

**2006 Cable-Stayed Bridge Workshop
Wind Induced Vibration of Cable-Stayed Bridges**

FHWA / MoDOT

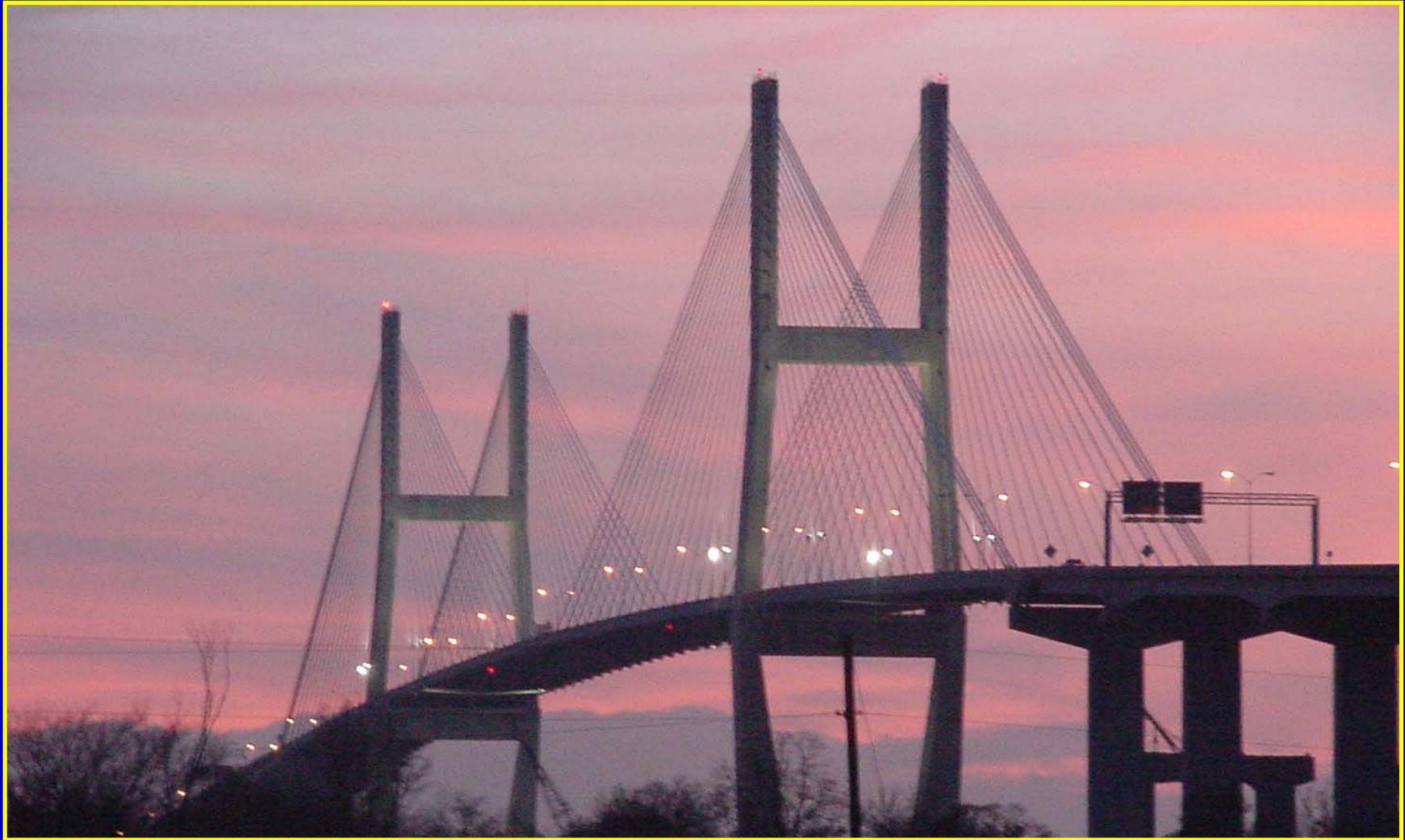
**April 26, 2006
St. Louis, Missouri**

Talmadge Memorial Bridge

**Lichtenstein Consulting Engineers, Inc.
www.LCE.us**

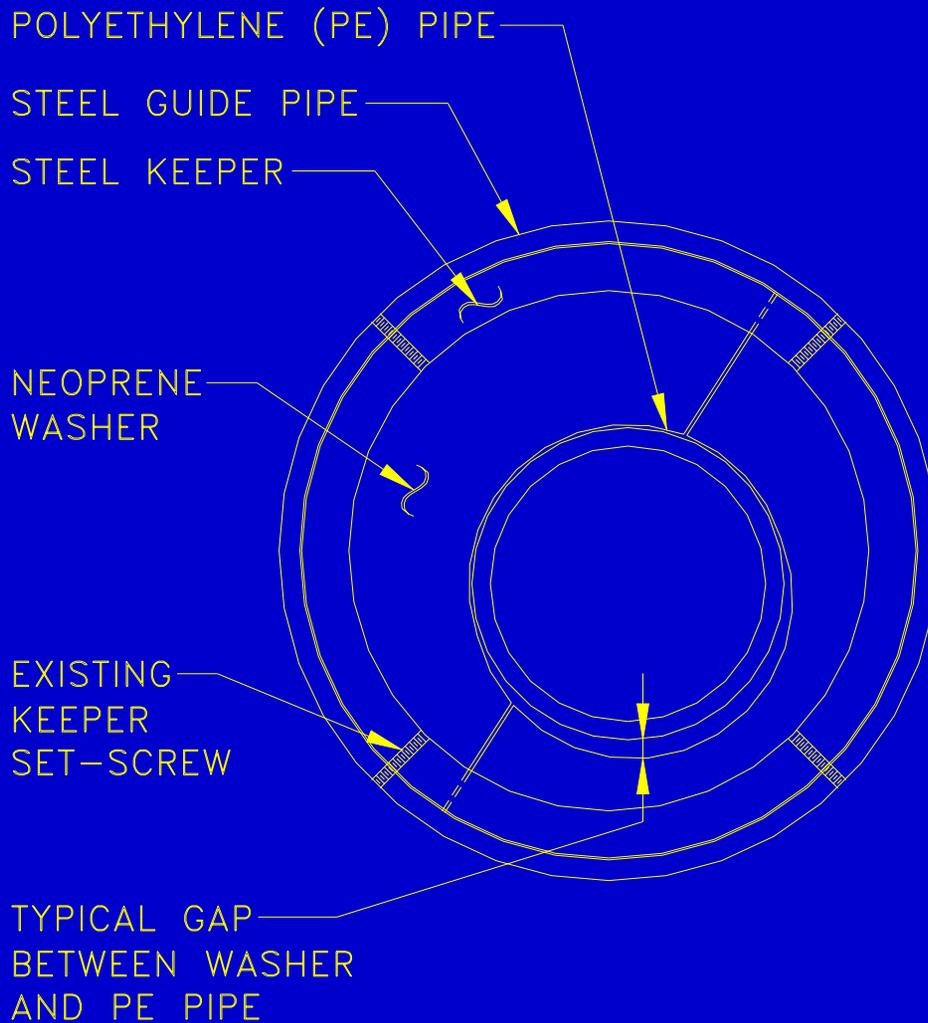


TALMADGE MEMORIAL BRIDGE



Savannah, Georgia

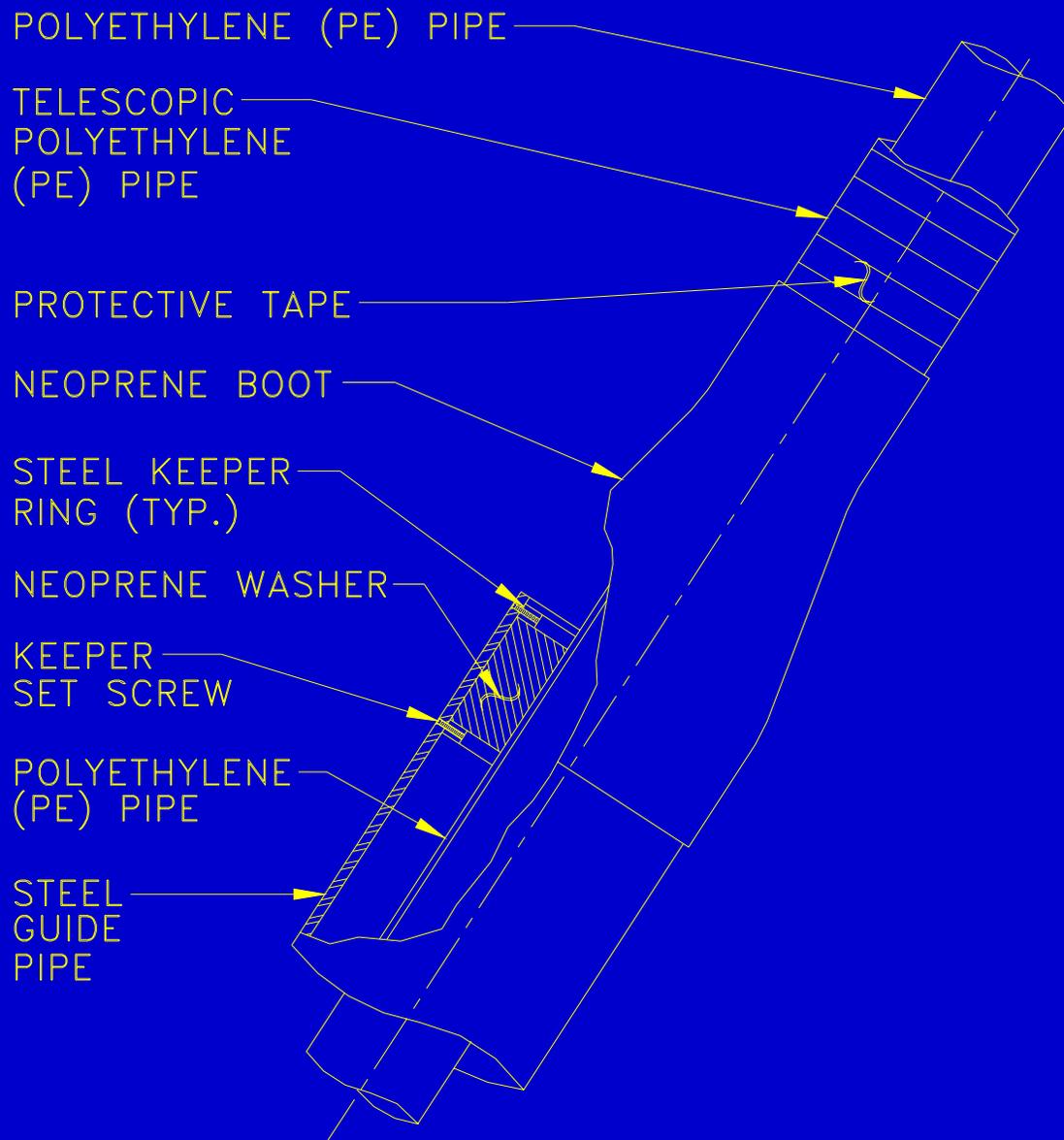
STAY CABLE SYSTEM



STEEL GUIDE PIPE FUNCTION

- Houses Washer and Keeper Ring System
- Conduit for Stay Cable

STAY CABLE SYSTEM



STEEL GUIDE PIPE CONFIGURATIONS

TALMADGE				
