National Pot Bearing Standards
FHWA, FDOT, NCDOT, PENNDOT

in association with:
Michael Baker Jr., Inc.
Harrisburg, PA

COMMENT/RESPONSE FORM

Submission Subject:	**National Pot Bearing Standards**		
	Review of PENNDOT Standard BD-613M		
Prepared By:	**Eric L. Martz, P.E. / Robert T. Doble, Jr., P.E.**		
Date of Response:	**May 9, 2005**	**Date of Receipt:**	**August 2004**

Comment No.	Comment	Response
FHWA	**Comments from FHWA: Vasant Mistry, P.E.**	
1	In general, the presentation and the design look good.	No response required.
2	GUIDED BEARING AND FIXED BEARING: If the additional cost of a groove weld is not prohibitive, we recommend a groove weld at the guide bar connection with the side plate for the guided bearing and at the piston connection with the plate for the fixed bearing in lieu of the fillet weld shown.	We discussed this issue with a pot bearing manufacturer. They stated that a groove weld is considerably more expensive than a fillet weld. They also stated that they have used fillet welded connections successfully on hundreds of projects.
3	It is not clear if ring tension is considered in the design of the pot of the pot bearing. We recommend considering ring tension in designing the pot for pot bearings.	The equation listed as AASHTO Equation 14.7.4.7-1 is taken from NCHRP Report 432, Equation D-15 (page D16). Note that the constant in the equation was increased by AASHTO from 33 to 40. This equation is the result of a derivation that accounts for both hoop stresses and bending stresses.
FDOT	**Comments from FDOT: Henry T. Bollmann, P.E.**	
1	Were the DS Brown MathCad calculations checked in detail by Michael Baker or a PE at PENNDOT? Need verification as the Standards are based on the DS Brown calculations.	Yes, the Mathcad calculations developed by D.S. Brown were checked by Baker. Baker presented a summary of the calculation check to PENNDOT during the BD-613M development stage and PENNDOT agreed with the calculation methodology.
2	Need provision in the Tables for plate thickness dimension at all 4 corners of the sole plate. These plates are often beveled transversely and longitudinally.	The sole plate thickness provided in the BD-613M standards is based on satisfying an allowable bending stress of 0.55*Fy. Since nearly every bridge will require different bevels in the longitudinal and/or transverse directions, the standards show the minimum sole plate thickness only. The designer then adds to the minimum thickness to account for the bevel (if required) and adjusts the total bearing height accordingly. This is explained in the “Sole Plate Design” notes (Note 2) on Sheet 1 of the BD-613M standards.

3	Am I clear on how these "standards" are to be used? Bridge designer uses these sheets to size the pot bearing and related plates. Uses the notes and details as needed. The bearing supplier provides shop drawings for approval.	The intent of the BD-613M standards is to provide bearing component sizes based on calculated loads in lieu of performing a complete bearing design. PENNDOT still requires the pot bearings to be detailed on the contract drawings as per the BD-613M standards. The fabricator is still required to submit shop drawings during construction. However, as long as the bearing is detailed in accordance with the contract drawings, design calculations are not required with the shop drawing submission. PENNDOT's intent is to evolve the BD-613M standards into construction standards, which would eliminate the need for shop drawings.
4	I like the design methodology shown here and the bearing design examples are helpful. I would use these "standards". The design of the pot bearings and detailing has always been a time consuming task.	No response required.
5	It's not clear to me where the direction of the guide bars is shown. I think in the plan view, section B-B sheet BD-613M, the direction of the guide needs to be shown (as a bearing) and how the masonry plate is oriented on the bridge pier. Note that for curved bridges each pot bearing will often have a different guide bearing angle.	The BD-613M standards depict the guide bars as parallel to the CL girder/beam and the masonry plate as perpendicular to the CL girder/beam. This is shown in Sections B-B and C-C on Sheet 12 of the standards. However, the designer can change the orientation of the guide bars and masonry plates as required as long as geometric clearances are verified. This is discussed in Note 12 on Sheet 1 of the standards.
6	There are notes "weld as per design"….as where pot is attached to the masonry plate. Are these notes directed to the Bridge designer or the pot bearing supplier?	The BD-613M standards are intended to be used by the bridge design engineer. Therefore, the notes are directed to the design engineer and as such he or she would be responsible for sizing the pot to masonry plate weld.
7	See the plan sheets I sent to Patricia Kiehl. Note the 6 inch block out for the swedge anchor bolt sheet C-112. We recommend this for construction tolerances. See note 9 on sheet C-112….we found this necessary to keep the bearings from being turned the wrong way in field placement. This has happened several times.	The BD-613M standards show a generic detail for the anchor bolt embedment. However, the blockout detail you refer to has been used on occasion for PENNDOT bridges as well. Notes 12 & 13 on Sheet 14 of the BD-613M standards are intended to eliminate bearing misplacement in the field. The project team is willing to discuss the inclusion of additional anchor bolt details and field placement instructions.

