYLAND, Earle S. Freedman, Robert J. Healy
MASSACHUSETTS, Alexander K. Bardow
MICHIGAN, Steve Beck, Raja Jildeh
MINNESOTA, Daniel L. Dorgan, Kevin Western
MISSISSIPPI, Mitchell K. Carr, B. Keith Carr
MISSOURI, Shyam Gupta, Paul Kelly, Paul Porter
MONTANA, Kent Barnes
NEBRASKA, Lyman D. Freemon, Mark Ahlman Hussam Fallaha
NEVADA, William C. Crawford, Jr.
NEW HAMPSHIRE, Mark W. Richardson, Mark D. Whittemore
NEW JERSEY, Harry A. Capers, Jr., Richard W. Dunne
NEW MEXICO, Jimmy D. Camp
NEW YORK, George A. Christian, Donald F. Dwyer, Arthur Yannotti
NORTH CAROLINA, Gregory R. Perfetti
NORTH DAKOTA, Terrence R. Udland
OHIO, Timothy J. Keller, Jawdat Siddiqi
OKLAHOMA, Robert J. Rusch
OREGON, vacant
PENNSYLVANIA, R. Scott Christie, Harold C. Rogers
PUERTO RICO, Jamie Cabre
RHODE ISLAND, David Fish
SOUTH CAROLINA, Douglas E. McClure, Barry W. Bowers, Jeff Sizemore
SOUTH DAKOTA, John C. Cole
TENNESSEE, Edward P. Wasserman
TEXAS, Mary Lou Ralls, William R. Cox, David P. Hohmann
UTAH, David Nazare
VERMONT, James B. McCarthy
VIRGINIA, George M. Clendenin, Julius F.J. Volgyi
WASHINGTON, Jerry A. Weigel, Tony M. Allen Bijan Khaleghi
WEST VIRGINIA, Greg Bailey, James W. Sothen
WISCONSIN, Stanley W. Woods
WYOMING, Gregg C. Fredrick, Keith R. Fulton
EASTERN LANDS HIGHWAY DIVISION, Hala Elgaaly
U.S. COAST GUARD, Nicholas E. Mpras
U.S. COAST GUARD, Jacob Patnaik
ALBERTA, Dilip K. Dasmohapatra
BRITISH COLUMBIA, Peter Brett
MANITOBA, Ismail Elkholy
NEW BRUNSWICK, Doug Noblel
NORTHWEST TERRITORIES, John Bowen
NOVA SCOTIA, Mark Pertus
ONTARIO, Bala Tharmabala
SASKATCHEWAN, Howard Yea
GOLDEN GATE BRIDGE, Kary H. Witt
MASS. METRO. DIST. COMM., David Lenhardt
N.J. TURNPIKE AUTHORITY, Richard J. Raczynski
N.Y. STATE BRIDGE AUTHORITY, William J. Moreau
PENNSYLVANIA TURNPIKE COMMISSION, Barry L. Troup
PORT AUTHORITY OF N.Y. AND N.J., Joseph J. Kelly
MILITARY TRAFFIC MANAGEMENT COMMAND, Robert D. Franz
U.S. ARMY CORPS OF ENGINEERS-DEPARTMENT OF THE ARMY, Paul C. T. Tan
U.S. DEPARTMENT OF AGRICULTURE-FOREST SERVICE, Nelson Hernandez

Introduction

The purpose of this guide is to present steel bridge bearing details that are cost effective, functional, and durable. Three major types of bridge bearings are presented.

1. **Elastomeric bearings**
   The details are for steel reinforced elastomeric pads; however, much of the content is directly applicable to fiberglass reinforced, plain, and cotton duck pads as well.
2. **High Load Multi-Rotational bearings (HLMR)**
   The details include pot, disc, and spherical bearings
3. **Steel bearings**
   The details are primarily used for fixed bearing lines.

These bearing categories are sufficient to cover the vast majority of structures in the national bridge inventory. Special bridges may require different bearings.

This guide is not intended as a stand-alone document and does not supersede the AASHTO specifications.

This guide does not include seismic isolation bearings. This is due to the complexity of the various approaches to individual isolation bearing designs.

This document contains many guidelines that are based on provisions of the AASHTO design and construction specifications. Designers should note that changes made to the AASHTO specifications after the publication of this document may be in conflict with the guidelines contained herein. In this case, the provisions in the AASHTO specifications shall take precedence over the guidelines in this document.

Table of Contents

Section 1
Elastomeric Bearings

1.1 General

This section is intended to assist in the design and detailing of elastomeric bridge bearings. The information included is intended to permit efficient fabrication, installation, and maintenance of these bearings.

Commentary

Elastomeric bearings have a low initial cost when compared to other bearing types, and require virtually no long-term maintenance.

This guideline document contains design guidance for areas that are not specifically addressed in the AASHTO specifications.

1.2 Reference Documents

- AASHTO LRFD Bridge Design Specifications
- AASHTO Standard Specifications for Highway Bridges
- *Steel Bridge Bearing Selection and Design Guide*, Volume II, Chapter 4, Highway Structures Design Handbook

1.3 Basic Assumptions

This document makes the following design and detailing assumptions for elastomeric bearings:

1. The bearings are normally vulcanized to a top plate or sole plate.
2. The bearings are attached to the girder; by field welding or bolting.
3. Masonry plates and anchor rods are not normally required.
4. The bearing bears directly on the concrete substructure.
5. Lateral forces on expansion bearings are restrained by means of friction, keeper angles, or concrete keeper blocks (keys). Lateral forces on fixed bearings are restrained by anchor rods.

Commentary

Some states prefer to attach the bearings to the beam by welding and others prefer bolting. Both methods are acceptable (refer to individual state requirements). Welded attachment allows for minor adjustment during installation and is often the most economical design. Bolting provides limited damage to coating systems and allows for easier removal in the future.

Several states design expansion bearings without a connection to the girder. The bearing is held in place by friction alone. There have been isolated problems with elastomeric bearings slipping and/or walking out from under beams. Research has shown that paraffin used in natural rubber bearings to prevent ozone degradation can bleed out, causing a large drop in friction values. Several states incorporate recesses and keeper assemblies to prevent the bearing from slipping; however, these methods are typically not cost effective. This problem can also be solved by specifying neoprene for the elastomer, since paraffin is not required in neoprene bearings. *(See Research Report 1304-3, "An Experimental Study of Elastomeric Bridge Bearings with Design Recommendations" J.V.Muscarella and J.A. Yura 1995.*

Several states design short simple span bridges using expansion bearings only. This method reduces the movement at each bearing by half.

1.4 Design and Detailing Recommendations

1.4.1 Design

The design of elastomeric bearings is the responsibility of the design engineer. The design should follow the provisions of the AASHTO specifications.

Commentary

States currently use both Method A and Method B as outlined in the AASHTO specifications. For specific information regarding the requirements of the individual state DOTs, refer to each state's design procedures.

It is recommended that AASHTO Method A be used for design since it is less complicated and has fewer testing requirements. Bearings designed using Method A have an excellent performance history.

1.4.1.1 Bearing Shapes

Elastomeric bearings can either be round or rectangular.

Commentary

The AASHTO Design Specifications allow the use of both round and rectangular bearings.

Round bearings are best used for standardization of bearings by an agency since only one dimension can vary in plan. Round bearings are recommended for curved and larger skewed bridges since they can accommodate movement and rotations in multiple directions. They also usually require a narrower bridge seat on skewed bridges.

Rectangular bearings are best suited for low skew bridges and on beams with large rotations and/or movements. Rectangular bearings also usually require a narrower bridge seat on low skew bridges.

1.4.1.2 Design Rotation and Movements

Elastomeric bearing assemblies should be designed for unfactored dead load and live load rotations, rotations due to profile grade, and an additional rotation of 0.005 radians for the combination of uncertainties and construction tolerances specified in the AASHTO Specifications.

Commentary

Bearing assemblies consist of the elastomeric bearing element, connection plates (if required), and a beveled or flat sole plate (if required). See Section 1.6 for details of typical bearing assemblies. Refer to Appendix A for information on calculating rotations. The experience of all the states contributing to this document is that the 0.005 radian value produces bearings that are easily installed and perform very well. For bearings requiring sole plates with minor bevels (<0.01 radians), the designer may alternatively choose to increase the thickness of the elastomer to accommodate the rotation and use a flat sole plate.

Sole plates should be beveled to account for a significant portion of the rotations due to profile grade. If beveled sole plates are used, the design rotation for the elastomer due to profile grade should be neglected in the final loaded condition.

Refer to Appendix A for information on the effect of beveled sole plates on bearing design rotations.

If the beam is cambered for dead loads, the dead load design rotation of the elastomer should be neglected.

Refer to Appendix A for information on the effect of beam cambering on bearing design rotations.

The bearings should be designed for all longitudinal and lateral movements.

Longitudinal translation due to dead load girder rotation may need to be accounted for on beams with large rotations or for deep girders. This translation should be added to the design longitudinal movement. Refer to Appendix B for guidance on horizontal movements.

The designer should specify on the plans a range of temperatures for setting the bearings based on the design of the bearings. Provisions should also be included for jacking the structure in order to reset the bearings if this range cannot be met during construction.

States have differing requirements for setting temperatures. A recommended temperature range is the average ambient temperature range for the bridge location plus or minus 10° F (5° C). Larger values can be specified provided that the bearing is designed for the additional movement.

1.4.2 Sole Plate Connections

The connection of the sole plate to I-girders may be welded or bolted.

Connection to box girders should be bolted.

Commentary

The suggested welded connection shown on the Detail Sheets may be made in either the fabrication shop or the field. Care should be taken during field welding operations, as uncontrolled welding heat can damage the elastomer. (See Section 1.4.4)

Welding allows for greater adjustment during installation and is more economical. The damage due to removal of the weld for future removal and maintenance can be reasonably repaired. The AWS/AASHTO D1.5 Bridge Welding Code has information on weld removal and repair.

Bolted connections with oversized holes allow for minor field adjustments of the bearing during installation. Bolting also requires less touch up painting on painted structures and simplified future removal.

Box girder bearings should be attached by bolting since a welded sole plate requires an overhead weld with limited clearance.

1.4.3 Sole Plate Details

The sole plate should extend transversely beyond the edge of the bottom flange of the girder a minimum of 1" (25 mm) on each side.

Commentary

This recommendation is intended to allow sufficient room for welding. Fabricators will not overturn a girder in the shop to make a small weld; therefore, it is assumed that the girder will be upright when this weld is made in the shop or in the field. (See Detail Sheets)

The minimum thickness of the sole plate should be 1½" (37mm) after beveling if the field weld is directly over the elastomer. Beveled plates as thin as

1½" exceeds the ¾" minimum thickness specified by AASHTO to minimize plate distortion due to welding.

¾" (20mm) may be used if there is a lateral separation between the weld and the elastomer that would provide a 1½" separation between the weld and the elastomer.

1.4.4 Bearing to Girder Connection

The bearing may be connected to the girder by field welding, or field bolting.

If welding is used, the welds should be in the horizontal position.

The temperature of the steel adjacent to the elastomer should be kept below 250°F (120°C).

The bearing should be detailed with at least 1½" (37 mm) of steel between the elastomer and any field welds.

The welds for the sole plate connection should only be along the longitudinal girder axis. Transverse joints should be sealed with an acceptable caulking material.

Commentary

Welding and bolting are both acceptable; however, welding is the more economical option. If bolting is selected, oversized holes are recommended to facilitate field fit-up. Refer to each state's standard details.

Overhead welds should be avoided due to limited clearance.

AASHTO specifications allow 400°F (200°C). However, this temperature is above the temperature that is commonly used for vulcanizing, and may cause separation of the elastomer from the sole plate. Temperature crayons or other heat-indicating devices should be specified for welding inspection.

The 1½" (37 mm) requirement refers to the distance between the weld and the elastomer, not the thickness of the plate.

The longitudinal welds are made in the horizontal position, which is the position most likely to result in a quality fillet weld. Transverse welds require overhead welds and are very difficult to complete due to limited clearance. The caulking of the underside transverse joint is intended to prevent corrosion between the sole plate and the bottom flange. Most states use a silicone-based caulk; however, other materials may be used.

1.4.5 Masonry Plate and Anchor Rods

1.4.5.1 Expansion Bearings

Masonry plates are not normally required for expansion bearings. The bearing should bear directly on the concrete substructure.

Anchor rods are not required for expansion bearings. Lateral forces are restrained by means of friction, concrete keeper blocks, or keeper angles. In certain cases, such as high movement expansion bearings, anchor rods may be required. See Detail Sheets.

Commentary

The bearing should be checked for sliding resistance. To prevent sliding, the maximum shear force in the bearing should be less than 20 percent of the dead load or any other loading that produces a smaller reaction. This criterion will be difficult to meet for bearings with high movement and low vertical load. An elastomeric bearing combined with a PTFE/stainless steel sliding surface should be considered for this case. (See Section 1.4.6.)

Eliminating masonry plates and anchor rods for expansion bearings greatly reduces the costs of the bearings. Concrete keeper blocks and keeper angles are less costly and easier to construct.

Bearings may be designed as expansion/expansion if the center of gravity of the bridge is relatively centered between the bearing lines. Bridges with grades greater than 3 percent or with large braking forces (e.g., bridges located near intersections) should not be designed as expansion/expansion. In these cases, a fixed bearing should be used on one end of the bridge.

For bridges that are very wide, or with high skews, care should be taken with the layout of keeper blocks and keeper angles. Skewed bridges will tend to expand along an axis that runs from acute corner to acute corner. Bridges that are wider than they are long will expand more in the transverse direction than in the longitudinal direction.

The major component of a bridge that drives thermal expansion is the concrete bridge deck. This element is directly exposed to sun light and usually achieves temperatures that higher than the ambient temperature. On skewed and wide bridges, the concrete deck expands in two dimensions and is not influenced significantly by the alignment of the girders below. On these types of bridges, the location and alignment of the keeper assemblies needs to be carefully studied.

1.4.5.2 Fixed Bearings

Masonry plates are not required for fixed elastomeric bearings. The bridge may be designed as expansion/expansion. The bearing should bear directly on the concrete substructure.

Commentary

Economical fixed bearings can be detailed without masonry plates, while still providing lateral resistance. See Detail Sheets.

1.4.5.3 Anchor Rod Design

The design of anchor rods for lateral load should take into account the bending capacity of the rod, edge distance to the concrete foundation, strength of the concrete and group action of the rods.

Commentary

The term “anchor bolts” should not be used because “bolt” implies that the rod has a head. The AASHTO specifications do not give specific requirements for the design of embedded anchors in shear. The American Concrete Institute publication “Building Code Requirements for Structural Concrete (ACI 318-02) is recommended.

Material for anchor rods should be ASTM F1554, and should be either threaded (with nuts) or swaged on the embedded portion of the rod. The design yield strength of this material may be specified as 36ksi (250MPa), 55ksi (380MPa), or 105ksi (725MPa), depending on the design. The yield strength should be given in the specifications or on the plans.

This material is specifically designed for anchor rod applications. Other materials have been used, but do not offer the economies of ASTM F1554. The designer should offer options of swaging or threading the anchor as different suppliers supply one or both of these options.

1.4.6 Elastomeric Bearings with Sliding Surfaces

Sliding surface bearings should only be used for situations where the combined effects of large movement and low load do not permit the economical used of conventional elastomeric bearings.

Commentary

Sliding surfaces are more costly to fabricate than conventional elastomeric bearings, and they introduce the need for future maintenance. Therefore, the use of this type of bearing should be limited to special situations.

Anchor rods should only be used on this bearing type when there is a concern for uplift, or where stream or ice forces may act on the superstructure.

Anchor rods, if used, should be investigated for the combined effects of shear and bending. A shear plate may be incorporated into the design to reduce the bending effects in the anchor rods.

Keeper blocks or keeper angles should be used to maintain alignment of the structure and provide lateral support. They have proven to be more cost effective than anchor rod assemblies at each bearing.

The nature of this type of bearing requires that the anchorage forces be passed through a plane that is above the bridge seat. If bending forces in the anchor rods are large, then shear blocks should be added. (See Detail Sheets)

1.5 Marking

The designer should add the following notes to the plans:

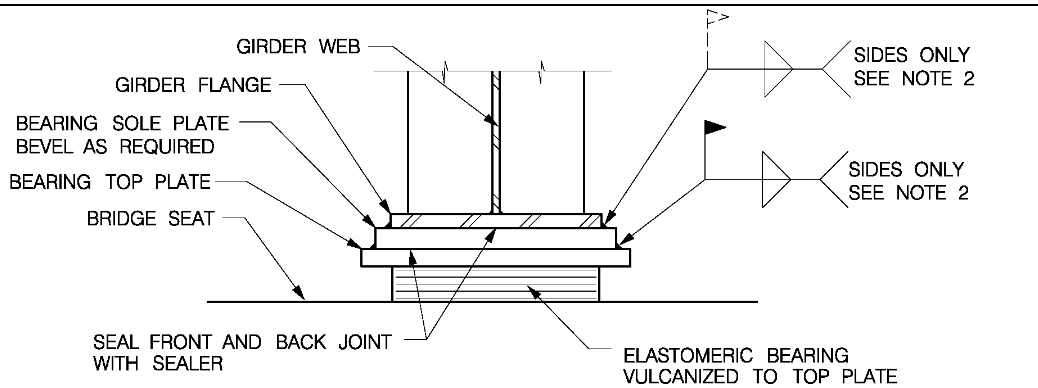
"All bearings shall be marked prior to shipping. The marks shall include the bearing location on the bridge, and a direction arrow that points up-station. All marks shall be permanent and be visible after the bearing is installed."

Commentary

Problems have occurred in the field with the installation of bearings with beveled sole plates. It is not always obvious which orientation a bearing must take on a beam before the dead load rotation has been applied. This is especially true for bearings with minor bevels.