Guide Pipe Thickness [inch]	Guide Pipe O.D. [inch]	Guide Pipe I.D. [inch]	PE Pipe O.D. [inch]	Area Ratio
0.44	14.00	13.12	10.75	1.5
0.38	11.75	11.00	8.63	1.6
0.34	9.63	8.94	6.63	1.8
0.32	8.63	7.98	5.56	2.1
0.56	18.00	16.88	10.75	2.5
0.50	16.00	15.00	8.63	3.0
0.44	14.00	13.12	6.63	3.9
0.41	12.75	11.94	5.56	4.6

STEEL GUIDE PIPE CONDITION FINDINGS

Circumferential Crack



STEEL GUIDE PIPE CONDITION FINDINGS

Circumferential Crack



STEEL GUIDE PIPE CONDITION FINDINGS

Surrounding Concrete Cracked & Spalled



STEEL GUIDE PIPE CONDITION FINDINGS

Non-Concentric Alignment



STEEL GUIDE PIPE CONDITION FINDINGS

Hard Contact with PE Pipe



WASHER CONDITION FINDINGS

1 ⁵/₁₆" Gap Between PE Pipe and Washer



WASHER FUNCTION

- Move Fixed Point Away From Anchorage Zone
- Reduce Bending Stresses In Anchorage Zone

WASHER CONDITON FINDINGS

Gap Between PE Pipe and Washer

Gap Dimension	Talmadge Quantity
0"	3
1/4"	154
1/2"	80
3/4"	15
1"	5
1-1/4"	1
1-5/16"	1 (max)
Missing Washers	29
Total Washers	288

WASHER CONDITION FINDINGS

Dislodged



WASHER CONDITION FINDINGS

Missing



WASHER CONDITION FINDINGS

Wedged Deep in Guide Pipe



Washer

KEEPER RING CONDITION FINDINGS

Missing



(Keeper Ring Function is to Contain Washer)

