Retrofit Measures for Superstructures, Bearings, and Seats

Presented by Richard V. Nutt

Elements to be Retrofitted

- Bridge Decks and Girders
- Bearings, Anchorages and Pedestals
- Expansion Joints
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Retrofit of Bridge Decks and Girders

- Lateral Load Path Enhancement
  - Deck to Girder Connection
  - Diaphragm Strengthening or Stiffening
  - Ductile End Diaphragms
  - Girder Strengthening
- Provide Longitudinal Continuity
  - Web and Flange Plates
  - Superstructure Joint Strengthening
- Reduction of Dead Load
- Strengthening of Continuous Superstructures
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Lateral Load Path Enhancement

- Deck to Girder Connection
- Diaphragm Strengthening or Stiffening
- Ductile End Diaphragms
- Girder Strengthening
Deck to Girder Connection

- Two rows of threaded rods at a specified pitch for the entire length of the girders.
- Drill and bond (epoxy cartridge) into existing concrete deck. Stagger as shown below.

Lateral Load Path Enhancement

- Deck to Girder Connection
- Diaphragm Strengthening or Stiffening
- Ductile End Diaphragms
- Girder Strengthening
Diaphragm Strengthening

Diaphragm Elevation

Section A-A

Section B-B

Diaphragm Strengthening Details
Lateral Load Path Enhancement

- Deck to Girder Connection
- Diaphragm Strengthening or Stiffening
- Ductile End Diaphragms
- Girder Strengthening

EBF Diaphragm Retrofit
Lateral Load Path Enhancement

- Deck to Girder Connection
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- Ductile End Diaphragms
- Girder Strengthening

Girder Bracing Retrofit
Bearing Stiffener Retrofit

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Provide Longitudinal Continuity

- Web and Flange Plates
- Superstructure Joint Strengthening

Web Splice Retrofit

Splice plate - place bolts through holes drilled in girders - use slotted holes to accommodate thermal movement

Elevation of Girders
Web Splice Details

- Splice plate
- Large offset of girder webs
- End bracing
- Small offset of girder webs
- Shim

Methods for accommodating girder misalignment

Provide Longitudinal Continuity

- Web and Flange Plates
- Superstructure Joint Strengthening
Provide Superstructure Continuity

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Strengthen Superstructure
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**Retrofit of Bearings, Anchorages and Pedestals**

- Strengthening of Existing Bearings
- Bearing Replacement
- Strengthening Superstructure to Substructure Connections
Retrofit of Bearings, Anchorages and Pedestals
- Strengthening of Existing Bearings
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Strengthening of Existing Bearings
- Fixed Bearings
  - Sole Plate to Girder
  - Bearing to Masonry Plate
  - Masonry Plate to Substructure
- Expansion Bearings
  - Sole Plate to Girder
  - Masonry Plate to Substructure
Bearing Sole Plate Connection

Vulnerable Tall Bearing (Exp)
Expansion Bearing Retrofit

After

Steel Wedge

Anchor Plate Retrofit

Flange of plate girder

New high strength bolts

Extension of anchor plate

Existing bearing

Reinforcing steel mat

Drill and bond extra anchor bolts
Masonry Plate Retrofit

Vulnerable Tall Bearing (Fixed)
Bearing Encasement Retrofit

Retrofit of Bearings, Anchorages and Pedestals

- Strengthening of Existing Bearings
- Bearing Replacement
- Strengthening Superstructure to Substructure Connections
Bearing Replacement

- Conventional Bearings
- Seismic Isolation Bearings
Bearing Replacement (Before)

Existing Bearing

Bearing Replacement (After)

New Bolt - Drilled and Grouted into Existing Concrete

Elastomeric Bearing Pad

New Concrete Pedestal

Existing Bolts to Remain

After
Bearing Replacement

- Conventional Bearings
- Seismic Isolation Bearings

Lead Rubber Bearing

[Diagram of a Lead Rubber Bearing with labels for Lead, Rubber, and Steel]
Friction Pendulum Bearing