8	Note the angle of the bolts which attach the top plate / bevel plate to the girder…sheet C-111. On our last job the contractor drilled the holes in the bottom flange of the girder at 90 degrees to the bottom of the box girder flange and the pot bearing manufacturer installed the bolts at 90 degrees to the top plate and so there was a fit up problem in the field…they had to bend the bolts to fit.	The sole plate attachment detail you reference is similar to the tapped bolt detail shown on Sheet 15 of the BD-613M standards. This sheet provides details for connecting sole plates to both steel girders and P/S concrete beams. However, situations often vary where other sole plate connection details are required. We suggest adding a note to the detail on Sheet 15 of the BD-613M standards that makes the designer aware of the potential for bolt/thread misalignment when using beveled plates.
9	An item of interest: DS Brown elected to fabricate the top plate and bevel plate shown on sheet C-111 from one plate. (made these into one plate).	No response required.
NCDOT	**Comments from NCDOT:** **James Gaither, PE [comments 1 –11] ;** **T.K. Koch, PE [comments 12 -17]**	
1	**Standard Drawing Comments:** Sheet 8—several of the sole plate, guide plate and guide bars are greater than 4” thick. Plates greater than 4” thick may not be available in M270 (ASTM A709), Grade 50. The AASHTO and ASTM specifications do not specify the yield for plates greater than 4”. Equivalent ASTM specifications require reduced yield for plates greater than 4”.	We agree that the ASTM and AASHTO specifications do not specify yield strengths for plates over 4”. This was apparently overlooked during the generation of the standards. The pot bearing manufacturer that we contacted performed a review of material certifications for plates they received that were over 4” thick. Their certifications show that the yield strength is still generally above 50 ksi. However, the project panel members should discuss the incorporation of a dual material specification for plates greater than 4” thick.

2	Sheet 10, pot is recessed into the masonry plate and caulked. We require the plate welded to the masonry plate and not recessed. We could not find reference in AASHTO on attaching the pot base to the masonry plate. There may be cost savings in welding instead of recessing and during an earthquake welding may perform better than recessing.	The primary reason for the recessed detail is to allow for future replacement of the pot bearing without the need to grind the existing weld or remove the masonry plate. See the last paragraph of AASHTO LRFD Bridge Design Specifications, Section C14.8.1, which suggests the recessed detail. Please note that the BD-613M standards also include an alternate welded connection for attaching the pot to the masonry plate (see BD-613M, Sheet 14, "Alternate Pot Plate Attachment"). This welded detail was included in the standards because PENNDOT used to specify welding only throughout the state.
3	Sheet 11: ss plate is 13 gauge. AASHTO LRFD 14.7.2.3.2 and our PSP requires 11 gauge when dimension greater than 12"	The AASHTO LRFD Bridge Design Specifications (1998 & 2004), Section 14.7.2.3.2 states that the SS mating surface shall be at least 16 gage when the maximum dimension of the surface is less than or equal to 12", and at least 13 gage when the maximum dimension of the surface exceeds 12".
4	Sheet 12: two guide bars and a guide plate instead of a center guide key will significantly increase fabrication cost. It may be appropriate to develop a separate standard for light-loaded and heavy-loaded bearings.	PENNDOT prefers external guide bars for bearing inspection purposes. If center guide bars are used, they may not be as visible during inspections. In addition, AASHTO LRFD (1998) Section C14.7.4.7 discusses a few disadvantages of using a center guide bar. However, if the project team members prefer to use center guide bars, these details will be incorporated into the standards as an option.
5	Sheet 13: bedding material 1/8". We require 3/16", although we have heard just recently that pads not in 1/8" increments are hard to obtain and are considering modifying this size.	The bedding material is used to create a more uniform bearing area under the masonry plate since the substructure concrete finish may be rough. Both material thicknesses mentioned will likely serve this purpose.
6	Sheet 13: PTFE is attached to the guide plate by three methods (countersunk screws, adhesive and recessed PTFE). AASHTO requires only two attachment methods. Screw heads may be exposed after PTFE is worn down and damage the SS.	To ensure that the PTFE surfaces do not separate from the steel plates, PENNDOT prefers all three attachment methods. The standards could be modified to include attachment methods preferred by all agencies.
7	Sheet 14: anchor bolts are F1554 Grade 55, we use A449.	PENNDOT prefers to use F1554 Gr. 55 anchor bolts. PENNDOT does not allow the use of A449 bolts because the bolts are quenched and tempered, and we are concerned about the potential for brittle failures.