1.6 Drawing Details

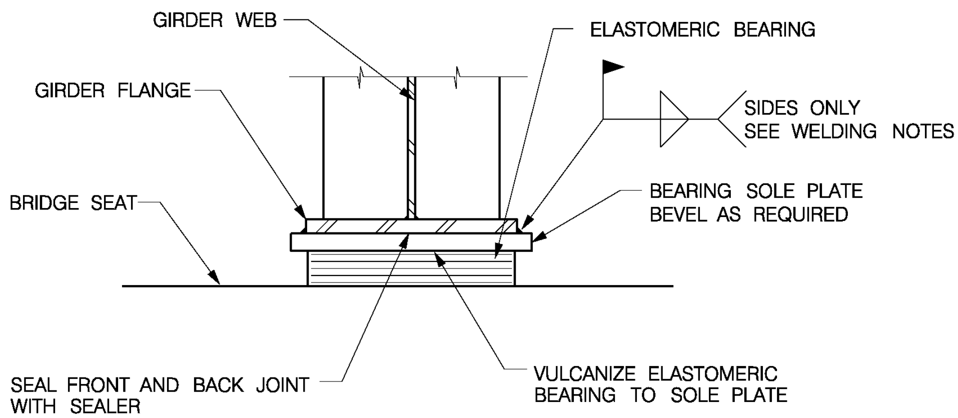
See Detail Sheets pages 7 thru 18



OPTION A

COMMENTARY:

1. *LOWER BEARING COST THAN OPTION B BECAUSE THE TOP PLATE IS FLAT, WHICH FACILITATES THE VULCANIZING PROCESS. HOWEVER, TOTAL COST MAY BE HIGHER DUE TO NEED FOR MULTIPLE PLATES.*
2. *CARE MUST BE EXERCISED WITH THE FIELD WELDING. THE TEMPERATURE OF THE STEEL ADJACENT TO THE BEARING MUST BE KEPT TO BELOW 250 DEGREES F (120 DEGREES C). TEMPERATURE CRAYONS SHOULD BE USED TO MONITOR THE STEEL TEMPERATURE DURING WELDING.*
3. *GOOD FOR BRIDGES WITH MANY DIFFERENT SOLE PLATES, SINCE THE SLOPE OF THE SOLE PLATE DOES NOT AFFECT THE MANUFACTURE OF THE BEARING.*
4. *LATERAL RESTRAINT BY FRICTION, KEEPER ANGLES, OR CONCRETE KEEPER BLOCKS.*
5. *DASHED FIELD WELDING SYMBOL REFERS TO OPTIONAL FIELD/SHOP WELD.*

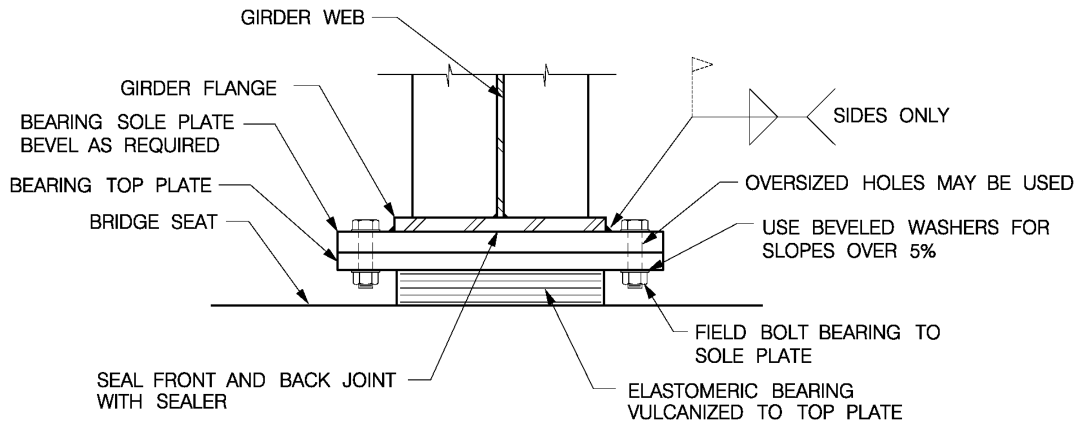


OPTION B

COMMENTARY:

1. *GOOD FOR LOCATIONS WHERE A LOW BEARING PROFILE IS REQUIRED, SUCH AS REHABILITATION PROJECTS.*
2. *CARE MUST BE EXERCISED WITH THE FIELD WELDING. THE TEMPERATURE OF THE STEEL ADJACENT TO THE BEARING MUST BE KEPT TO BELOW 250 DEGREES F (120 DEGREES C). TEMPERATURE CRAYONS SHOULD BE USED TO MONITOR THE STEEL TEMPERATURE DURING WELDING.*
3. *THIS DESIGN IS GOOD WHEN MANY OF THE BEARINGS ON THE BRIDGE HAVE THE SAME SLOPE ON THE BEVELED SOLE PLATE. THIS REDUCES FABRICATION COSTS.*
4. *LATERAL RESTRAINT BY FRICTION, KEEPER ANGLES, OR CONCRETE KEEPER BLOCKS.*

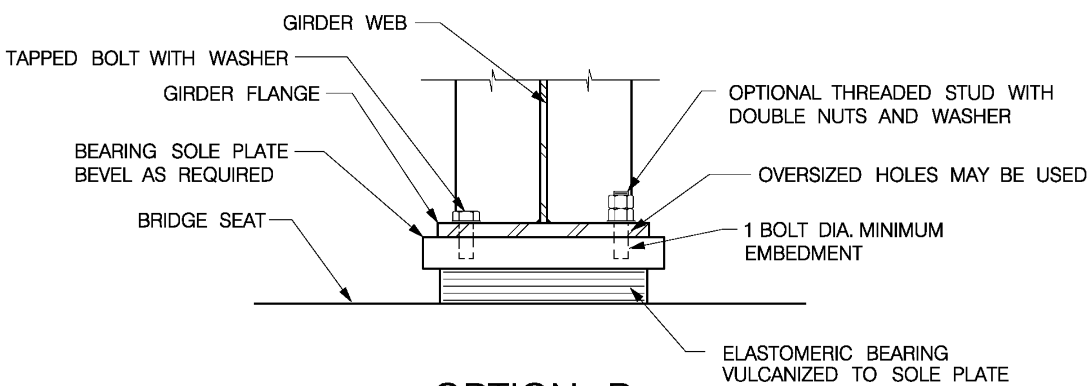
AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS EXPANSION BEARINGS WITH FIELD WELDED CONNECTIONS	LATEST REVISION DATE 1–22–04 DRAWING NUMBER E 1.1



OPTION A

COMMENTARY:

1. *THIS DESIGN IS GOOD WITH MANY DIFFERENT SOLE PLATES, SINCE THE SLOPE OF THE SOLE PLATE DOES NOT AFFECT THE MANUFACTURE OF THE BEARING.*
2. *GIRDER FABRICATOR AND BEARING MANUFACTURER MUST COORDINATE BOLT HOLE LOCATIONS. THE DESIGNER SHOULD TRY TO MINIMIZE THE NUMBER OF BOLT HOLE PATTERNS ON EACH PROJECT.*
3. *LATERAL RESTRAINT BY FRICTION, KEEPER ANGLES, OR CONCRETE KEEPER BLOCKS.*
4. *DASHED FIELD WELD SYMBOL REFERS TO OPTIONAL FIELD/SHOP WELD.*

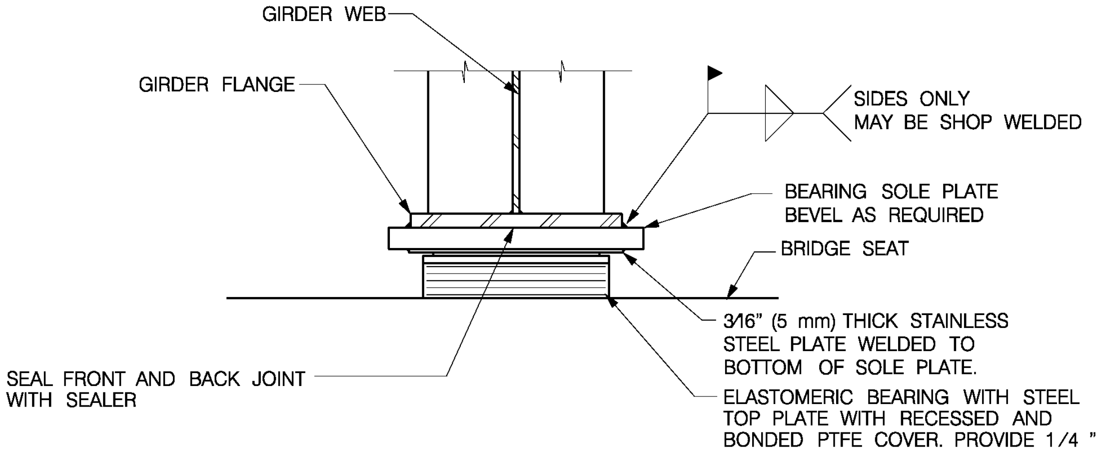


OPTION B

COMMENTARY:

1. *THIS DESIGN IS GOOD WHEN MANY OF THE BEARINGS ON THE BRIDGE HAVE THE SAME SLOPE ON THE BEVELED SOLE PLATE. THIS REDUCES FABRICATION COSTS.*
2. *GIRDER FABRICATOR AND BEARING MANUFACTURER MUST COORDINATE BOLT HOLE LOCATIONS. THE DESIGNER SHOULD TRY TO MINIMIZE THE NUMBER OF BOLT HOLE PATTERNS ON EACH PROJECT.*
3. *LATERAL RESTRAINT BY FRICTION, KEEPER ANGLES, OR CONCRETE KEEPER BLOCKS.*

AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS EXPANSION BEARINGS WITH FIELD BOLTED CONNECTIONS	LATEST REVISION DATE 1–22–04 DRAWING NUMBER E 1.2

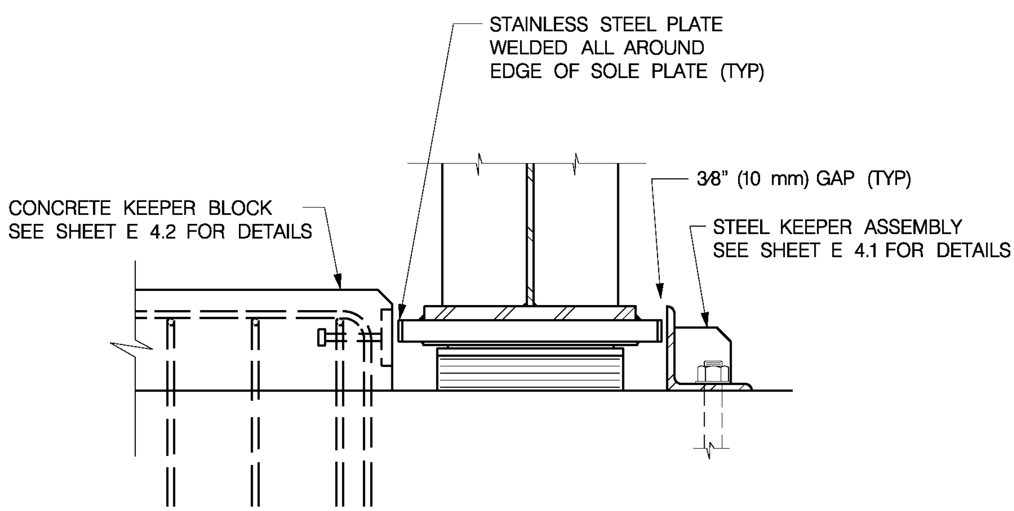


OPTION A

NON–GUIDED

COMMENTARY:

1. *WELDED CONNECTION ALLOWS FOR MINOR ADJUSTMENT OF THE BEARING/BEAM CONNECTION.*
2. *LATERAL LOADS TO BE RESISTED BY KEEPER ANGLES, OR CONCRETE KEEPER BLOCKS. SEE DETAILS BELOW, AND SHEET E 4.1 & 4.2.*
3. *SEVERAL STATES SPECIFY RESTRAINT FOR ELASTOMERIC BEARINGS. FOR THESE CASES, A BONDED MASONRY PLATE WITH ANCHOR RODS MAY BE ADDED TO THIS DETAIL TO RESTRAIN THE BEARING FROM MOVEMENT.*



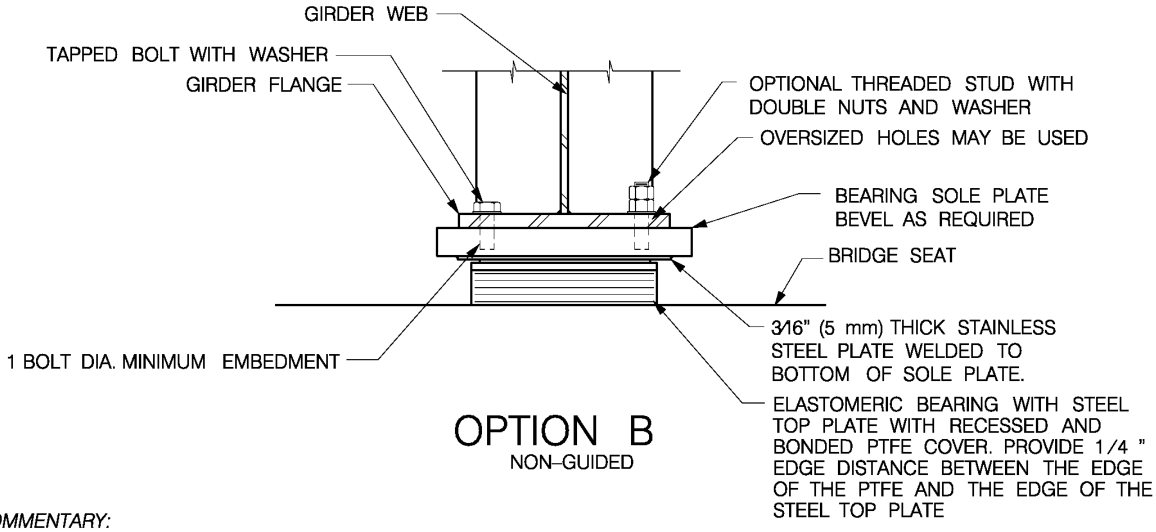
GUIDE DETAILS

USE EITHER KEEPER BLOCKS OR KEEPER ANGLES

COMMENTARY:

THE GAP BETWEEN THE KEEPERS MAY BE ADJUSTED AS PER STATE STANDARDS AND UNUSUAL THERMAL MOVEMENT CONDITIONS

AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS LARGE MOVEMENT EXPANSION BEARINGS WITH WELDED ATTACHMENT WITHOUT BEARING ANCHOR RODS	LATEST REVISION DATE 1–22–04 DRAWING NUMBER E 2.1

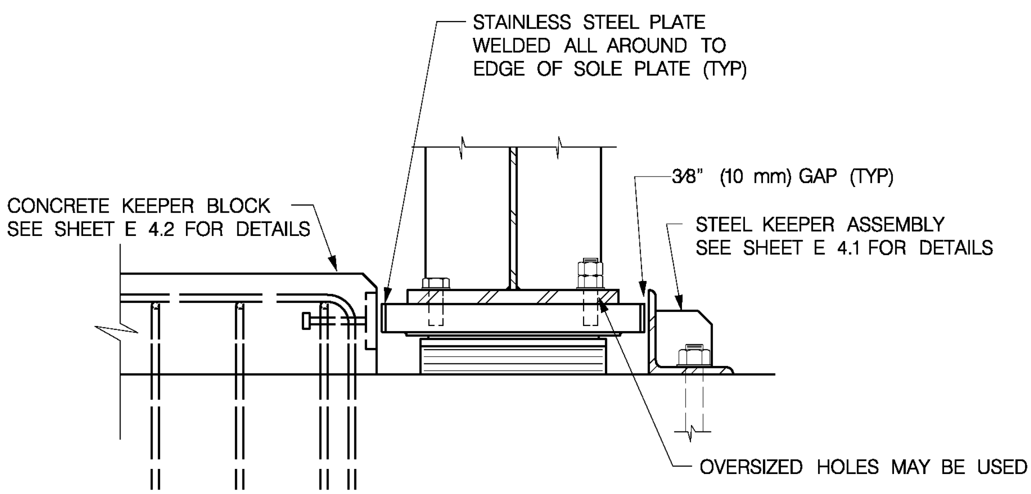


OPTION B

NON–GUIDED

COMMENTARY:

1. *OVERSIZED HOLES FOR THE BOLTED CONNECTION ALLOWS FOR MINOR ADJUSTMENT OF THE BEARING/BEAM CONNECTION.*
2. *LATERAL LOADS TO BE RESISTED BY KEEPER ANGLES, OR CONCRETE KEEPER BLOCKS. SEE DETAILS BELOW AND ON SHEETS E4.1 & 4.2.*
3. *GIRDER FABRICATOR AND BEARING MANUFACTURER MUST COORDINATE BOLT HOLE LOCATIONS. THE DESIGNER SHOULD TRY TO MINIMIZE THE NUMBER OF BOLT HOLE PATTERN ON EACH PROJECT.*
4. *SEVERAL STATES SPECIFY RESTRAINT FOR ELASTOMERIC BEARINGS. FOR THESE CASES, A BONDED MASONRY PLATE WITH ANCHOR RODS MAY BE ADDED TO THIS DETAIL TO RESTRAIN THE BEARING FROM MOVEMENT.*



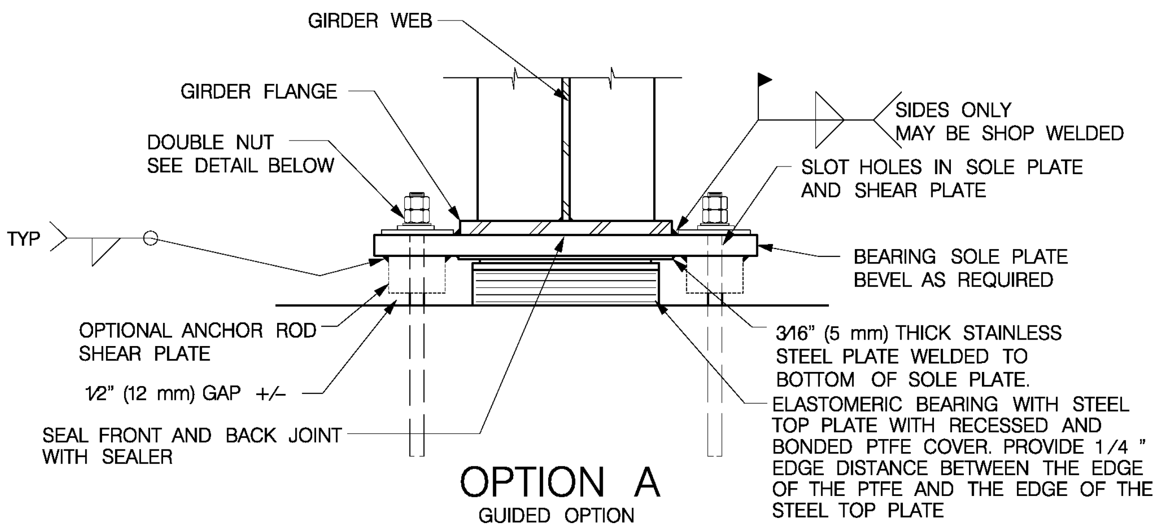
GUIDE DETAILS

USE EITHER KEEPER BLOCKS OR KEEPER ANGLES

COMMENTARY:

