ARKANSAS HIGHWAY & TRANSPORTATION DEPARTMENT
BRIDGE DIVISION

DESIGN MEMORANDUM 05-01

DATE: December 1, 2005

TO: Bridge Division Personnel

FROM: Phil Brand, Bridge Engineer CPB

SUBJECT: Elastomeric Bearing Design Guidelines & Analysis Programs

This memorandum supersedes previous memorandums dated November 23, 1994, March 22, 1996 and August 13, 1999. Bridge Division design criteria for steel-reinforced elastomeric bearings have been established for both Method A and B procedures in accordance with the LRFD Bridge Design Specifications with 2005 Interim Revisions and are shown on Page 2 of 2.

In addition, to provide consistency and a convenient means to design steel-reinforced elastomeric bearings, Excel analysis programs have been developed for use by Bridge Division personnel. These elastomeric bearing analysis programs can be accessed as follows:

W:\Bridge Division Info\spreadshts\2005LRFD_METHABRG.XLS
Method A Analysis Program for Fixed or Expansion Bearings

W:\Bridge Division Info\spreadshts\2005LRFD_METHBEXP.XLS
Method B Analysis Program for Expansion Bearings

W:\Bridge Division Info\spreadshts\2005LRFD_METHBFIX.XLS
Method B Analysis Program for Fixed Bearings

The designer should copy these programs from the W:drive when needed, so that the latest update of the program is used. The first sheet in the Excel file is a documentation sheet, which also provides input guidelines and specification data. One copy of the documentation sheet should be included in the design calculations for the permanent job record. The second sheet consists of the elastomeric bearing analysis program.

Method A or Method B design procedures may be used. The two methods should typically not be mixed on a job unless approved by the Design Section Supervisor. Jobs with multiple units or bridges where considerably different beam reactions occur may make the use of both methods necessary. In this case specifications and plan documents should provide for long-duration testing of all the bearings on the job per subsection 808.05 of the Construction Specifications.

AMS:

STEEL REINFORCED ELASTOMERIC BEARING DESIGN CRITERIA

(LRFD BRIDGE DESIGN SPECIFICATIONS WITH 2005 INTERIMS)

Design Load Cases:

CASE A (Max. Reaction):	**Reaction = PDLmax + PLLmax**	**Rotation = ROTct + ROTLL**
CASE B (Max. Rotation):	**Reaction = PDLmin + PLLfor max rot**	**Rotation = ROTct + ROTLLmax rot**

Use Service Loads without Dynamic Load Allowance, Where:

PDLmax	=	Max. Dead Load Reaction with Deck Form Weight and Future Wearing Surface
PDLmin	=	Min. Dead Load Reaction with Deck Form Weight, but without Future Wearing Surface
PLLmax	=	Maximum Live Load Reaction
PLLfor max. rot	=	Live Load Reaction occurring simultaneously with Maximum Live Load Rotation. (Use 60% of PLLmax if refined analysis is not available)
ROTct*	=	0.007 radians for construction/fabrication tolerances unless pintle bearings are used.
	=	0.0 radians for pintle bearings
ROTLL	=	Live Load Rotation occurring simultaneously with PLLmax. (Use 0.0 radians unless a refined analysis is used to calculate value.)
ROTLLmax rot	=	Live Load Rotation occurring simultaneously with PLLfor max rot. (Use linear calculation at maximum live load deflection if refined analysis is not available.)

* Dead Load Rotation is eliminated through use of tapered external load plates where applicable.

Division Guidelines:

- Use 50-durometer hardness
- Minimum Interior Layer Thickness = 1/2" if possible (7/16" may be used if necessary)
- Minimum Exterior Layer Thickness = 1/4" (top & bottom cover layers)
- Minimum Steel Laminae Thickness = 12 gauge (0.1046 inches) w/minimum 30 ksi yield strength
- Total Elastomer Thickness (hrt) = Sum of exterior and interior layer thicknesses
- Design may be based on interior girder loads if the exterior girder dead load is at least 75% of the interior girder dead load (both without future wearing surface). Curved bridges, and bridges with sidewalks, trapezoidal spans, or atypical cantilevers may require independent bearing designs for all girders.
- As permitted by design specification, the number of interior layers for design calculations may be increased by one layer if each exterior layer thickness exceeds 50% of the interior layer thickness.
- Exterior layer thickness shall not exceed 70% of the interior layer thickness.
- For design calculations, use the value of shear modulus, G, that causes the more critical condition.
- Pad Length (parallel to CL Bridge) shall be less than or equal to Pad Width (perpendicular to CL Bridge).
- When practicable, the Pad Width should meet the following preferred limitations: Pad Width not less than flange width, but not more than 4" + flange width.

Design Expansion Length for Pad & Slot Length for External Load Plate:

Temperature Range = 0° F to 120° F (steel girders); 10° F to 80° F (concrete girders)

Coefficient of Thermal Expansion , α = 0.0000065 in/in/°F (steel); 0.000006 in/in/°F (concrete)

EL = Expansion Length (inches)
SD = Outside Pipe Sleeve Diameter

Load Factor = 1.2
Bolt Location Tolerance = 0.5 inches

DeltaS = 0.65(α)(EL)(Tmaxdesign - Tmindesign)(1.2)
Slot Length (for Expansion Bearings) = 2(DeltaS) + SD + 0.5

Anchor Bolts: Recommended Maximum Anchor Bolt size is 2.75 inches. Grade 36 or Grade 55 may be used.

Seismic Performance Category	Effectiveness of Anchor Bolts
Zone 1	100%
Zone 2	50%
Zone 3	0%