8	Sheet 14, for curved girder bridges should guide bars be oriented toward fixed bearings, and if so how?	The guide bar orientation is determined by the bridge design engineer. Many factors may influence the preferred orientation, such as intended direction of movement, bearing configuration at other substructure units, expansion dam type, and others.
9	**Calculation comments:** Sheet 3, Section 3F and Sheet 4 Section 4B—The equation to determine recess required for pot to masonry plate connection is not the equation referenced in eq. 6.7.6.2-1 and 6.7.6.2.2-2.	We agree. The calculation references to AASHTO LRFD, Section 6 are incorrect. The recess calculation is based on checking against the allowable bearing stress of 0.8*Fy using 1/3 of the pot circumference for bearing. A minimum recess depth of ¼" is used if the stress check yields a smaller recess. The allowable stress of 0.8*Fy is taken from the AASHTO Standard Specifications for bearing on pins.
10	Sheet 6, Section 6C iv and Sheet 7 6D iv – To determine weld required for the guide bar SS connection, the calculations reference 1992 AASHTO Section 10.32.2 and Eq. 10-12. Why did it not reference AASHTO LRFD specification?	The AASHTO LRFD Bridge Design Specifications do not list provisions for service load design of welds. Therefore, the equations from the 1992 AASHTO Standard Specifications were used to determine the required weld size based on service loads. (Note that PENNDOT used the 1992 AASHTO Standard Specifications prior to switching to LRFD. The 1992 Standard Specifications are still used in lieu of the 1996 Standard Specifications for non-LRFD designs such as curved girder bridges.) We suggest adding a note to the BD-613M standards listing the allowable service stress for weld design.
11	Sheet 7, section 6E and sheet 10 Section 8D—To determine guide plate and sole plate thickness; the loaded area was calculated using a 56.31 degree angle. This could be a simplification of a finite element analysis; in any event, the origin of this value is unclear.	The 56.31 degree angle represents a 1.5:1 distribution of load through the plates.
12	3a) Piston Face width --The calculations do not appear to be using the latest equations from LRFD, especially 14.7.4.7-2. There is now a 1.5 in the numerator instead of 2.5.	The pot bearing design calculations supporting the BD-613M standards are based on the AASHTO LRFD Specs. (Second Edition, 1998). AASHTO Equation 14.7.4.7-2 (1998) lists the constant 2.5 in the numerator because the term "Hs" (also in the numerator) is the applied horizontal service load. The Third Edition of the AASHTO LRFD Specs. (2004) modified equation 14.7.4.7-2 to include the constant 1.5 in the numerator in place of 2.5 because the term "Hu" is the applied lateral load from applicable strength and extreme event limit states.

13	3b) eq. 14.7.4.6-3 has changed to .04Dp.	The 0.045 factor is recommended in the Structural Committee for Economical Fabrication (SCEF) Specification, Standard 106, Section 106.4.2.1.3. This specification was used in conjunction with the AASHTO specifications to develop the BD-613M standards. PENNDOT decided to use the more conservative value of 0.045.
14	3e) eq. 14.7.4.7-1 has changed – the 40 in the numerator is now 25.	See response to comment 12. The terms "Hu" and "Θu" in AASHTO Eq. 14.7.4.7-1, which are the lateral load and rotation respectively, are calculated as strength or extreme limit state values in the Third Edition of the AASHTO LRFD Specs. Previously in the Second Edition, these terms were service limit state values. This difference accounts for the lower constant in the equation.
15	3F) the equation for pot recess does not match LRFD 6.7.6.2.2-1.	See response to comment 9.
16	4c) Piston Thickness—there appears to be no allowance for compressive deflection—i.e., no 2δu term. We should consider assuming some flat dimension like 1/16" for this term since it is difficult to quantify…	The equation cited is from the SCEF Specification, Standard 106, Section 106.4.2.3.2. This specification was used in conjunction with the AASHTO specifications to develop the BD-613M standards. The SCEF specification does not include a term for the compressive deflection. The SCEF equation was used to develop the BD-613M standards in lieu of the similar AASHTO equation. The actual compressive deflection is likely small when compared to the deflection due to rotation coupled with the extra 0.125" that is included in the calculation.
17	6E) Again – to echo JG's comments—the origin of the 56.31 degree angle is obscure. I think most designers would assume 45 degrees.	See response to comment 11.
Baker	**Comments from Baker:**	
1	Sheet 1 of BD-613M, note 9 under "Instructions for Using Design Tables" lists dimension "Z" as one of the dimensions to reevaluate should the longitudinal movement exceed 3". Dimension "Z" is the length of the guide bar and should not be included in this note. The guide bar is designed to accommodate the required length of guide plate PTFE and would be unaffected by a longitudinal movement greater than 3".	We agree that the dimension "Z" is unaffected if longitudinal movements greater than 3" need to be accommodated. This dimension should be removed from the note.