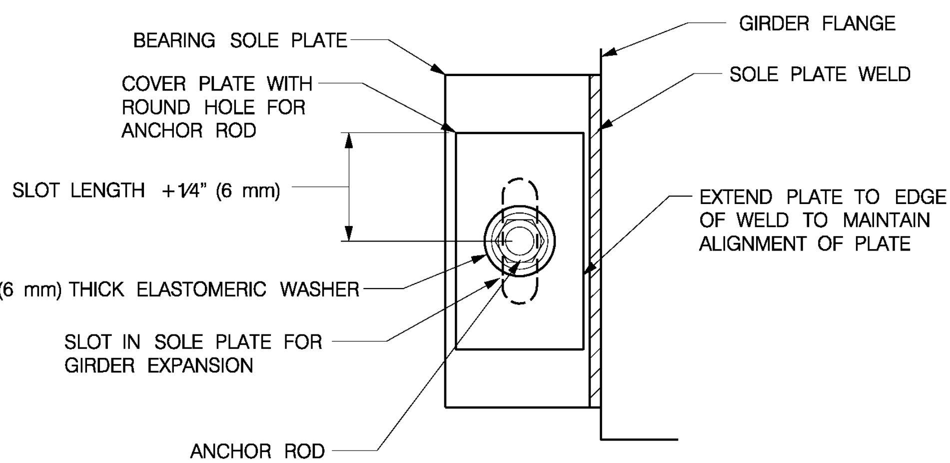
THE GAP BETWEEN THE KEEPERS MAY BE ADJUSTED AS PER STATE STANDARDS AND UNUSUAL THERMAL MOVEMENT CONDITIONS

AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS LARGE MOVEMENT EXPANSION BEARINGS WITH BOLTED ATTACHMENT WITHOUT BEARING ANCHOR RODS	LATEST REVISION DATE 1–22–04 DRAWING NUMBER E 2.2



COMMENTARY:

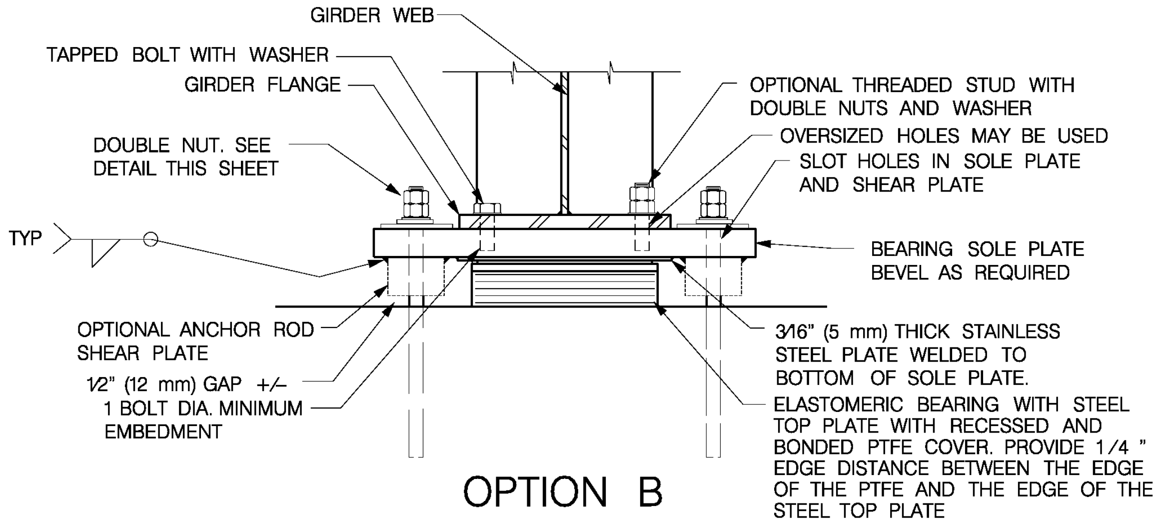
1. *WELDED CONNECTION ALLOWS FOR MINOR ADJUSTMENT OF THE BEARING/BEAM CONNECTION.*
2. *ANCHOR ROD SHEAR PLATE USED TO MINIMIZE BENDING IN ANCHOR RODS UNDER LATERAL LOAD.*
3. *SHEAR PLATE MAY BE OMITTED FOR BEARINGS WITH SMALL LATERAL LOADS AND/OR LOW PROFILE BEARINGS.*
4. *USE ELASTOMERIC WASHER UNDER DOUBLE NUTS TO ALLOW FOR BEAM ROTATION.*
5. *INSTALL LOWER NUT IN CONTACT WITH TOP PLATE AND THEN BACK OFF 1⁄2 TURN. INSTALL UPPER NUT SNUG TIGHT TO PREVENT LOWER NUTS FROM LOOSENING. LARGER GAPS MAY BE REQUIRED FOR BEARINGS WITH MORE THAN TWO RODS DUE TO VERTICAL MOVEMENT AT THE RODS DURING GIRDER ROTATION.*



ANCHOR ROD SLOT DETAIL

PLAN

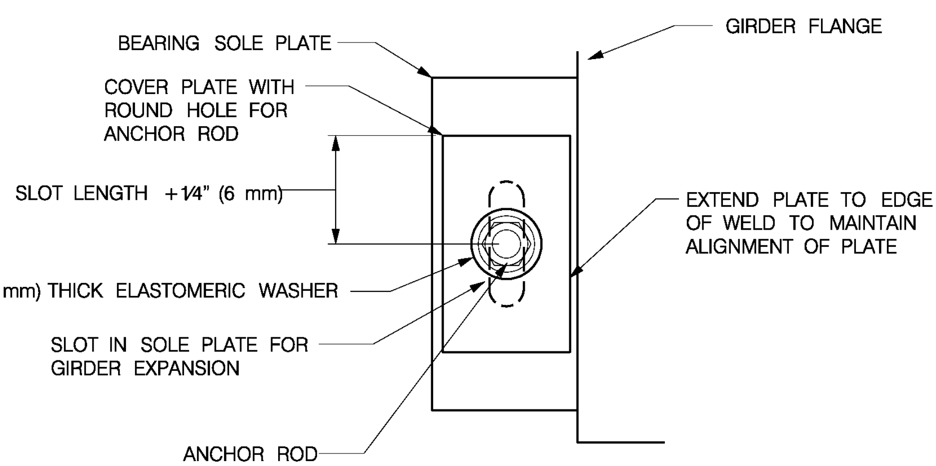
AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS LARGE MOVEMENT EXPANSION BEARINGS WITH WELDED ATTACHMENT WITH BEARING ANCHOR RODS	LATEST REVISION DATE 1–22–04 DRAWING NUMBER E 2.3



OPTION B

COMMENTARY:

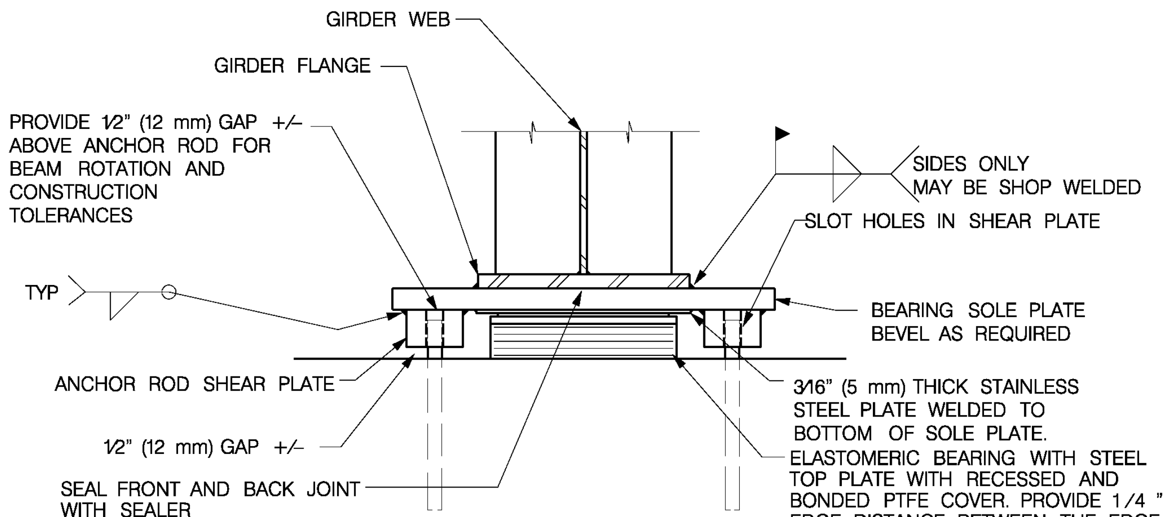
1. *OVERSIZED HOLES FOR THE BOLTED CONNECTION ALLOWS FOR MINOR ADJUSTMENT OF THE BEARING/BEAM CONNECTION.*
2. *ANCHOR ROD SHEAR PLATE USED TO MINIMIZE BENDING IN ANCHOR RODS UNDER LATERAL LOAD.*
3. *SHEAR PLATE MAY BE OMITTED FOR BEARINGS WITH SMALL LATERAL LOADS AND/OR LOW PROFILE BEARINGS.*
4. *USE ELASTOMERIC WASHER UNDER DOUBLE NUTS TO ALLOW FOR BEAM ROTATION.*
5. *GIRDER FABRICATOR AND BEARING MANUFACTURER MUST COORDINATE BOLT HOLE LOCATIONS. THE DESIGNER SHOULD TRY TO MINIMIZE THE NUMBER OF BOLT HOLE PATTERNS ON EACH PROJECT.*
6. *INSTALL LOWER NUT IN CONTACT WITH TOP PLATE AND THEN BACK OFF 1/2 TURN. INSTALL UPPER NUT SNUG TIGHT TO PREVENT LOWER NUTS FROM LOOSENING. LARGER GAPS MAY BE REQUIRED FOR BEARINGS WITH MORE THAN TWO RODS DUE TO VERTICAL MOVEMENT AT THE RODS DURING GIRDER ROTATION.*



ANCHOR ROD SLOT DETAIL

PLAN

AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS LARGE MOVEMENT EXPANSION BEARINGS WITH BOLTED ATTACHMENT WITH BEARING ANCHOR RODS	LATEST REVISION DATE 1-22-04 DRAWING NUMBER E 2.4

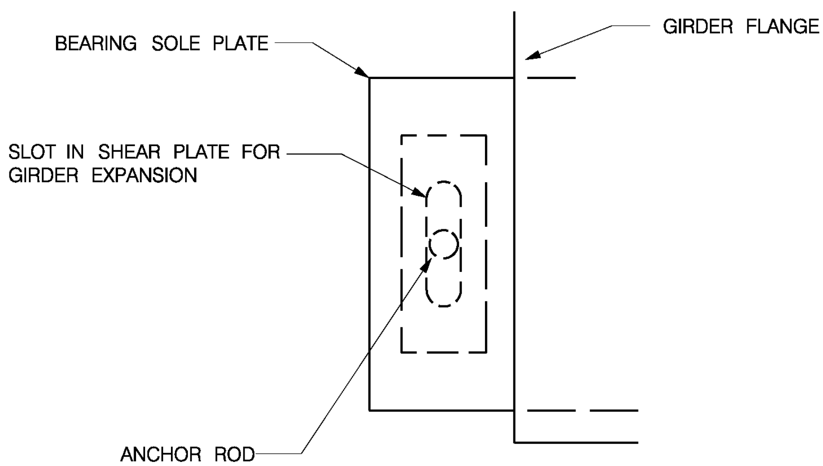


OPTION A

WELDED ATTACHMENT

COMMENTARY:

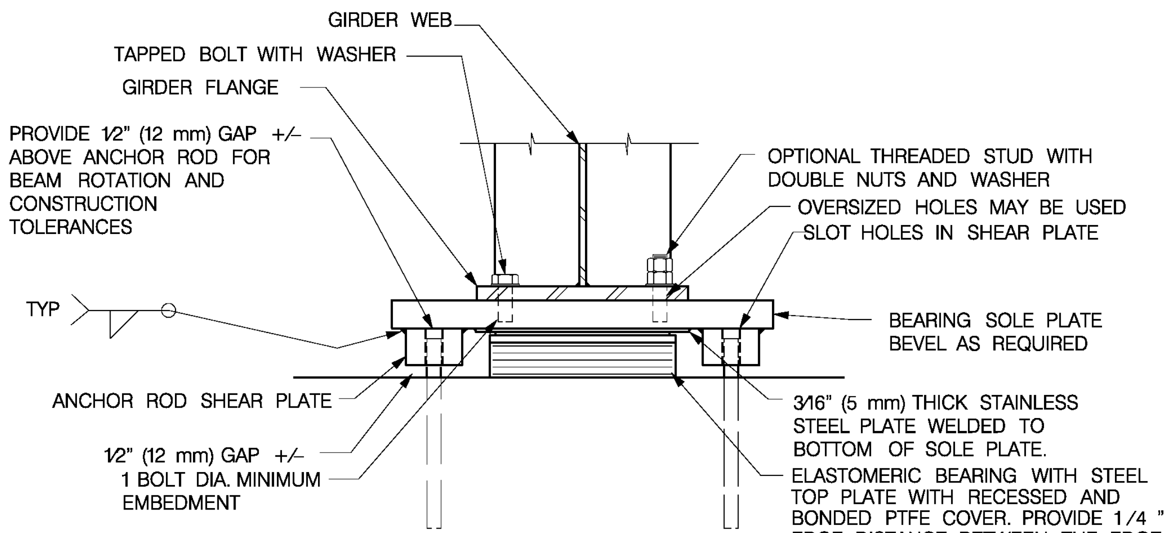
1. *WELDED CONNECTION ALLOWS FOR MINOR ADJUSTMENT OF THE BEARING/BEAM CONNECTION.*
2. *ANCHOR ROD SHEAR PLATE USED TO MINIMIZE BENDING IN ANCHOR RODS UNDER LATERAL LOAD.*



ANCHOR ROD SLOT DETAIL

PLAN

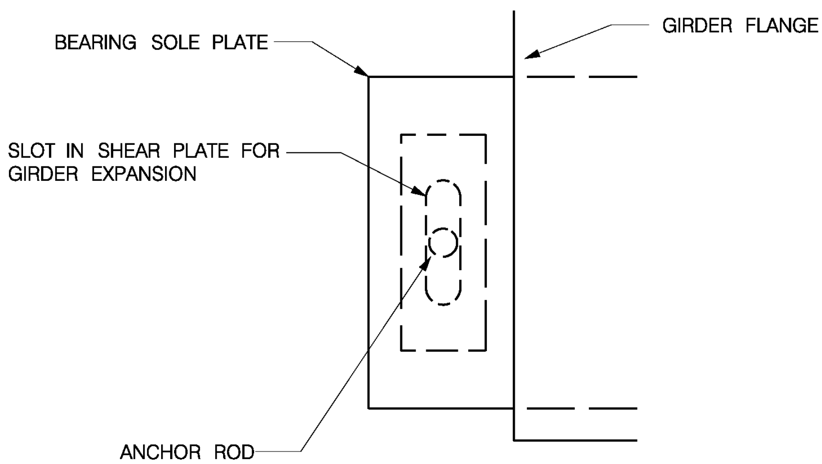
AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS LARGE MOVEMENT EXPANSION BEARINGS WITH WELDED ATTACHMENT WITH BEARING ANCHOR STUDS	LATEST REVISION DATE 1–22–04 DRAWING NUMBER E 2.5



OPTION B
BOLTED ATTACHMENT

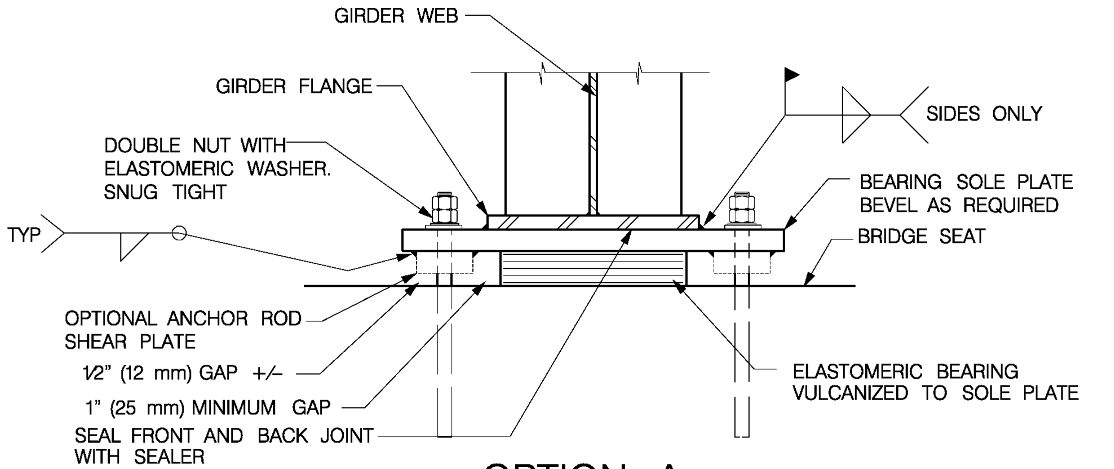
COMMENTARY:

1. *OVERSIZED HOLES FOR THE BOLTED CONNECTION ALLOWS FOR MINOR ADJUSTMENT OF THE BEARING/BEAM CONNECTION.*
2. *ANCHOR ROD SHEAR PLATE USED TO MINIMIZE BENDING IN ANCHOR RODS UNDER LATERAL LOAD.*
3. *GIRDER FABRICATOR AND BEARING MANUFACTURER MUST COORDINATE BOLT HOLE LOCATIONS. THE DESIGNER SHOULD TRY TO MINIMIZE THE NUMBER OF BOLT HOLE PATTERNS ON EACH PROJECT.*



ANCHOR ROD SLOT DETAIL
PLAN

AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS LARGE MOVEMENT EXPANSION BEARINGS WITH BOLTED ATTACHMENT WITH BEARING ANCHOR STUDS	LATEST REVISION DATE 1-22-04 DRAWING NUMBER E 2.6

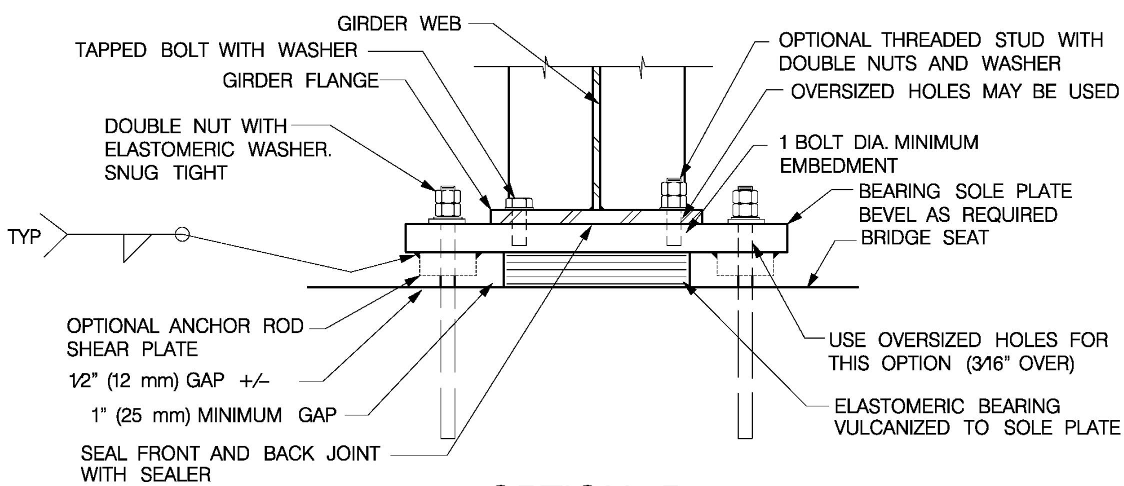


OPTION A

WELDED BEAM ATTACHMENT

COMMENTARY:

1. *WELDED CONNECTION ALLOWS FOR MINOR ADJUSTMENT OF THE BEARING/BEAM CONNECTION.*
2. *ANCHOR ROD SHEAR PLATE USED TO MINIMIZE BENDING IN ANCHOR RODS UNDER LATERAL LOAD. SHEAR PLATE MAY BE OMITTED FOR BEARINGS WITH SMALL LATERAL LOADS.*
3. *ADDITIONAL LATERAL RESTRAINT MAY BE PROVIDED BY KEEPER ANGLES, OR CONCRETE KEEPER BLOCKS BETWEEN BEAMS.*
4. *USE ELASTOMERIC WASHER UNDER DOUBLE NUTS TO ALLOW FOR BEAM ROTATION.*
5. *INSTALL LOWER NUT IN CONTACT WITH TOP PLATE AND THEN BACK OFF 1/2 TURN. INSTALL UPPER NUT SNUG TIGHT TO PREVENT LOWER NUTS FROM LOOSENING. LARGER GAPS MAY BE REQUIRED FOR BEARINGS WITH MORE THAN TWO RODS DUE TO VERTICAL MOVEMENT AT THE RODS DURING GIRDER ROTATION.*



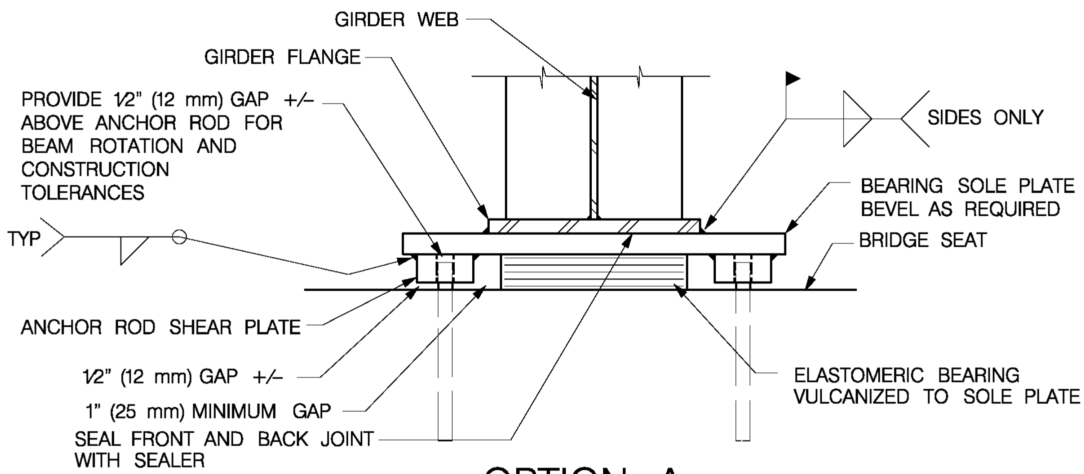
OPTION B

BOLTED BEAM ATTACHMENT

COMMENTARY:

1. *SIMILAR COMMENTARY TO DETAIL ABOVE.*
2. *OVERSIZED HOLES ONLY ALLOW FOR MINOR ADJUSTMENT IN THE FIELD, THEREFORE CORRECT ANCHOR ROD LOCATIONS ARE CRITICAL.*
3. *GIRDER FABRICATOR AND BEARING MANUFACTURER MUST COORDINATE BOLT HOLE LOCATIONS. THE DESIGNER SHOULD TRY TO MINIMIZE THE NUMBER OF BOLT HOLE PATTERNS ON EACH PROJECT.*

AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS FIXED ELASTOMERIC BEARINGS WITH ANCHOR RODS	LATEST REVISION DATE 1–22–04 DRAWING NUMBER E 3.1

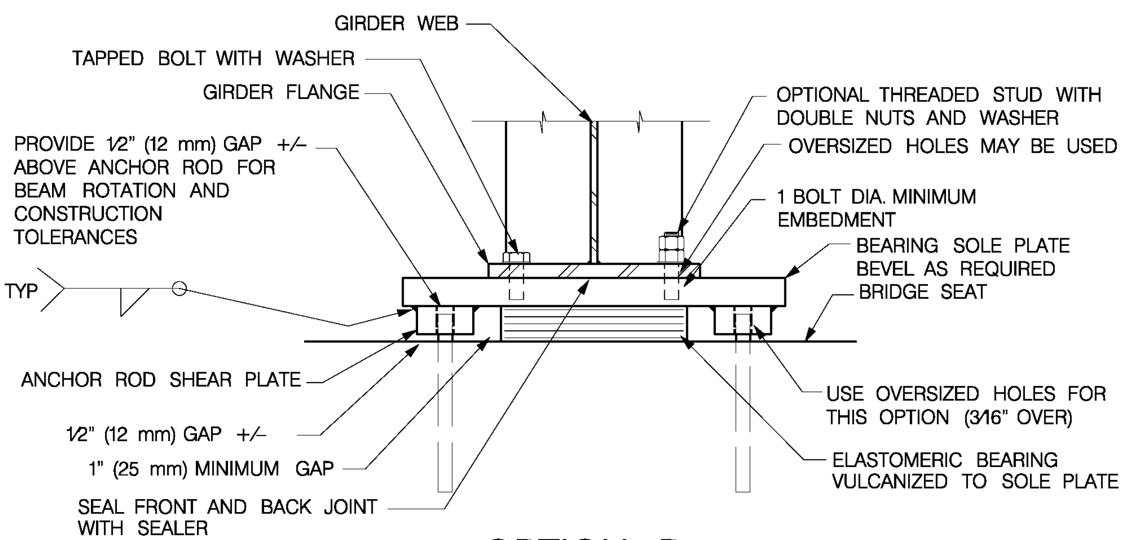


OPTION A

WELDED BEAM ATTACHMENT

COMMENTARY:

1. *WELDED CONNECTION ALLOWS FOR MINOR ADJUSTMENT OF THE BEARING/BEAM CONNECTION.*
2. *ANCHOR ROD SHEAR PLATE USED TO MINIMIZE BENDING IN ANCHOR RODS UNDER LATERAL LOAD.*



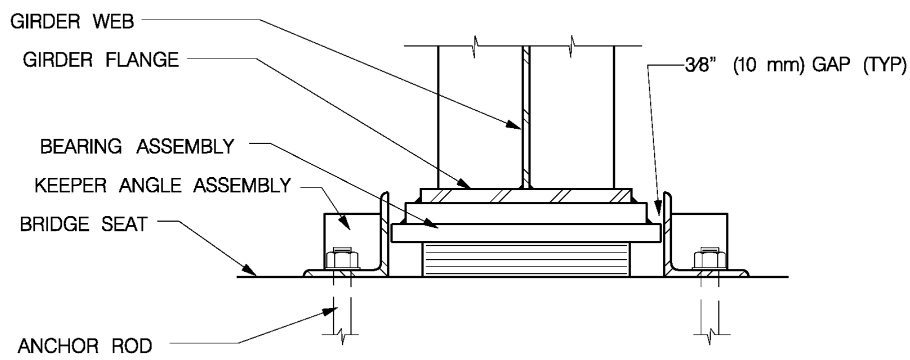
OPTION B

BOLTED BEAM ATTACHMENT

COMMENTARY:

1. *SIMILAR COMMENTARY TO DETAIL ABOVE.*
2. *OVERSIZED HOLES ONLY ALLOW FOR MINOR ADJUSTMENT IN THE FIELD, THEREFORE CORRECT ANCHOR ROD LOCATIONS ARE CRITICAL.*
3. *GIRDER FABRICATOR AND BEARING MANUFACTURER MUST COORDINATE BOLT HOLE LOCATIONS. THE DESIGNER SHOULD TRY TO MINIMIZE THE NUMBER OF BOLT HOLE PATTERNS ON EACH PROJECT.*

AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS FIXED ELASTOMERIC BEARINGS WITH ANCHOR STUDS	LATEST REVISION DATE 1–22–04 DRAWING NUMBER E 3.2

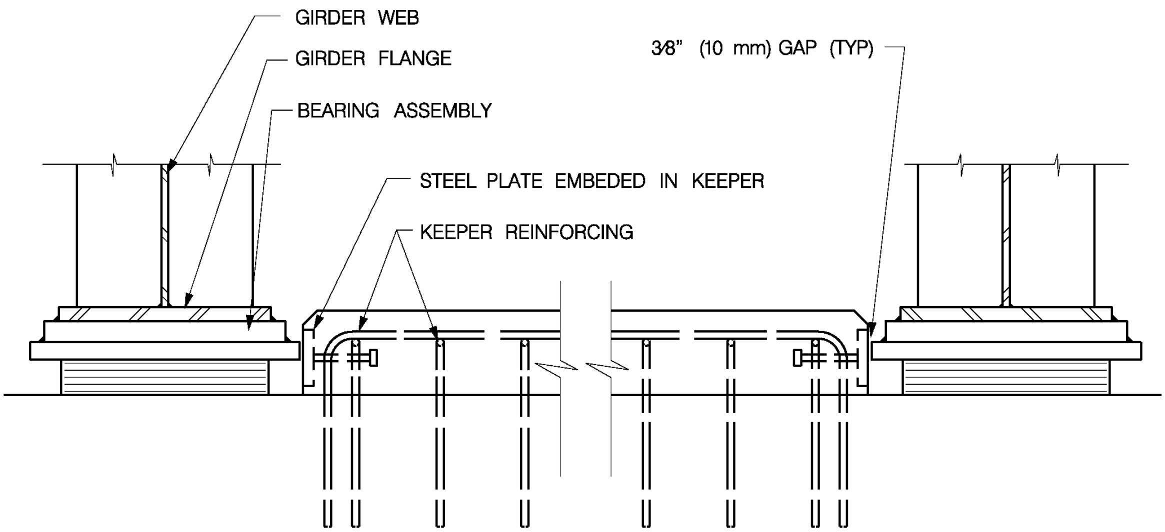


STEEL KEEPER ANGLE ASSEMBLY

COMMENTARY:

1. *WELDED BEARING ASSEMBLY SHOWN. DETAILS SIMILAR FOR OTHER BEARING DESIGNS.*
2. *KEEPER ANGLES DO NOT NEED TO BE INSTALLED ON EVERY BEARING. ON VERY WIDE BRIDGES, THE KEEPERS SHOULD BE USED ON THE INTERIOR GIRDERS ONLY IN ORDER TO PREVENT BINDING OF THE BEARING ASSEMBLY DUE TO LATERAL THERMAL MOVEMENT OF THE BRIDGE.*
3. *ON BRIDGES WITH A SKEW GREATER THAN 30 DEGREES, CONSIDERATION SHOULD BE GIVEN TO SKEWING THE KEEPER ASSEMBLY ALONG THE LINE OF THERMAL MOVEMENT OF THE BRIDGE DECK. SEE SECTION 1.4.5 AND APPENDIX B OF THIS DOCUMENT.*
4. *CARE SHALL BE TAKEN IN THE LAYOUT OF THE ANCHOR RODS ON BRIDGES WITH HEAVILY REINFORCED PIER BENT CAPS IN ORDER TO AVOID CONFLICTS WITH PIER REINFORCING. THIS PROBLEM IS MORE PRONOUNCED ON SKEWED BRIDGES AND REHABILITATION PROJECTS. THE DESIGNER SHOULD SHOW THE BEARING KEEPER ASSEMBLY IN PLAN WITH THE PIER REINFORCING TO DOCUMENT THE LAYOUT.*
5. *ALL STEEL IN KEEPER ASSEMBLIES SHALL BE GALVANIZED ACCORDING TO ASTM A123.*
6. *THE GAP BETWEEN THE KEEPERS MAY BE ADJUSTED AS PER STATE STANDARDS AND UNUSUAL THERMAL MOVEMENT CONDITIONS*

AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS LATERAL RESTRAINT DEVICES STEEL KEEPER ANGLES	LATEST REVISION DATE 1–22–04 DRAWING NUMBER E 4.1



CONCRETE KEEPER BLOCK

COMMENTARY:

1. *WELDED BEARING ASSEMBLY SHOWN. DETAILS SIMILAR FOR OTHER BEARING DESIGNS.*
2. *THIS DESIGN IS GOOD FOR HEAVILY REINFORCED PIER CAPS, SKEWED BRIDGES, AND REHABILITATION PROJECTS WHERE THE EXACT LOCATION OF THE SUBSTRUCTURE REINFORCING MAY NOT BE KNOWN. FOR THIS CASE, THE LOCATION OF THE REINFORCING BARS MAY BE ADJUSTED IN THE FIELD TO MISS THE UNDERLYING STEEL.*
3. *KEEPER BLOCKS DO NOT NEED TO BE INSTALLED ON EVERY BEARING. ON VERY WIDE BRIDGES, THE KEEPER BLOCKS SHOULD BE USED BETWEEN THE INTERIOR GIRDERS ONLY IN ORDER TO PREVENT BINDING OF THE BEARING ASSEMBLY DUE TO LATERAL THERMAL MOVEMENT OF THE BRIDGE.*
4. *ON BRIDGES WITH A SKEW GREATER THAN 30 DEGREES, CONSIDERATION SHOULD BE GIVEN TO SKEWING THE KEEPER BLOCK ALONG THE LINE OF THERMAL MOVEMENT OF THE BRIDGE DECK. SEE SECTION 1.4.5 AND APPENDIX B OF THIS DOCUMENT.*
5. *ALL STEEL ASSEMBLIES SHALL BE GALVANIZED ACCORDING TO ASTM A123.*
6. *THE GAP BETWEEN THE KEEPERS MAY BE ADJUSTED AS PER STATE STANDARDS AND UNUSUAL THERMAL MOVEMENT CONDITIONS*

AASHTO/NSBA STEEL BRIDGE COLLABORATION	ELASTOMERIC BEARINGS LATERAL RESTRAINT DEVICES CONCRETE KEEPER BLOCK	LATEST REVISION DATE 1–22–04 DRAWING NUMBER E 4.2

Section 2
High Load Multi-Rotational Bearings

2.1 General

This section is intended to assist in the design and detailing of high load multi-rotational (HLMR) bridge bearing assemblies. The information included is intended to permit efficient fabrication, installation, and maintenance of these bearings.

Commentary

High load multi-rotational bearings are frequently used on modern steel bridges where the number of girders is minimized and the span lengths are maximized. There are three basic HLMR bearing types currently used: elastomeric pot bearings, polyurethane disc bearings, and spherical bearings. See Section 2.2 for specific information on each bearing type.

The AASHTO design specifications give significant detail in the design requirements of HLMR bearings. However, there are numerous ways of achieving the requirements set forth in AASHTO. Each bearing manufacturer has a unique way to fabricate bearings in an economical fashion based on the equipment that they possess and the personnel that they employ. In order to allow the individual manufacturer to achieve the greatest economy in bearing construction, it is recommended that the engineer specify the loads and geometric requirements for the bearing but leave the actual design and detailing of the bearing to the manufacturer. A table has been provided on the Detail Sheets depicting required information from the designer.

Because their design may incorporate sliding steel plates, HLMR bearings require long-term maintenance. At some point in the future, the sliding surfaces will need to be inspected. The following guidelines include recommendations on design and detailing practices that will reduce initial costs and allow for future maintenance. The intent of these recommendations is to allow for future removal with minimal vertical jacking of the bridge superstructure. This allows the removal of individual bearings without interrupting the traffic on the bridge, and without causing damage to bridge deck expansion joint systems and utilities carried by the superstructure.