KEEPER RING CONDITION FINDINGS

Dislodged

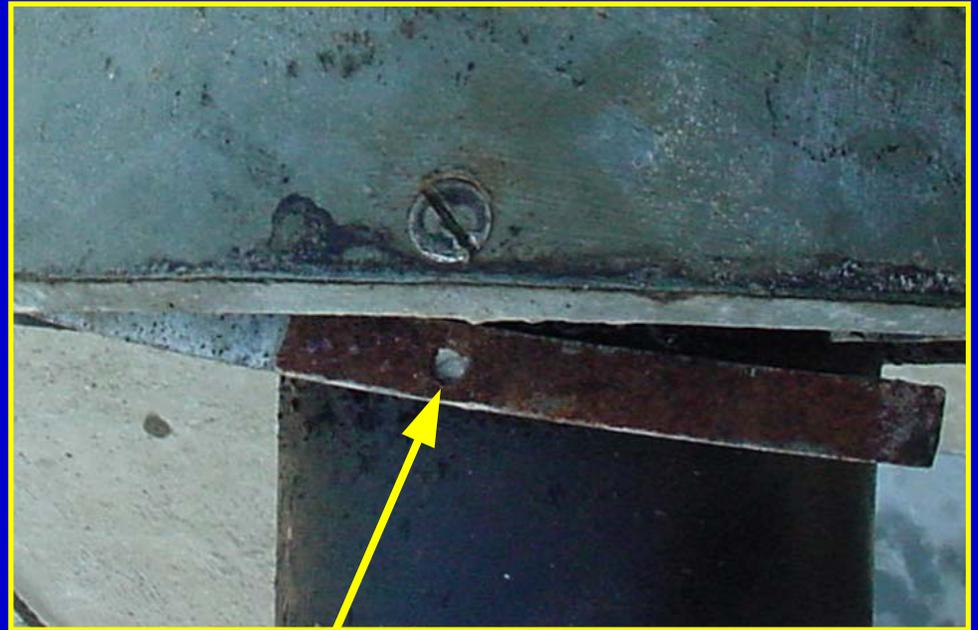


KEEPER RING CONDITION FINDINGS

Missing or Broken Set-Screws



**Missing
Set-Screw**



**Broken
Set-Screw**

PROTECTIVE BOOT CONDITION FINDINGS

Poor Fit

Longitudinally Undersized



Circumferentially Oversized



PROTECTIVE BOOT FUNCTION

- Part of Corrosion Protection System
- Prevent Water From Infiltrating Anchorage Zone

Neoprene Pad

LESSONS LEARNED – TALMADGE BRIDGE (Steel Guide Pipe)

- **FORCES**

- Applied by Washer from WL, LL, DL, etc.
- Bearing on Surrounding Concrete

- **GEOMETRIC CONSTRAINTS**

- Ratio of Guide Pipe Area to Stay Cable Area

- **“CONSTRUCTABILITY”**

- Alignment Tolerance for Concentricity
- Heat Straightening Provisions

LESSONS LEARNED – TALMADGE BRIDGE (Washer and Keeper Ring System)

- **WASHERS**
 - Full Bearing
 - Material with Good Damping Characteristics
- **KEEPER RINGS**
 - Robust and Durable Design
 - Consider Force from Washer

LESSONS LEARNED – TALMADGE BRIDGE (Protective Boots)

- **Protective Boots**
 - Waterproof
 - Accommodate Cable Vibration
 - Secure and Reusable Clamps

LESSONS LEARNED – TALMADGE BRIDGE (Damping)

- Include Provisions for In-Situ Damping Measurements
- Multiple Vibration Contingency Measures

REHABILITATION CONSIDERATIONS (Full Bearing Washer)



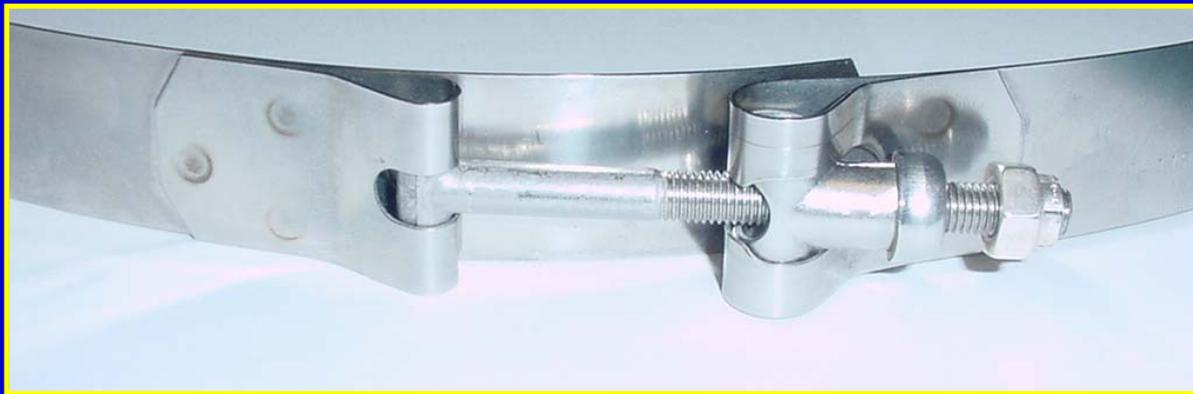
REHABILITATION CONSIDERATIONS (Durable Keeper Ring System)



REHABILITATION CONSIDERATIONS (Waterproof Protective Boot)



REHABILITATION CONSIDERATIONS (Secure and Reusable Clamps)





Lichtenstein

Consulting Engineers



The End.

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