2	If this standard is to be used nationally, the references to PENNDOT specifications (DM-4 & Pub. 408) should be removed and replaced with specifications appropriate for a national standard.	Perhaps more generic references to construction specifications could be incorporated to indicate use of specifications from the applicable state DOTs.
3	Consider adding a note to the example "DESIGN LOADS" tables on sheet 2 of BD-613M alerting designers that all applicable horizontal and vertical loads should be considered when calculating the design horizontal and vertical loads. (CF, BR, and etc. may apply to the design of pot bearings in certain situations, not just DL, LL+I and wind.)	An additional note may be a helpful reminder to designers.
4	Dimension "V" listed in the BD-613M bearing tables is the piston diameter and has been set as 0.02" less than dimension "S", which is the pot inside diameter and neoprene disc diameter. The 0.02" difference between these two dimensions represents the total clearance between the piston and the pot wall (0.01" clear around the perimeter) and is consistent for all bearing sizes listed in the BD-613M tables. AASHTO Section C14.7.4.7 states that an acceptable range for this clearance is 0.02" to 0.04". AASHTO Equation 14.7.4.7-4 is also provided to determine the clearance required to prevent the escape of elastomer between the piston and pot wall and is based on geometry. Note that the 0.02" minimum controls over AASHTO Equation 14.7.4.7-4 for all design cases covered in the standards. In a recent review of shop drawings provided for pot bearings, the fabricator modified the clear dimension between the pot and piston to 0.04" (0.02" clear around the perimeter). The fabricator stated that the 0.02" total clearance was very tight and essentially unachievable given the tolerances in machining the pot and piston. As a result, the fabricator reduced the piston diameter to provide a total clearance of 0.04". Consider modifying the piston diameter (dimension "V") to allow for a clearance range, or list the minimum piston diameter allowed.	The bearing manufacturer we contacted prefers that the difference between the pot inside diameter and the piston outside diameter be a minimum of 0.04". They also stated that additional consideration should be included to have this clearance increased if extremely high horizontal loads are required which cause large piston face widths. As a result, the project team should discuss this issue and possibly revise the clearance.

5	The length of the PTFE attached to the top of the guide plate (dimension “HH”) for guided pot bearings is less than the length of the PTFE mounted on the sides of the guide plate (dimension “KK”) for every design case listed in the BD-613M standards. Hence, one would expect the length of stainless steel mated to each of the PTFE surfaces (dimension “LL” for the guide plate stainless steel and dimension “NN” for the guide bar stainless steel) to vary in accordance with the length differences in PTFE surfaces so that the same movement capacity would be provided for each of the components. However, both the guide plate and guide bar stainless steel surfaces are listed as the same length in the guided pot bearing tables in the BD-613M standards. The guide plate stainless steel length (dimension “LL”) could be reduced based on the difference in PTFE lengths (dimension “KK” minus dimension “HH”).	We agree that the stainless steel sheet attached to the sole plate that mates with the top PTFE surface could be reduced in length as stated. However, this would be a small reduction in length. In addition, it is likely that the same sheet of stainless steel would be used to fabricate both the guide bar stainless steel sheets and the sole plate stainless steel sheets. Therefore, making the sole plate sheet shorter would require an additional cut in the fabrication process. Please note that the dimensions of the PTFE surfaces mated to the top and sides of the guide plate were sized based on the allowable stress of the PTFE. Since the applied stress is different in the vertical and horizontal directions, the length of top PTFE surface is different than the length of the side PTFE surface.

cc: Patricia Kiehl, P.E., PENNDOT
Vasant Mistry, P.E., FHWA
Henry T. Bollmann, P.E., FDOT
Tom Koch, P.E., NCDOT