2.2 Reference Documents

- AASHTO LRFD Bridge Design Specifications
- AASHTO Standard Specifications for Highway Bridges
- SCEF Standard 106

Commentary

SCEF refers to the Mid-Atlantic States Structural Committee for Economical Fabrication

- *Steel Bridge Bearing Selection and Design Guide*, Volume II, Chapter 4, Highway Structures Design Handbook

2.3 Basic Assumptions

2.3.1 Approach

Contract plans for bridges with HLMR bearings should not include specific details for the bearings. Only schematic bearing details combined with specified loads, movements, and rotations need to be shown. The bearing is designed by the manufacturer, taking advantage of the cost-effective fabrication procedures that are available in the shop.

Commentary

The detailing of HLMR bearings varies from manufacturer to manufacturer. This complicates the design process, since a designer would need to detail multiple bearings from multiple manufacturers in order to make bidding competitive. This is even further complicated when multiple bearing types are feasible.

2.3.2 Recommended Bearing Types

There are three common HLMR bearing types that function in essentially the same manner:

- Pot Bearings
- Disc Bearings
- Spherical Bearings

Commentary

The AASHTO design specifications give significant guidance for the design and manufacture of these bearings. Therefore, all three types of HLMR bearings should be allowed on most projects.

2.4 Design and Detailing Recommendations

2.4.1 Design

The design of HLMR bearings should be the responsibility of the bearing manufacturer. The design of accessory pieces of the bearing, such as the sole plate, masonry plate and anchor rods, is the responsibility of the bridge designer.

Commentary

The design will be in accordance with AASHTO based on the parameters outlined below. Sole plate, masonry plate and anchor rod design is best handled by the bridge designer since the bearing manufacturer may not be aware of important dimensional limitations.

The bridge designer should include notes on the plans allowing the bearing manufacturer to make minor adjustments to the dimensions of the sole plate, masonry plate and anchor rods. The bridge designer should also identify dimensions that are not to be changed due to design or geometric constraints. For instance, the reinforcing steel in the concrete substructure often limits anchor rod locations. The bearing designer must coordinate any changes with both the contractor and the bridge design engineer.

2.4.1.1 Design Rotation and Movements

HLMR bearings assemblies should be designed for dead load and live load rotations, rotations due to profile grade, and additional rotations for uncertainties (0.005 radians) and construction tolerances (0.005 radians for pot and spherical bearings only) as specified in the AASHTO Specifications.

Commentary

Bearing assemblies consist of the bearing element, connection plates (if required), and a flat or beveled sole plate (if required). See Section 2.6 for details of typical bearing assemblies. Please refer to Appendix A for information on calculating rotations.

The design rotations for uncertainties and construction tolerances have recently changed in the AASHTO LRFD Bridge Design Specifications. The AASHTO Standard Specifications for Highway Bridges was not changed since it was archived. The design procedures for HLMR bearings are consistent in both specifications; therefore it is recommended that the values specified in the AASHTO LRFD Bridge Design Specifications be used for bridges designed under the AASHTO Standard Specifications.

Sole plates should be beveled to account for a significant portion of the rotation due to profile and grade. If beveled sole plates are used, the design rotation for the bearing due to profile grade should be neglected.

Refer to Appendix A for information on the effect of beveled sole plates on bearing design rotations.

If the beam is cambered for dead loads, the dead load design rotation of the elastomer should be neglected in the final loaded condition. The bearing designer should check the bearing for this temporary condition to ensure that no damage occurs and that there is no metal-to-metal contact.

Refer to Appendix A for information on the effect of beam cambering on bearing design rotations.

The bearings should be designed for all longitudinal and lateral movements.

Longitudinal translation due to dead load girder rotation may need to be accounted for on beams with large rotations or for deep girders. This translation should be added to the design longitudinal movement. Refer to Appendix-B for guidance on horizontal movements.

The designer should include a temperature-setting table on the plans for expansion bearings. This table should indicate the position of the top plates of the bearing relative to the base plates for different installation temperatures.

States have differing requirements for setting temperatures. A recommended temperature range is the average ambient temperature range for the bridge location plus or minus 10°F (5°C). Larger values can be specified provided that the bearing is designed for the additional movement.

2.4.2 Specifications

The approach for HLMR bearing specifications should be a design-build format. The specifications should outline the parameters that will be allowed for the design and the AASHTO specifications will be referenced for most criteria.

Commentary

Each state should develop a specification for bearing design and construction in a format that is compatible with their standard specifications for construction.

2.4.3 Sole Plate Connection

The connection of the sole plate to I-girders may be welded or bolted.

Commentary

Welding allows for greater adjustment during installation and is more economical. The damage due to removal of the weld for future removal and maintenance can be reasonably repaired. The AWS/AASHTO Bridge Welding code has information on weld removal and repair.

Bolted connections with oversized holes allow for minor field adjustments of the bearing during installation. Bolting also requires less touch up painting on painted structures and simplified future removal.

Connection to box girders should be bolted. If the bolts are installed in drilled and tapped holes in the sole plate, the bolts and the hole should be made perpendicular to the plane of the bottom flange, which is also the plane of the top of the sole plate.

Box girder bearings should be attached with bolts since a welded sole plate requires an overhead weld that is often difficult to perform due to limited access.

2.4.4 Sole Plate Details

The sole plate should extend transversely beyond the edge of the bottom flange of I-girders at least 1" (25mm) on each side.

Commentary

This is done to facilitate the field welding process by allowing for ½" (13mm) of adjustment in the field. (See Detail Sheets.) Note: This is only for I-girders. Sole plates need not extend beyond flanges on box beams, and they should be field bolted in order to avoid overhead welds that are difficult to perform due to limited clearance.

Welds for sole plate connections for I-girders should only be longitudinal to the girder axis. Transverse joints should be sealed with an approved caulking material.

The longitudinal welds are made in the horizontal position, which is the position most likely to result in a quality fillet weld. Transverse welds require overhead welds and are very difficult to complete due to limited clearance. The silicone caulking of the underside transverse joint is intended to prevent corrosion between the sole plate and the bottom flange. Caulking must be installed after welding. Most states use a silicone based caulk; however, other materials may be used.

The minimum thickness of the sole plate should be ¾" (20mm).

This is the minimum thickness specified by AASHTO to minimize plate distortion due to welding.

2.4.5 Future Maintenance

HLMR bearings should be designed for future removal with a maximum vertical jacking height of ¼" (6mm) after the load is removed.

Commentary

This allows for future removal of the main bearing elements for maintenance. By limiting the jacking, the work can be done under live load and without damage to bridge joints, utilities, etc. The jacking height is measured after all compressive deflection due to load and rotation is removed.

The minimum distance between the bottom of masonry plate to top of sole plate should be 4" (100mm).

This is set in order to facilitate weld removal, bolting and jacking operations.

2.4.6 Masonry Plate and Anchor Rods

The masonry plate should bear directly on a 1/8" (3mm) thick preformed pad that rests directly on the substructure.

Commentary

This method of using a preformed pad to take up bearing surface irregularities is preferred to grouting under a masonry plates supported by leveling nuts. The grouting option results in point loads at the anchor rods due to the high stiffness of the rods when compared to the grout material, which can lead to masonry plate warping. For this reason, grouting should be limited to special cases only. No design of the bearing pad is required since it is assumed that the pad will yield and deform to fill the uneven surfaces of the concrete bearing seat. The preformed pad may be either an elastomeric or fabric bearing with a maximum durometer of 70. The least expensive option is a plain elastomeric pad.

The location of anchor rods should allow for future bearing removal.

The slope of the girder should be taken into account. Details without anchor rod nuts are preferred in order to facilitate installation and future maintenance. (See Detail Sheets.)

2.4.6.1 Anchor Rod Design

The design of anchor rods for lateral load should take into account the bending capacity of the rod, edge distance to the concrete foundation, strength of the concrete and group action of the rods.

Commentary

The term "anchor bolts" should not be used because "bolt" implies that the rod has a head. The AASHTO specifications do not give specific requirements for the design of embedded anchors in shear. The American Concrete Institute publication "Building Code Requirements for Structural Concrete (ACI 318-02) is recommended.

Material for anchor rods should be ASTM F1554, and should be either threaded (with nuts) or swaged on the embedded portion of the rod. The design yield strength of this material may be specified as 36ksi (250MPa), 55ksi (380MPa), or 105ksi (725MPa) depending on the design. The yield strength should be given in the specification, or on the plans.

This material is specifically designed for anchor rod applications. Other materials have been used, but do not offer the economies of ASTM F1554. The designer should offer options of swaging or threading the anchor as different suppliers supply one or both of these options.

2.4.7 Manufacture

Manufacture of bearings should follow AASHTO and AWS specifications.

Thermal cutting of plates and anchor rod holes is recommended.

The allowable surface roughness of the cut edges should be free of abrupt irregularities and have an ANSI surface roughness not exceeding 1000μin (25 μin).

Commentary

State special provisions take precedence over AASHTO and AWS requirements.

Some states require these large diameter holes to be drilled. Modern flame cutting equipment is able to produce a reasonably smooth edge.

Drilling, sawing, or thermal cutting may produce plate edges and hole perimeters; however, thermal cutting is the most cost effective.

2.5 Marking

The designer should add the following notes to the plans:

"All bearings shall be marked prior to shipping. The

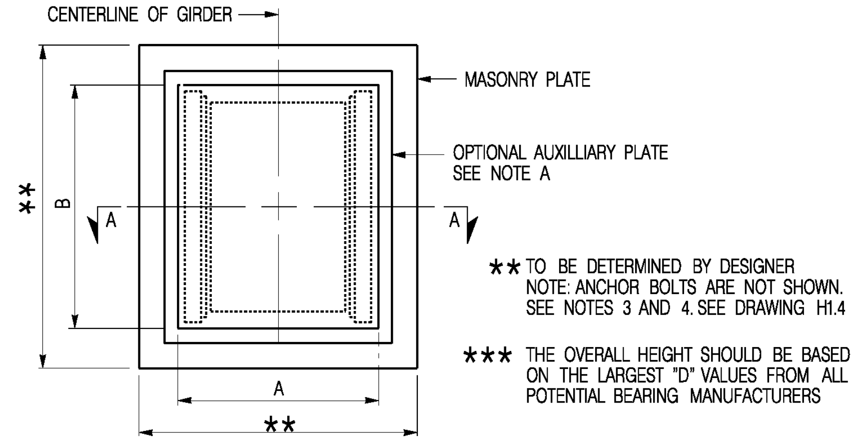
Commentary

Problems have occurred in the field with the installation of bearings with beveled sole plates. It is not always obvious which orientation a bearing must take on a beam before the dead marks shall include the bearing location on the bridge, and a direction arrow that points up-station. All marks shall be permanent and be visible after the bearing is installed." The marks shall be on the top plate of the bearing.

2.6 Drawing Details

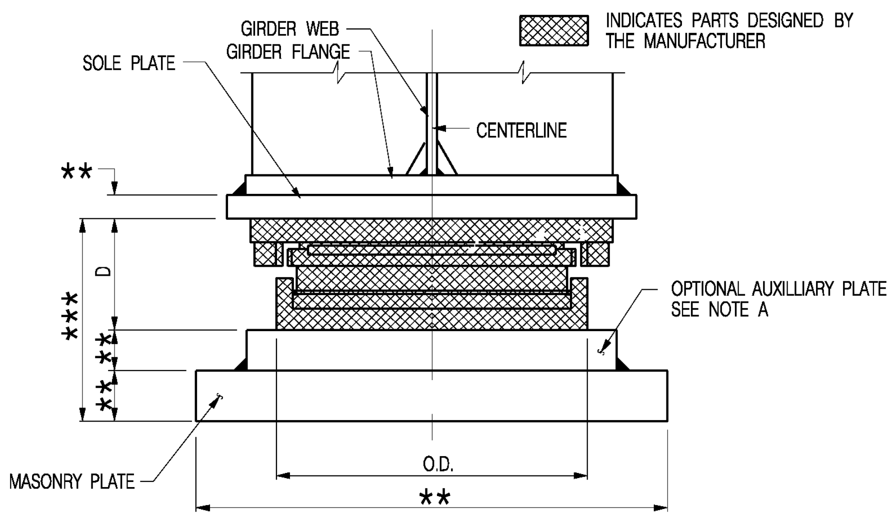
See Detail Sheets pages 25 thru 34.

load rotation has been applied. This is especially true for bearings with minor bevels.



GUIDED EXPANSION BEARING

POT BEARING SHOWN, DISC AND SPHERICAL BEARINGS SIMILAR



SECTION A–A
GUIDED EXPANSION BEARING SCHEMATIC

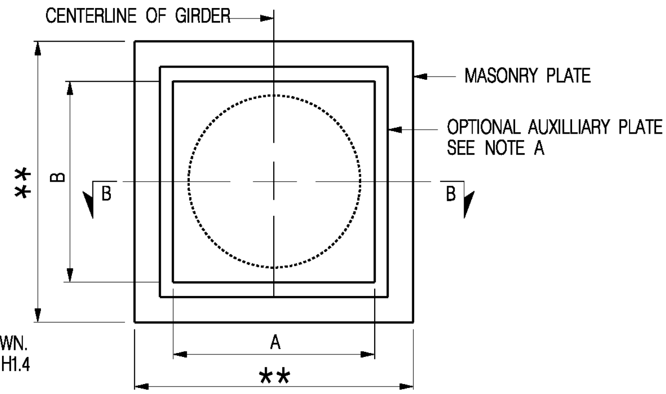
NOTE A: THE AUXILLIARY PLATE IS USED TO:
1. INCREASE THE DISTANCE FROM THE FIELD WELD TO THE ELASTOMER AND/OR TEFLON SURFACES.
2. PROVIDE ROOM FOR THE THE FIELD WELDING PROCESS.

THIS PLATE CAN BE ELIMINATED IN SOME SITUATIONS.

NOTE B: THE BEARING MANUFACTURER MAY INCORPORATE THE BEVELED SOLE PLATE INTO THE DESIGN OF THE BEARING TOP PLATE, THEREBY ELIMINATING THE SOLE PLATE

NOTE C: SOME STATES REQUIRE BOLTED ATTACHMENT OF THE BEARING TOP PLATE TO THE GIRDER. SEE DETAIL SHEET E1.2 FOR DETAILS OF BOLTED BEARING ATTACHMENTS.

AASHTO/NSBA STEEL BRIDGE COLLABORATION	HIGH LOAD MULTI–ROTATIONAL BEARINGS	LATEST REVISION DATE 1–22–04
	GUIDED EXPANSION BEARING	DRAWING NUMBER H 1.1

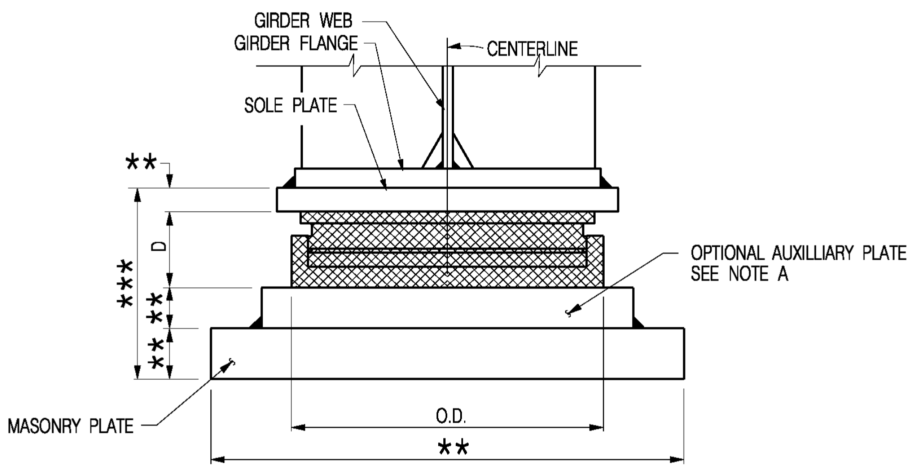


** TO BE DETERMINED BY DESIGNER
NOTE: ANCHOR BOLTS ARE NOT SHOWN.
SEE NOTES 3 AND 4. SEE DRAWING H1.4

*** THE OVERALL HEIGHT SHOULD BE BASED ON THE LARGEST "D" VALUES FROM ALL POTENTIAL BEARING MANUFACTURERS

FIXED BEARING
NOT TO SCALE

POT BEARING SHOWN, DISC AND SPHERICAL BEARINGS SIMILAR



SECTION B-B
FIXED BEARING SCHEMATIC
NOT TO SCALE

NOTE A: THE AUXILLIARY PLATE IS USED TO:
1. INCREASE THE DISTANCE FROM THE FIELD WELD TO THE ELASTOMER AND/OR TEFLON SURFACES.
2. PROVIDE ROOM FOR THE THE FIELD WELDING PROCESS.

THIS PLATE CAN BE ELIMINATED IN SOME SITUATIONS.

NOTE B: THE BEARING MANUFACTURER MAY INCORPORATE THE BEVELED SOLE PLATE INTO THE DESIGN OF THE BEARING TOP PLATE, THEREBY ELIMINATING THE SOLE PLATE

NOTE C: SOME STATES REQUIRE BOLTED ATTACHMENT OF THE BEARING TOP PLATE TO THE GIRDER. SEE DETAIL SHEET E1.2 FOR DETAILS OF BOLTED BEARING ATTACHMENTS.

AASHTO/NSBA STEEL BRIDGE COLLABORATION	HIGH LOAD MULTI–ROTATIONAL BEARINGS FIXED BEARING	LATEST REVISION DATE 1–22–04 DRAWING NUMBER H 1.2

NOTES TO THE DESIGNER:

THE VALUES SHOWN ARE FROM ONE MANUFACTURER AND ARE BASED ON ASSUMED HORIZONTAL LOAD REQUIREMENTS (SEISMIC PERFORMANCE CATEGORY A). THE DESIGNER SHOULD CONTACT MANUFACTURERS WITH SPECIFIC REQUIREMENTS FOR THEIR PRODUCTS TO GET MORE DETAILED INFORMATION ON BEARING DIMENSIONS.

THESE TABLES ARE TO BE USED AS A REFERENCE TO ASSIST THE DESIGNER IN SIZING THE SOLE PLATE AND THE MASONRY PLATE.