Eradiquake Isolation Bearing
Characteristics of Typical Isolation Bearings

<table>
<thead>
<tr>
<th>Bearing Type</th>
<th>Flexible Element</th>
<th>Energy Dissipation</th>
<th>Rigidity for Service Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead-filled elastomeric bearings</td>
<td>Standard elastomeric bearing</td>
<td>Plastically deformed lead core</td>
<td>Elastic stiffness of lead core</td>
</tr>
<tr>
<td>Eradiquake bearings</td>
<td>Flat slider with low friction coefficient and uniaxial polyurethane springs</td>
<td>Friction</td>
<td>No slip until friction coefficient exceeded</td>
</tr>
<tr>
<td>Friction-pendulum bearings</td>
<td>Spherical slider with low friction coefficient</td>
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</tbody>
</table>

Note: Some of the above hardware is patented or proprietary and is only available through licensed suppliers.

Knock-off Device

Backwall Sacrificial Knock-Off Element
Expansion Joint
Bearing
Superstructure
Abutment
Friction or Settlement Slab
Retrofit of Bearings, Anchorages and Pedestals

- Strengthening of Existing Bearings
- Bearing Replacement
- Strengthening Superstructure to Substructure Connections

Pipe Shear Key

- Cast-in-place Deck and Diaphragm
- Patch Core Hole after Placing Pipe
- Polystyrene
- Pre-molded Expansion Joint Filler
- Pipe X1-strong

Section A-A
Elements to be Retrofitted

- Bridge Decks and Girders
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Retrofit of Expansion Joints

- Bearing Seat Extensions
  - Seat Extensions and Catcher Blocks
  - Pipe Extenders
- Restrainers
  - Longitudinal Joint Restrainers
  - Transverse Restrainers
  - Vertical Motion Restrainers
- Energy Dissipation Devices
- Shock Transmission Units
Bearing Seat Extensions

- Seat Extensions and Catcher Blocks
- Pipe Extenders

Abutment Seat Extender
Bearing Seat Extensions

- Seat Extensions and Catcher Blocks
- Pipe Extenders

Pipe Seat Extender

- C/L Hinge
- 900 mm
- 750 mm
- 150 mm
- Pipe 8xx-Strong
- 40 x 350 x 350 mm
Restrainers

- Longitudinal Joint Restrainers
- Transverse Restrainers
- Vertical Motion Restrainers

Caltrans Cable Restrainer

25 mm Dia stud
Face of concrete
Bearing plate
Thick steel washer
Steel spherical washer

Swaged fitting & stud
19 mm cable

Washer, nut & thread locking system, each end
Disc springs
Cable yield indicator
Cable Restrainer Hardware

- END VIEW
- PLAN

- Wall thickness
- Reduced section
- 45° bevel

SECTION A-A
CABLE YIELD INDICATOR

SECTION B-B
Front of disc
Disc gap

AS INSTALLED ON STUD
DISC SPRINGS

Multi-cable Restrainer Assembly

- Deck Access Opening with Temporary Deck Cover Plate
- Concrete Blistter
- End Anchorage

Cable Drum Unit
Cables

Bottom Access Opening with Steel Cover Plate

Note: Access may be gained from either the deck or soffit (bottom side), but not both.
Bumper Block

End Diaphragm Anchorage
Precast Girder Anchorage

Deck Anchorage

Countsink Bolt Heads Into Deck - Holes Drilled Through Deck
Anchorage in Deck
Restrainer Cable
Cored Hole
End Diaphragm
Restrainer Orientation (Rigid Supports)

Restrainer Orientation (Flexible Supports)
Restrainer at Pier

Restrainers
- Longitudinal Joint Restrainers
- Transverse Restrainers
- Vertical Motion Restrainers
**Transverse Shear Keys**

- Steel plate with welded anchor studs
- * Provide clearance at closest point between shear key and existing bearing assembly
- Bottom flange of existing girder
- Existing keeper plate
- Horizontal stirrups in both directions
- Drill and bond dowels
- Existing girder and bearing assembly
- Roughen existing surface to 1/4"

**Bearing Keeper Brackets**

- Centerline
- New high strength bolts
- Existing steel bearing
- Reinforcing mat - place @ center of pad
- Bearing plate extension - weld to existing plate
- Keeper bracket - weld to plate extension
- Leave small gap
Steel Pipe Restrainers

- Longitudinal Joint Restrainers
- Transverse Restrainers
- Vertical Motion Restrainers
Vertical Hold Down Retrofit

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