DIMENSIONS FOR GUIDED EXPANSION BEARING

TOTAL VERTICAL LOAD kips	TOTAL HORIZ. LOAD kips	A INCHES	B INCHES	O.D. INCHES	D INCHES
50	10.0	10.000	10.250	6.375	4.125
75	14.9	11.000	11.250	7.250	4.250
100	20.0	11.750	12.250	8.125	4.500
150	30.0	14.250	13.500	10.000	4.875
200	40.0	15.750	14.500	11.750	5.000
250	50.0	17.750	16.000	12.875	5.500
300	60.0	19.250	16.250	14.250	6.000
350	70.0	20.000	18.250	15.875	6.375
400	80.0	22.250	19.000	17.125	6.875
450	90.0	23.000	19.000	18.375	7.000
500	100.0	23.750	22.750	19.375	7.000
550	110.0	24.500	22.750	19.750	7.375
600	120.0	26.500	22.750	21.375	8.250
650	130.0	27.250	22.750	22.625	8.250
700	140.0	27.750	27.250	23.625	8.375
750	150.0	28.250	27.250	24.125	8.500
800	160.0	28.250	27.250	25.000	8.875
850	170.0	30.750	26.500	25.875	9.375
900	180.0	31.500	26.500	26.750	9.375
950	190.0	32.000	31.750	26.875	9.625
1000	200.0	32.250	31.750	27.500	9.750
1100	220.0	33.500	31.750	28.875	9.875
1200	240.0	26.750	26.500	30.750	10.375
1300	260.0	27.875	27.500	32.250	10.625
1400	280.0	28.750	28.250	32.625	11.125
1500	300.0	29.625	29.000	33.500	11.500
1600	320.0	30.500	29.750	34.750	11.750
1700	340.0	31.500	30.500	35.750	12.000
1800	360.0	32.500	31.500	37.000	12.250
1900	380.0	33.000	33.125	37.375	12.500
2000	400.0	33.750	35.125	38.125	12.500
2100	420.0	34.250	38.125	39.125	12.375
2200	440.0	35.000	38.000	40.125	12.625
2300	460.0	35.875	38.750	41.625	13.125
2400	480.0	36.250	41.250	41.875	13.125
2500	500.0	37.125	42.000	42.625	13.375
2600	520.0	37.875	42.750	43.500	13.625
2700	540.0	38.500	43.250	44.375	13.750
2800	560.0	39.125	43.750	45.250	14.000
2900	580.0	40.000	44.500	46.250	14.125
3000	600.0	40.500	45.000	46.625	14.375
3100	620.0	41.125	45.500	45.625	14.750
3200	640.0	41.750	46.000	46.875	15.125
3300	660.0	42.375	46.500	47.625	15.375
3400	680.0	43.000	47.000	48.500	15.500
3500	700.0	43.750	47.750	49.375	15.625

DIMENSIONS FOR FIXED BEARING

TOTAL VERTICAL LOAD kips	TOTAL HORIZ. LOAD kips	A INCHES	B INCHES	O.D. INCHES	D INCHES
50	10.0	6.500	6.500	6.375	3.000
75	14.9	7.500	7.500	7.250	3.000
100	20.0	8.250	8.250	8.125	3.250
150	30.0	9.750	9.750	10.000	3.375
200	40.0	10.750	10.750	11.750	3.500
250	50.0	11.750	11.750	12.875	3.625
300	60.0	12.750	12.750	14.250	3.625
350	70.0	13.500	13.500	15.875	4.125
400	80.0	14.500	14.500	17.125	4.125
450	90.0	15.000	15.000	18.375	4.125
500	100.0	15.750	15.750	19.375	4.250
550	110.0	16.500	16.500	19.750	4.375
600	120.0	17.000	17.000	21.375	4.625
650	130.0	17.750	17.750	22.625	4.750
700	140.0	18.250	18.250	23.625	4.750
750	150.0	18.750	18.750	24.125	4.875
800	160.0	19.500	19.500	25.000	5.000
850	170.0	20.000	20.000	25.875	5.000
900	180.0	20.500	20.500	26.750	5.000
950	190.0	21.000	21.000	26.875	5.375
1000	200.0	21.500	21.500	27.500	5.375
1100	220.0	22.250	22.250	28.875	5.500
1200	240.0	23.250	23.250	30.750	5.625
1300	260.0	24.000	24.000	32.250	5.750
1400	280.0	25.000	25.000	32.625	6.125
1500	300.0	25.750	25.750	33.500	6.125
1600	320.0	26.500	26.500	34.750	6.250
1700	340.0	27.250	27.250	35.750	6.375
1800	360.0	28.000	28.000	37.000	6.500
1900	380.0	28.500	28.500	37.375	6.750
2000	400.0	29.250	29.250	38.125	6.875
2100	420.0	30.000	30.000	39.125	6.875
2200	440.0	30.500	30.500	40.125	6.875
2300	460.0	31.250	31.250	41.625	7.250
2400	480.0	31.750	31.750	41.875	7.500
2500	500.0	32.500	32.500	42.625	7.625
2600	520.0	33.000	33.000	43.500	7.625
2700	540.0	33.750	33.750	44.375	7.750
2800	560.0	34.250	34.250	45.250	7.750
2900	580.0	34.750	34.750	46.250	7.875
3000	600.0	35.250	35.250	46.625	7.875
3100	620.0	36.000	36.000	45.625	8.250
3200	640.0	36.500	36.500	46.875	8.375
3300	660.0	37.000	37.000	47.625	8.500
3400	680.0	37.500	37.500	48.500	8.500
3500	700.0	38.000	38.000	49.375	8.625

NOTE: VALUES USED IN THESE TABLES ARE BASED ON UNFACTORED LOADS

AASHTO/NSBA STEEL BRIDGE COLLABORATION	HIGH LOAD MULTI-ROTATIONAL BEARINGS PRELIMINARY BEARING DIMENSIONS US CUSTOMARY UNITS	LATEST REVISION DATE 1-22-04 DRAWING NUMBER H 1.3 US

NOTES TO THE DESIGNER:

THE VALUES SHOWN ARE FROM ONE MANUFACTURER AND ARE BASED ON ASSUMED HORIZONTAL LOAD REQUIREMENTS (SEISMIC PERFORMANCE CATEGORY A). THE DESIGNER SHOULD CONTACT MANUFACTURERS WITH SPECIFIC REQUIREMENTS FOR THEIR PRODUCTS TO GET MORE DETAILED INFORMATION ON BEARING DIMENSIONS.

THESE TABLES ARE TO BE USED AS A REFERENCE TO ASSIST THE DESIGNER IN SIZING THE SOLE PLATE AND THE MASONRY PLATE.

DIMENSIONS FOR GUIDED EXPANSION BEARING					
TOTAL VERTICAL LOADS kN	TOTAL HORIZ. LOADS kN	A mm	B mm	O.D. mm	D mm
222.4	44.48	254	260	162	106
333.6	66.72	279	286	184	107
444.8	88.96	298	311	207	115
667.2	133.44	362	343	254	123
889.6	177.92	400	368	299	126
1112.0	222.40	451	406	327	139
1334.4	266.88	488	413	362	151
1556.8	311.36	508	464	403	162
1779.2	355.84	565	483	435	176
2001.6	400.32	584	483	467	177
2224.0	444.80	603	578	492	178
2446.4	489.28	622	578	502	188
2668.8	533.76	673	578	543	208
2891.2	578.24	692	578	575	211
3113.6	622.72	705	692	600	213
3336.0	667.20	718	692	613	217
3558.4	711.68	718	692	635	224
3780.8	756.16	781	673	657	238
4003.2	800.64	800	673	679	239
4225.6	845.12	813	806	683	246
4448.0	889.60	819	806	699	247
4892.8	978.56	851	806	734	251
5337.6	1067.52	679	673	781	264
5782.4	1156.48	708	699	819	270
6227.2	1245.44	730	718	829	284
6672.0	1334.40	753	737	851	292
7116.8	1423.36	775	756	883	297
7561.6	1512.32	800	775	908	306
8006.4	1601.28	826	800	940	310
8451.2	1690.24	838	842	949	319
8896.0	1779.20	857	892	969	319
9340.8	1868.16	870	969	994	313
9785.6	1957.12	889	965	1019	321
10230.4	2046.08	911	984	1057	332
10675.2	2135.04	921	1048	1064	334
11120.0	2224.00	943	1067	1083	341
11564.8	2312.96	962	1086	1105	345
12009.6	2401.92	978	1099	1127	350
12454.4	2490.88	994	1111	1149	356
12899.2	2579.84	1016	1130	1175	360
13344.0	2668.80	1029	1143	1184	364
13788.8	2757.76	1045	1156	1159	375
14233.6	2846.72	1060	1168	1191	385
14678.4	2935.68	1076	1181	1210	389
15123.2	3024.64	1092	1194	1232	395
15568.0	3113.60	1111	1213	1254	397

DIMENSIONS FOR FIXED BEARING					
TOTAL VERTICAL LOADS kN	TOTAL HORIZ. LOADS kN	A mm	B mm	O.D. mm	D mm
222.4	44.48	165	165	162	75
333.6	66.72	191	191	184	76
444.8	88.96	210	210	207	84
667.2	133.44	248	248	254	86
889.6	177.92	273	273	299	88
1112.0	222.40	298	298	327	92
1334.4	266.88	324	324	362	93
1556.8	311.36	343	343	403	104
1779.2	355.84	368	368	435	105
2001.6	400.32	381	381	467	106
2224.0	444.80	400	400	492	107
2446.4	489.28	419	419	502	111
2668.8	533.76	432	432	543	118
2891.2	578.24	451	451	575	121
3113.6	622.72	464	464	600	122
3336.0	667.20	476	476	613	125
3558.4	711.68	495	495	635	126
3780.8	756.16	508	508	657	127
4003.2	800.64	521	521	679	128
4225.6	845.12	533	533	683	135
4448.0	889.60	546	546	699	135
4892.8	978.56	565	565	734	139
5337.6	1067.52	591	591	781	144
5782.4	1156.48	610	610	819	145
6227.2	1245.44	635	635	829	155
6672.0	1334.40	654	654	851	157
7116.8	1423.36	673	673	883	158
7561.6	1512.32	692	692	908	161
8006.4	1601.28	711	711	940	164
8451.2	1690.24	724	724	949	172
8896.0	1779.20	743	743	969	174
9340.8	1868.16	762	762	994	176
9785.6	1957.12	775	775	1019	176
10230.4	2046.08	794	794	1057	183
10675.2	2135.04	806	806	1064	190
11120.0	2224.00	826	826	1083	193
11564.8	2312.96	838	838	1105	195
12009.6	2401.92	857	857	1127	196
12454.4	2490.88	870	870	1149	198
12899.2	2579.84	883	883	1175	199
13344.0	2668.80	895	895	1184	201
13788.8	2757.76	914	914	1159	208
14233.6	2846.72	927	927	1191	214
14678.4	2935.68	940	940	1210	215
15123.2	3024.64	953	953	1232	216
15568.0	3113.60	965	965	1254	218

NOTE: VALUES USED IN THESE TABLES ARE BASED ON UNFACTORED LOADS

AASHTO/NSBA STEEL BRIDGE COLLABORATION	HIGH LOAD MULTI–ROTATIONAL BEARINGS PRELIMINARY BEARING DIMENSIONS METRIC UNITS	LATEST REVISION DATE 1–22–04 DRAWING NUMBER H 1.3 M

NOTES TO DESIGNER:

1. THE "B" DIMENSION GIVEN IN THE TABLES INCLUDES 1" (25 mm) FOR MOVEMENT AND 1" (25 mm) FOR CONSTRUCTION TOLERANCE EACH WAY. IF THE MAXIMUM ONE-WAY DESIGN MOVEMENT EXCEEDS 1" (25 mm), THE "B" DIMENSION MUST BE INCREASED BY TWICE THE DIFFERENCE. (FOR EXAMPLE: DESIGN MOVEMENT = 1 1⁄2" (38 mm), "B" DIMENSION SHOULD BE INCREASED BY 1" (25 mm.) THE CENTERLINE OF ALL BEARING COMPONENTS SHALL BE IN LINE AT 70 DEGREES F (21 DEGREES C) UNDER FULL DEAD LOAD.

2. THE DESIGNER SHALL DESIGN AND DETAIL THE SOLE PLATE, MASONRY PLATE AND ANCHOR ROD SPACING BASED ON THE BEARING SELECTED FROM THE APPROPRIATE TABLES ON THIS SHEET.

3. THE DESIGNER SHALL SET THE LOCATION OF ANCHOR RODS. THEY MAY BE SET OUTSIDE OF THE SOLE PLATE OR UNDER THE SOLE PLATE. A MINIMUM OF FOUR ANCHOR RODS, 1" (25 mm) DIAMETER, SHALL BE USED FOR ALL HLMR BEARINGS.

4. THE WIDTH OF THE MASONRY PLATE WILL BE DEPENDENT ON THE ANCHOR ROD LOCATION. THE LENGTH OF THE MASONRY PLATE SHALL BE AT LEAST 4" (100 mm) GREATER THAN THE AUXILLIARY PLATE. THE THICKNESS OF MASONRY PLATE SHALL BE DETERMINED BY THE DESIGNER.

5. AT LOCATIONS WHERE LARGE MOVEMENTS ARE EXPECTED OR WHEN VERY LARGE SOLE PLATES ARE REQUIRED. THE DESIGNER SHALL GIVE CONSIDERATION TO PROVIDING FOUR BEARING STIFFENERS TO BETTER DISTRIBUTE THE LOAD TO THE BEARING RATHER THAN USING TWO BEARING STIFFENERS LOCATED AT THE CENTERLINE OF BEARING. IF FOUR STIFFENERS ARE USED THEY SHALL BE SPREAD APART AT LEAST THE WIDTH OF THE STIFFENER TO FACILITATE WELDING THE STIFFENERS TO THE WEB.

6. THE MINIMUM GAP BETWEEN THE GUIDE BARS AND THE BEARING ON EXPANSION BEARINGS SHALL BE 1⁄8" (3 mm), ON STRUCTURES WIDER THAN 40 FEET (12 m) OR CURVED STRUCTURES WHERE LATERAL MOVEMENTS ARE EXPECTED THE DESIGNER SHALL SPECIFY THE REQUIRED "GUIDE CLEARANCE".

7. TOP AND BOTTOM BEARING PLATES SHALL BE WELDED TO THE SOLE PLATE AND MASONRY PLATE, RESPECTIVELY. THE SIZE OF WELD SHALL NOT BE LESS THAN 5⁄16" (8 mm). THE PLATES SHALL BE PREHEATED IN ACCORDANCE WITH AWS BRIDGE WELDING CODE.

8. WITH MULTI-ROTATIONAL EXPANSION BEARINGS THE COEFFICIENT OF FRICTION USED FOR COMPUTING THE DESIGN HORIZONTAL FORCES ACTING ON THE SUPPORTING SUBSTRUCTURE SHALL BE 5%, WHEREAS THE MAXIMUM COEFFICIENT OF FRICTION VALUE SPECIFIED FOR THE MANUFACTURER IS 3%.

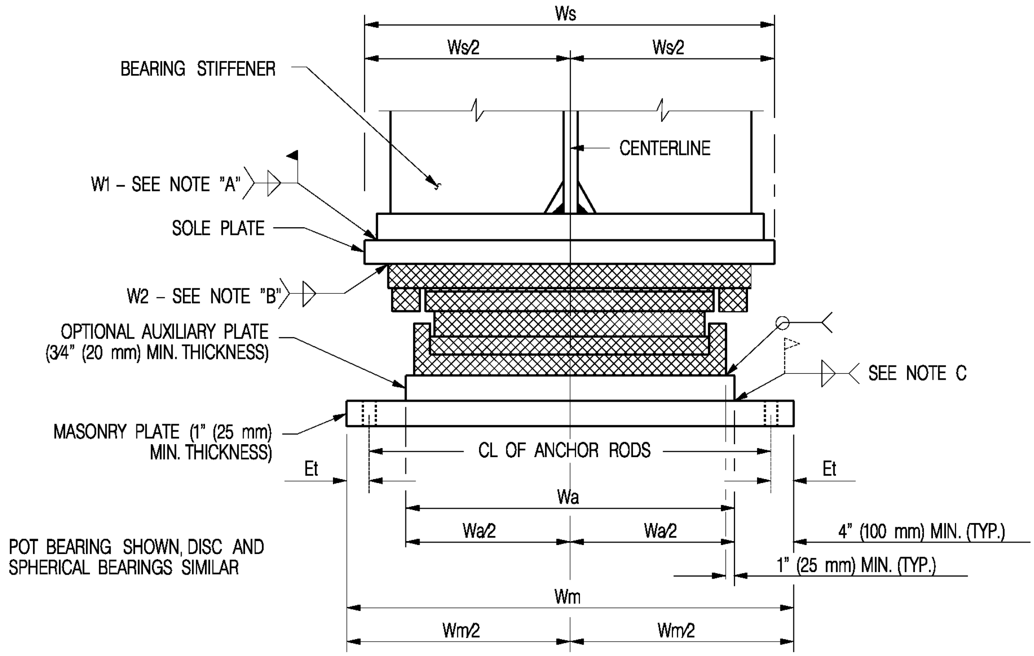
9. THE MINIMUM VERTICAL LOAD ON POT BEARINGS SHALL NOT BE LESS THAN 20% OF THE LOAD CAPACITY OF THE BEARING.

10. A TAPERED SOLE PLATE MAY BE REQUIRED WHEN THE BOTTOM OF THE BEAM/GIRDER AND THE TOP OF BEARINGS ARE NOT PARALLEL TO EACH OTHER. THE SOLE PLATE SHALL BE TAPERED IF EITHER OF THE FOLLOWING CONDITIONS EXIST:
    1) LONGITUDINAL GRADE OF THE BOTTOM FLANGE IS ONE PERCENT OR MORE.
    2) THE REQUIRED TAPER IS 1⁄8" (3 mm) OR MORE.
    FOR CASES WHERE THE SOLE PLATE IS NOT TAPERED, THE BEARING MUST BE DESIGNED FOR A ROTATION EQUAL TO THE THEORETICAL GRADE OF THE SOLE PLATE

11. THE DESIGNER SHALL ASTERISK (*) THE PEDESTAL ELEVATIONS ON THE SUBSTRUCTURE SHEETS AND PLACE THE FOLLOWING NOTE ON THE RESPECTIVE SHEETS:

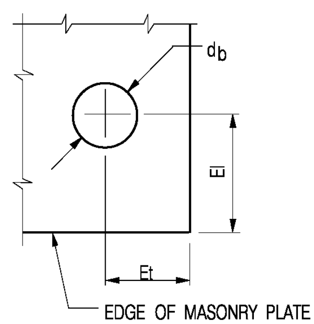
    *THESE ELEVATIONS MAY HAVE TO BE ADJUSTED TO ACCOMMODATE THE ACTUAL BEARINGS FURNISHED. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO COORDINATE ANY CHANGES IN THE BEARINGS WHICH MAY AFFECT THE PEDESTAL ELEVATIONS.

AASHTO/NSBA STEEL BRIDGE COLLABORATION	HIGH LOAD MULTI-ROTATIONAL BEARINGS DESIGNER NOTES	LATEST REVISION DATE 1-22-04 DRAWING NUMBER H 1.4



FRONT VIEW

NOTE: SOME STATES REQUIRE BOLTED ATTACHMENT OF THE BEARING TOP PLATE TO THE GIRDER. SEE DETAIL SHEET E1.2 FOR DETAILS OF BOLTED BEARING ATTACHMENTS.



TYPICAL ANCHOR ROD DETAIL

DESIGNER NOTES:

NOTE "A": DESIGNER SHALL DETERMINE SIZE OF WELD "W1". THE USE OF CAP SCREWS OR BOLTS ARE ALLOWED AS AN ALTERNATE.

NOTE "B": DESIGNER SHALL DETERMINE SIZE OF WELD "W2" (5/16" (8 mm) MINIMUM).

NOTE C: THE DESIGNER SHALL DETERMINE THE SIZE OF ALL COMPONENTS AND MAKE APPROPRIATE ENTRIES IN THE CHART SHOWN ON DRAWING H1.7. THE DESIGNER MAY WISH TO INCLUDE A SCHEMATIC BEARING LOCATION PLAN VIEW SHOWING BEARING TYPES AND THEIR LOCATIONS.

NOTE D: FOR BEARING WITGHOUT AUXILIARY PLATE THE WELD OF THE BEARING TO THE BEARING TO THE MASONRY PLATE MAY BE EITHER A SHOP WELD OR A FIELD WELD.

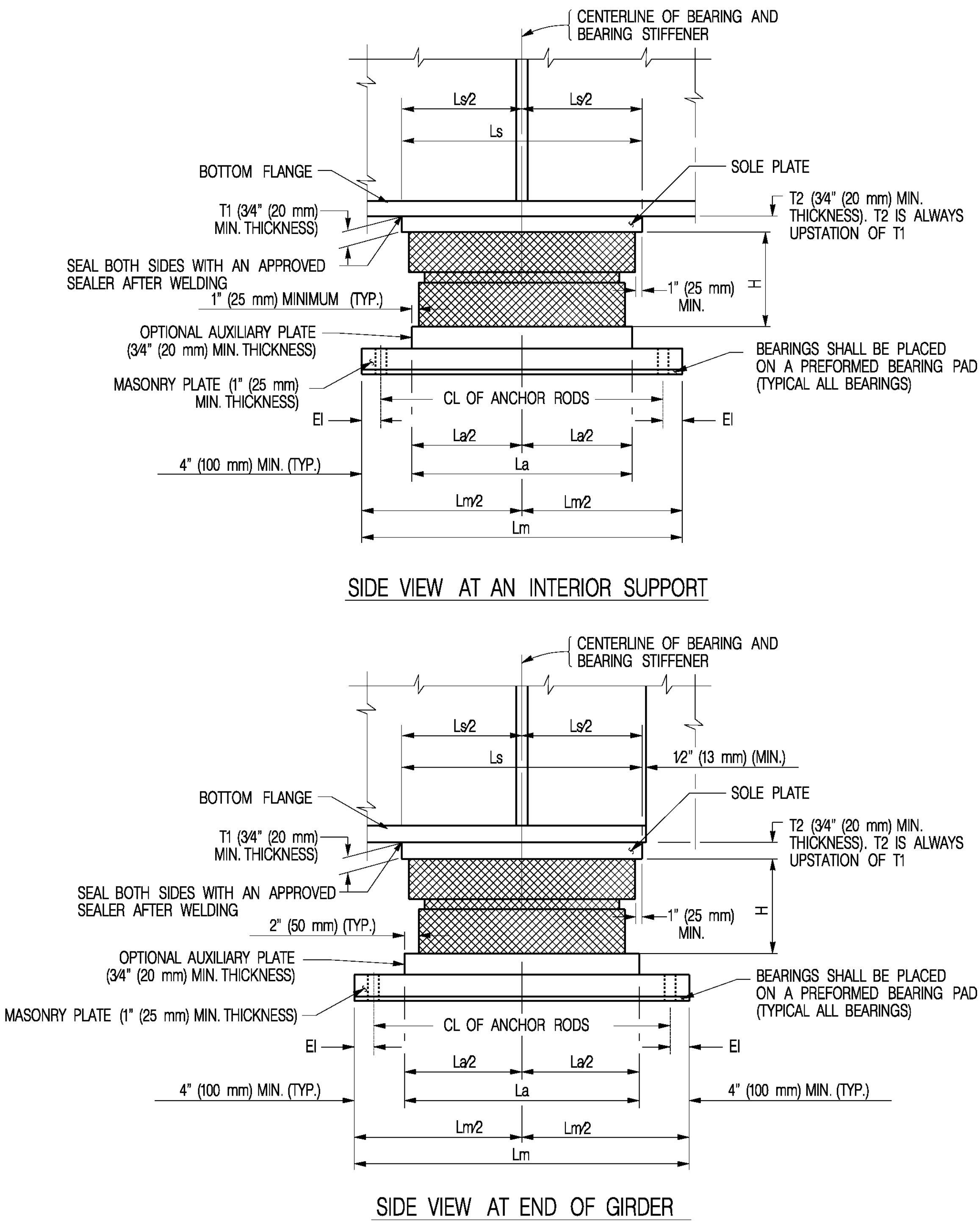
MINIMUM DISTANCES FOR DESIGN:

d_b = ROD DIA. + 5/16" (8 mm)

E_t = 1.75 X ROD DIA. + 3/16" (5 mm)

E_l = 1.75 X ROD DIA. + 3/16" (5 mm)

AASHTO/NSBA STEEL BRIDGE COLLABORATION	HIGH LOAD MULTI–ROTATIONAL BEARINGS	LATEST REVISION DATE 1–22–04
	BEARING CONNECTION DETAILS	DRAWING NUMBER H 1.5



POT BEARING SHOWN, DISC AND SPHERICAL BEARINGS SIMILAR

AASHTO/NSBA STEEL BRIDGE COLLABORATION	HIGH LOAD MULTI-ROTATIONAL BEARINGS SIDE VIEW DETAILS	LATEST REVISION DATE 1-22-04 DRAWING NUMBER H 1.6

NOTES:

THE CONTRACTOR SHALL SUPPLY MULTI-ROTATIONAL STRUCTURAL BRIDGE BEARINGS CONFORMING TO THE REQUIREMENTS OF THE SPECIFICATION AND SUBJECT TO THE FOLLOWING CONDITIONS:

1. THE BEARING DEVICES SUPPLIED SHALL BE CAPABLE OF TRANSMITTING THE LOADS AND MOVEMENT SHOWN ON THESE PLANS.
2. THE DIMENSION "H" IN THE BEARING TABLE REPRESENTS THE ASSUMED TOTAL HEIGHT OF BEARING MECHANISM BETWEEN THE SOLE PLATE AND MASONRY PLATE USED BY THE DESIGNER TO ESTABLISH THE PEDESTAL ELEVATIONS. THE MINIMUM PEDESTAL HEIGHT SHALL NOT BE CHANGED WITHOUT WRITTEN APPROVAL.
3. THE BEARING DEVICE, MASONRY PLATE, SOLE PLATE, ANCHOR RODS, NUTS, WASHER PLATES AND BEARING PAD SHALL BE INCLUDED IN THE UNIT PRICE BID FOR THE BEARING ITEMS.
4. ALL EXPANSION BEARINGS SHALL HAVE A MAXIMUM FRICTION COEFFICIENT OF 3%.
5. ALL STEEL SHALL CONFORM TO AASHTO M270 GRADE 50 (GRADE 345).
6. ALL EXPOSED METAL COMPONENTS OF THE BEARING SYSTEM SHALL EITHER BE PAINTED OR METALIZED.
7. THE BEARING DESIGN SHALL CONFORM TO THE PROVISIONS OF THE LATEST EDITIONS OF AASHTO.

WHENEVER JACKING OF THE SUPERSTRUCTURE IS NEEDED TO RESET THE BEARINGS, THE CONTRACTOR SHALL SUBMIT A JACKING SEQUENCE FOR APPROVAL.

BEARING TABLE

LOCATION	FIX/ EXP.	ITEM NO.	QUAN. REQ'D.	LOADS		*ONE WAY LONGIT. MOVEMENT	**(G) GUIDE CLEARANCE	MASONRY PLATE					AUXILLIARY PL			SOLE PLATE				BRG.	d_b	ANCHOR RODS		WELD SIZE	
				VERT.	HORZ.			Lm	Wm	Tm	Et	El	La	Wa	Ta	Ls	Ws	T1	T2	H		d	RODS/BRG.	W1	W2

T2 IS UPSTATION OF T1.

THE BRIDGE DESIGNER MUST IDENTIFY IF THE LOADS SHOWN ARE FACTORED OR UNFACTORED

ADDITIONAL INFORMATION SHOWN IN AASHTO TABLE C14.4.1-1 MAY ALSO BE INCLUDED IN THIS TABLE

*ONE WAY LONGITUDINAL MOVEMENT IS THE MAXIMUM ONE WAY MOVEMENT (EXPANSION OR CONTRACTION) OF THE SUPERSTRUCTURE WHEN BEARINGS ARE SET AT 70 DEGREES F (20 DEGREES C) PLUS 1" (25 mm) TOLERANCE.

**ON WIDE STRUCTURES AND ON CURVED STRUCTURES PROVISIONS SHALL BE MADE FOR LIMITED LATERAL MOVEMENT.

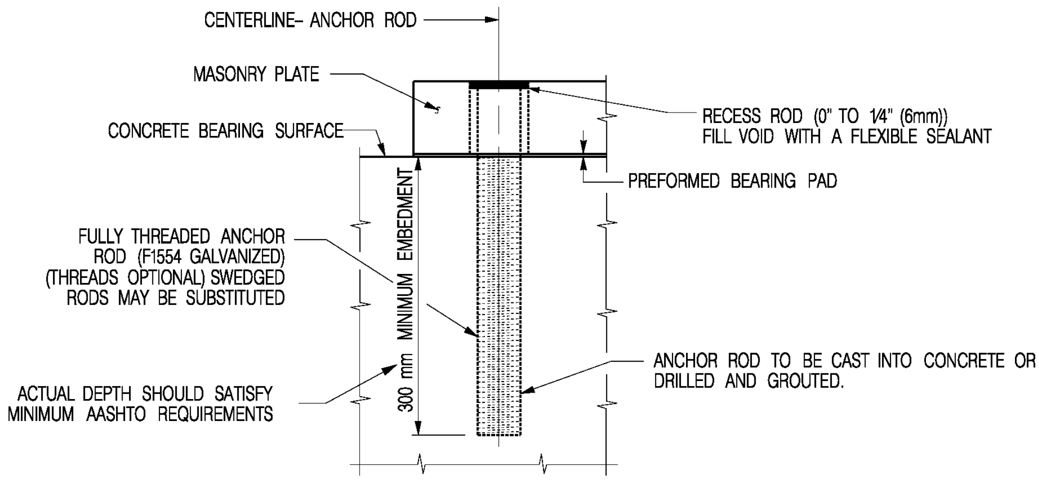
AASHTO/NSBA
STEEL BRIDGE
COLLABORATION

HIGH LOAD MULTI-ROTATIONAL BEARINGS

INFORMATION AND NOTES TO BE INCLUDED ON CONSTRUCTION PLANS

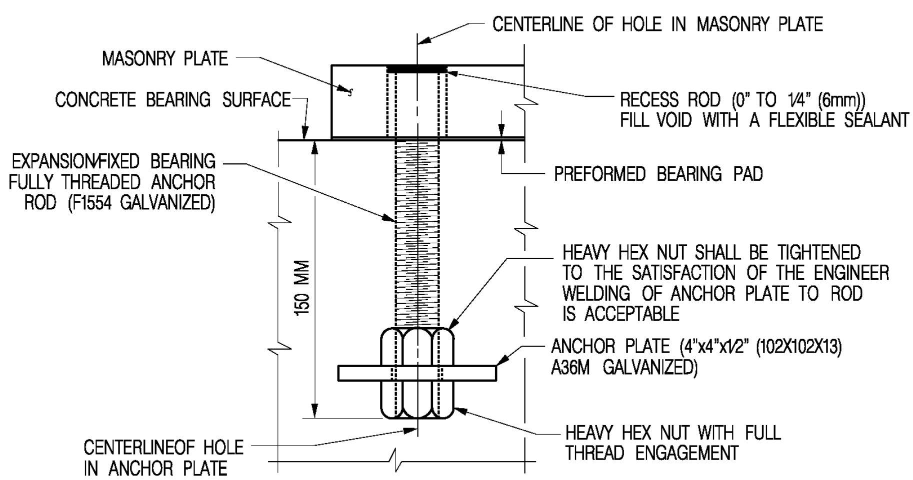
LATEST REVISION DATE
1-22-04

DRAWING NUMBER
H 1.7



ANCHOR ROD DETAIL ON PEDESTALS

ANCHOR RODS, WASHERS, WASHER PLATES, ANCHOR PLATES AND NUTS SHALL BE GALVANIZED IN ACCORDANCE WITH THE SPECIFICATION REQUIREMENTS.

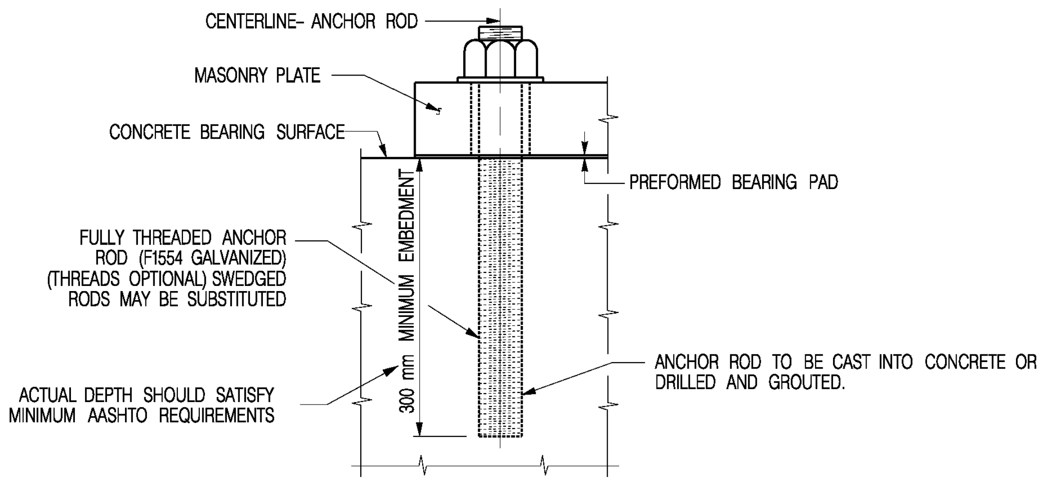


OPTIONAL ANCHOR ROD DETAIL WITH ANCHOR PLATE ON PEDESTALS

DESIGNER:

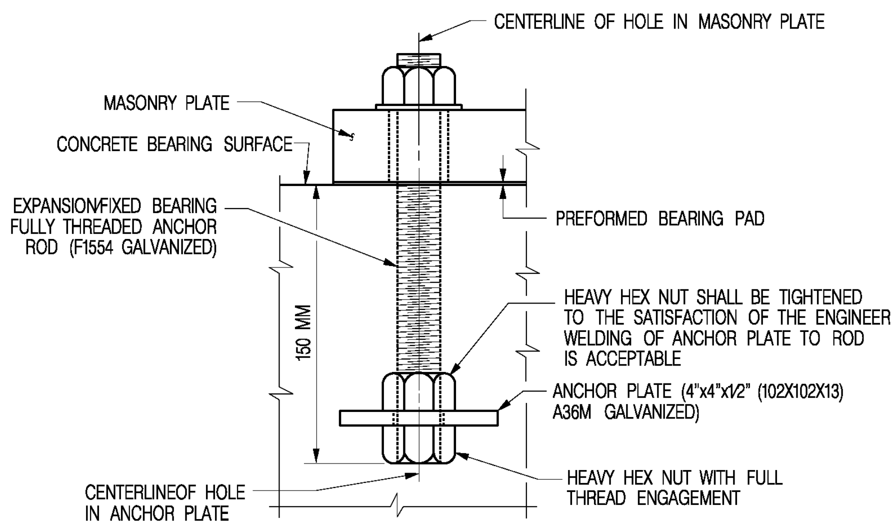
SHOW BOTH ANCHOR BOLT DETAILS ON THE PLANS. IF THE BEARINGS MUST RESIST CALCULATED UPLIFT, SPECIAL DETAILS MUST BE USED.

AASHTO/NSBA STEEL BRIDGE COLLABORATION	HIGH LOAD MULTI–ROTATIONAL BEARINGS	LATEST REVISION DATE 1–22–04
	ANCHOR ROD DETAILS WITHOUT ANCHOR ROD NUTS	DRAWING NUMBER H 1.8



ANCHOR ROD DETAIL ON PEDESTALS

ANCHOR RODS, WASHERS, WASHER PLATES, ANCHOR PLATES AND NUTS SHALL BE GALVANIZED IN ACCORDANCE WITH THE SPECIFICATION REQUIREMENTS.



OPTIONAL ANCHOR ROD DETAIL WITH ANCHOR PLATE ON PEDESTALS

DESIGNER:

SHOW BOTH ANCHOR BOLT DETAILS ON THE PLANS.

LOCATE ANCHOR BOLTS AWAY FROM THE BEARING UNIT TO FACILITATE INSTALLATION AND ALLOW FOR FUTURE MAINTENANCE AND REMOVAL. NOTE: THIS MAY REQUIRE A LARGER MASONRY PLATE.

AASHTO/NSBA STEEL BRIDGE COLLABORATION	HIGH LOAD MULTI–ROTATIONAL BEARINGS	LATEST REVISION DATE 1–22–04
	ANCHOR ROD DETAILS WITH ANCHOR ROD NUTS	DRAWING NUMBER H 1.9

Section 3
Steel Bearings

3.1 General

This section is intended to assist in the design and detailing of steel bridge bearings. The information included is intended to permit efficient fabrication, installation, and maintenance of these types of bearings.

Commentary

Where practical, steel bearings should only be considered for fixed bearing types.

Many states have experienced long-term problems with steel expansion bearings. The most important issues have been high cost, the need for expensive sliding surfaces (bronze), corrosion and binding of parts, and poor performance.

Steel roller and rocker expansion bearings should not be used below bridge deck mechanical expansion joints. The design of these types of bearings relies on the rotation between steel elements. Debris and corrosion between steel plates due to deck joint failure will result in poor performance of the bearing.

3.2 Reference Documents

- AASHTO LRFD Bridge Design Specifications
- AASHTO Standard Specifications for Highway Bridges
- *Steel Bridge Bearing Selection and Design Guide*, Volume II, Chapter 4, Highway Structures Design Handbook

3.3 Basic Assumptions

This document makes the following design and detailing assumptions for steel bearings:

1. Steel bearings are limited to fixed bearing designs that do not need sliding or rolling surfaces.
2. The bearings are attached to the girder by field welding or bolting.
3. Lateral forces are restrained by means of keeper angles, concrete keeper blocks (keys), or anchor rods.

Commentary

If an owner desires to use steel sliding surface expansion bearing, refer to Section-2 for design guidelines.

Some states prefer welding and others prefer bolting. Welded attachment allows for minor adjustment during installation and is often the most economical design. Bolting provides limited damage to coating systems and allows for easier removal in the future.

3.4 Design and Detailing Recommendations

3.4.1 Design

The design of steel bearings is the responsibility of the design engineer. The design should follow the provisions of the AASHTO specifications.

3.4.1.1 Design Rotation

Steel bearing assemblies should be designed for unfactored dead load and live load rotations and

Commentary

Bearing assemblies consist of the bearing element, connection plates and a sole plate additional rotation of 0.010 radians to account for the combination of uncertainties and construction tolerances specified in the AASHTO Specifications.

(beveled or flat). See Section 3.6 for details of typical bearing assemblies. Please refer to Appendix A for information on calculating rotations.

Sole plates should be beveled to account for a significant portion of the rotations due to profile grade. If beveled sole plates are used, the design rotation for the bearing due to profile grade should be neglected in the final loaded condition.

Refer to Appendix A for information on the effect of beveled sole plates on bearing design rotations.

If the beam is cambered for dead loads, the dead load design rotation of the bearing should be neglected.

Refer to Appendix A for information on the effect of beam cambering on bearing design rotations.

3.4.2 Sole Plate Connections

The connection of the sole plate to I-girders may be welded or bolted.

Connection to box girders should be bolted. If the bolts are installed in drilled and tapped holes in the sole plate, the bolts and the hole should be made perpendicular to the plan of the bottom flange, which is also the plane of the top of the sole plate.

Commentary

The suggested welded connection shown on the Detail Sheets may be either a shop or field weld.

Welding allows for greater adjustment during installation and is more economical. The damage due to removal of the weld for future removal and maintenance can be reasonably repaired. The AWS/AASHTO D1.5 Bridge Welding Code has information on weld removal and repair.

Bolted connections with oversized holes allow for minor field adjustments of the bearing during installation. Bolting also requires less touch up painting on painted structures and simplified future removal.

Box girder bearings should be attached with bolts since a welded sole plate requires an overhead weld that is often difficult to perform due to limited access.

3.4.3 Sole Plate Details

The sole plate should extend transversely beyond the edge of the bottom flange of I-girders at least 1" (25mm) on each side.

The minimum thickness of the sole plate should be ¾" (20mm).

Commentary

This recommendation is intended to allow sufficient room for welding. Fabricators will not overturn a girder in the shop to make a small weld; therefore, it is assumed that the girder will be upright when this weld is made in the shop or in the field.

This is the minimum thickness specified by AASHTO to minimize plate distortion due to welding.

3.4.4 Bearing to Girder Connection

The bearing may be connected to the girder by field welding, or field bolting.

If welding is used, the welds should be in the horizontal position.

Commentary

Welding and bolting are both acceptable. If bolting is selected, oversized holes are recommended to facilitate field fit-up. Refer to each state's standard details.

Overhead welds are difficult to perform due to limited access.

The welds for the sole plate connection should only be along the longitudinal girder axis. Transverse joints should be sealed with an acceptable caulking material.

The longitudinal welds are made in the horizontal position, which is the position most likely to result in a quality fillet weld. Transverse welds require overhead welds and are very difficult to complete due to limited access. The caulking of the underside transverse joint is intended to prevent corrosion between the sole plate and the bottom flange. Most states use a silicone based caulk; however, other materials may be used.

3.4.5 Masonry Plate and Anchor Rods

The masonry plate should bear directly on a 1/8" (3mm) thick preformed pad that rests directly on the substructure.

Commentary

This method of using a preformed pad to take up bearing surface irregularities is preferred to grouting under a masonry plate supported by leveling nuts. The grouting option results in point loads at the anchor rods due to the high stiffness of the rods when compared to the grout material, which can lead to masonry plate warping. For this reason, grouting should be limited to special cases only. No design of the bearing pad is required since it is assumed that the pad will yield and deform to fill the uneven surfaces of the concrete bearing seat. The preformed pad may be an elastomeric, cotton duck, or random fiber material.

3.4.5.1 Anchor Rod Design

The design of anchor rods for lateral load should take into account the bending capacity of the rod, edge distance to the concrete foundation, strength of the concrete and group action of the rods.

Commentary

The term "anchor bolts" should not be used because "bolt" implies that the rod has a head. The AASHTO specifications do not give specific requirements for the design of embedded anchors in shear. The American Concrete Institute publication "Building Code Requirements for Structural Concrete (ACI 318-02) is recommended.

Material for anchor rods should be ASTM F1554, and should either be threaded (with nuts), or swaged on the embedded portion of the rod. The design yield strength of this material may be specified as36ksi (250MPa), 55ksi (380MPa), or 105ksi (725MPa) depending on the design. The yield strength should be given in the specifications, or on the plans.

This material is specifically designed for anchor rod applications. Other materials have been used, but do not offer the economies of ASTM F1554. The designer should offer options of swaging or threading the anchor as different suppliers supply one or both of these options.

3.5 Marking

The designer should add the following notes to the plans:

"All bearings shall be marked prior to shipping. The marks shall include the bearing location on the bridge, and a direction arrow that points up-station. All marks shall be permanent and shall be visible after the bearing is installed."

Commentary

Problems have occurred in the field with the installation of bearings with beveled sole plates. It is not always obvious which orientation a bearing must take on a beam before the dead load rotation has been applied. This is especially true for bearings with minor bevels.

Appendix A
Recommendations for Beam Rotation Calculations

Dead Load Rotations:
In general, bearings should not be designed for dead load rotations if proper camber is provided in the girders. The bearing design is based on a girder that provides a level surface for the bearing to support. Some states design bridges with minor grades without beveled sole plates. For these cases, the bearing must be designed for rotation due to profile as well (see following page for detailed discussion on these issues).

1. Non-Composite Dead Load Rotation:
   - Rotation for non-composite dead load should be calculated with steel section properties only.
   - If deck pour sequences are incorporated into the design, these sequences and the appropriate stiffness changes that take place during deck casting may be accounted for in the rotation calculations.
2. Composite Dead Load Calculations:
   - All composite dead loads should be distributed to each girder equally. The rotations should be calculated using section properties based on long term dead loads (concrete modular ratio of 3*n).

Live Load Rotations:
There is great variation in the methods used for calculation of live load rotations. The following guide has been developed based on methods used in several states. Experience has shown that actual rotations measured in the field are significantly lower than those typically calculated.

In an effort to provide more cost effective bridges, the AASHTO/NSBA Steel Bridge Collaboration recommends that a realistic approach be taken in the calculation of live load rotations. Many of these recommendations are now part of the Second Edition of the AASHTO LRFD Bridge Design Specifications. The AASHTO specifications require that bearings be designed for uncertainties. Therefore, there is no need for excessive conservatism in the design for beam rotation.

1. Live Load Distribution:
   - The live load condition is to have all lanes loaded on the bridge. This represents the maximum credible load condition that the bridge will experience. Therefore, the live load should be applied to all travel lanes and distributed to each beam equally.

     Wheel Load Dist. Factor = (number of lanes * 2 wheels/lane)/number of beams
2. Simple-Span Bridges:
   - The maximum rotation of the beam end can be calculated using normal stiffness methods. However, many beam design computer programs do not calculate the beam end rotation. An approximate beam end rotation can be determined based on maximum mid-span deflection as follows (note that this is an exact solution only in the case when the beam is prismatic and the beam deflection is parabolic):
     i. Calculate the maximum LL Deflection = Δ
     ii. Approximate End Rotation = $4*\Delta$/SPAN Length
3. Continuous-Span Bridges:
   - Composite section properties should be used for all segments of all girders. This includes the negative moment regions, where the transformed concrete slab should be used in place of the cracked section (beam and slab reinforcement). A crack in a slab may cause localized stress increases that warrant a cracked section analysis for design; however, the overall behavior of the beam has been demonstrated in field studies to be as if the slab is uncracked.

Effect of Beveled Sole Plates and Girder Camber on Bearing Design

The use of beveled sole plates and cambering of beams have an impact on the design rotations for bearings on steel bridges. The designer should account for these in the design of the bearings.

Girder Camber:

Girder camber is used to provide a beam that has a web that follows the final roadway profile after the application of total dead load. This means that the dead load rotation of the beam at each support is built into the girder via an opposite rotation. When the beam is placed, the bottom of the beam will be out of parallel by a factor that is equal to the dead load rotation. This will induce a rotation into the bearing as the beam is set; however, this rotation decreases to zero as the beam is loaded with total dead load. Ideally, the dead load rotation that the bearing experiences is zero in the finished structure. Many designers do not evaluate elastomeric bearings under this temporary condition when the beam is set, since the situation is temporary and the loads and rotations are much lower than the full design load and rotation of the bearing. HLMR bearings are normally checked for this temporary condition to ensure that no damage occurs and that there is no metal-to-metal contact.

Beveled Sole Plates:

Properly beveled sole plates provide a level surface under the sole plate after the application of full dead load. As stated above, the beam camber normally accounts for the dead load rotation. If a beam is not cambered, then the sole plate can also be used to account for the dead load rotation. The sole plate normally only accounts for the profile of the beam. If the beam is cambered, then the sole plate only needs to account for the beam profile.

The following tables demonstrate the effects of beam cambering and a beveled sole plate on the rotation analysis of elastomeric bearings on a simple steel bridge:

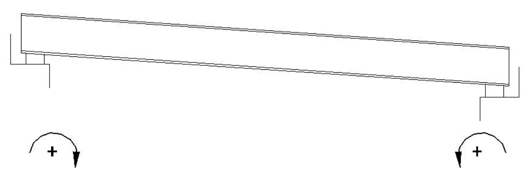
The numbers shown are not specific to any bridge, however they demonstrate the effects of cambering and beveled sole plates.

The first table is for a beam without camber and beveled plates. The addition of a rotation due to profile grade and the dead load rotation tend to increase the design rotation of the bearing.

The second table is for a beam with cambering but without beveled sole plates. Many designers use this scenario for beams with flat profiles (typically less than 0.01 radians). In this case, the cambering eliminates the dead load rotation from the design rotation of the bearing.

The third table is for a beam with both cambering and beveled sole plates. In this case, the beveled sole plate eliminates the rotation induced by profile grade.

SAMPLE TABULATION OF BEARING ROTATIONS FOR ELASTOMERIC BEARINGS



WITHOUT BEVELED SOLE PLATES OR GIRDER CAMBER

PROFILE GRADE	+ 0.005 RAD	- 0.005 RAD
DEAD LOAD	+ 0.014 RAD	+ 0.014 RAD
LIVE LOAD	+ 0.011 RAD	+ 0.011 RAD
UNCERT. & TOL.	+ 0.005 RAD	+ 0.005 RAD
DESIGN ROTATION	+ 0.035 RAD	+ 0.025 RAD

WITHOUT BEVELED SOLE PLATES AND WITH GIRDER CAMBER

PROFILE GRADE	+ 0.005 RAD	- 0.005 RAD
DEAD LOAD	0.000 RAD	0.000 RAD
LIVE LOAD	+ 0.011 RAD	+ 0.011 RAD
UNCERT. & TOL.	+ 0.005 RAD	+ 0.005 RAD
DESIGN ROTATION	+ 0.021 RAD	+ 0.011 RAD

WITH BEVELED SOLE PLATES AND WITH GIRDER CAMBER

PROFILE GRADE	0.000 RAD	0.000 RAD
DEAD LOAD	0.000 RAD	0.000 RAD
LIVE LOAD	+ 0.011 RAD	+ 0.011 RAD
UNCERT. & TOL.	+ 0.005 RAD	+ 0.005 RAD
DESIGN ROTATION	+ 0.016 RAD	+ 0.016 RAD

Appendix B
Recommendations for Thermal Movement Calculations

The AASHTO specifications outline requirements for calculation of thermal movement. The following are general guidelines that are intended to supplement the AASHTO specifications. The designer should establish an installation temperature range and design and specify the bearings accordingly.

Standard Bridges:
In this context a standard bridge is defined as a steel stringer bridge that has the following geometric conditions:

1. Straight beams
2. Zero to moderate skew (about 30 degrees)
3. Span length to width ratio greater than 2
4. Less than three travel lanes.

The major contributor to thermal movements is the bridge deck. This portion of the bridge structure is exposed to the highest temperature extremes and is a continuous flat plate. A flat plate will expand and contract in two directions, and will not be significantly affected by the steel framing below. For bridges that meet the general criteria listed above, the calculations for thermal movement can be based on the assumption that the bridge expands along its major axis, which is along the span length.

Non-Standard Bridges:
The treatment of non-standard bridges requires careful design and planning. A refined analysis may be required for non-standard bridges in order to determine the thermal movements, beam rotations (transverse and longitudinal), as well as the structural behavior of the system. The stiffness of substructure elements may also have an effect on the thermal movement at bearings. The following are general basic guidelines outlining the thermal movement behavior for non-standard bridges:

Curved Girder Bridges:
It has been well documented that curved girder bridges do not expand and contract along the girder lines. The most often used approach is to design bearing devices to expand along a chord that runs from the point of zero movement (usually a fixed substructure element) to the bearing element under consideration. (See Figure B-1.)

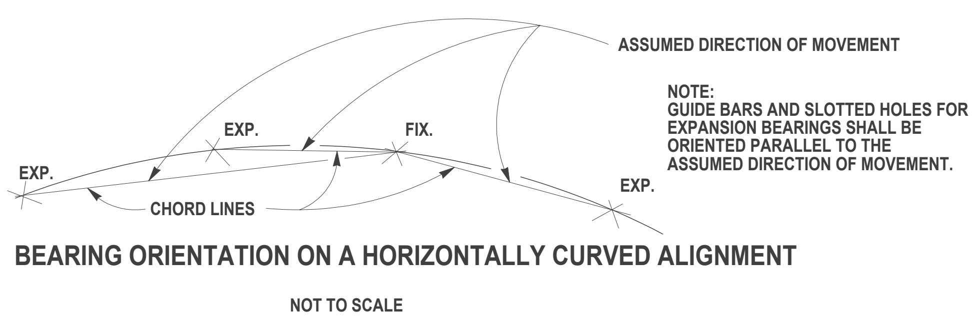


Figure B-1

Large Skew Bridges:
The major axis of thermal movement on a highly skewed bridge is along the diagonal from the acute corners, due to the thermal movement of the bridge deck. The alignment of bearings and keeper assemblies should be parallel to this axis. The design of the bearings should also be based on thermal movement along this line. (See Figure B-2.)

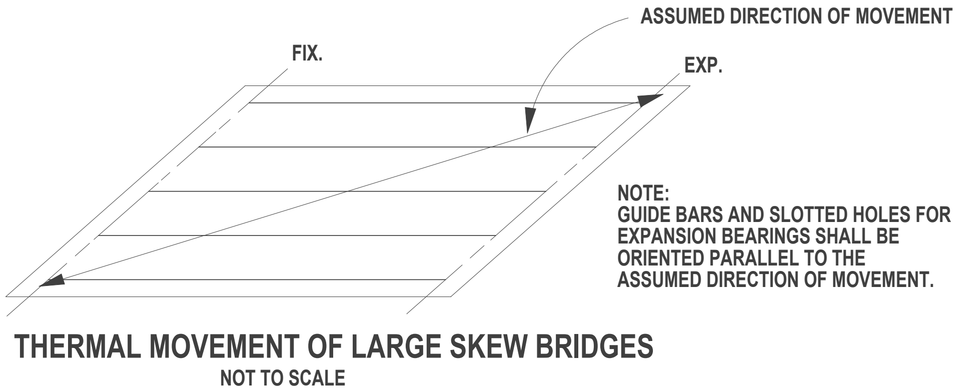


Figure B-2

Bridges with small span-to-width ratios:
Bridges with widths that approach and sometimes exceed their lengths are subject to unusual thermal movements. A square bridge will expand equally in both directions, and bridges that are wider than they are long will expand more in the transverse direction than in the longitudinal direction. The design of bearing devices and keeper assemblies should take this movement into account.

Wide bridges:
Bridges that are wider than three lanes will experience transverse thermal movements that can become excessive. Care should be taken along lines of bearings lines not to guide or fix all bearings along the line. Guides and keeper assemblies should be limited to the interior portions of the bridge that do not experience large transverse movements.

AASHTO Document No: SBB-1
Printed March 2005
ISBN: 1056051-310-1