LULING BRIDGE DECK REHAB

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PRESENTATION OVERVIEW

• Bridge description
• Cracking on orthotropic steel deck
• Replacement of concrete overlay
• As-rehabbed load rating
BRIDGE DESCRIPTION
BRIDGE LOCATION

Luling Bridge
Main Spans: 2,745’ - Five Span Cable Stayed Twin Trapezoidal Box Girder Orthotropic Deck
Year Built: 1983
CRACKS ON ORTHOTROPIC STEEL DECK
STEEL DECK CRACKING

DECK PLATE

CRACK

TRANSVERSE STIFFENER

WELD

DECK PLATE

DECK RIB

TRANSVERSE STIFFENER

Typ. Crack in Deck Plate

Stiffener Weld

Web Stiffener

Section A-A
STEEL DECK CRACKING
STEEL DECK CRACKING
FINITE ELEMENT MODEL

Refined mesh at location of crack
MODELING ASSUMPTIONS

- Deck, box girders, and floorbeams are modeled using shell elements.
- Longitudinal and transverse stiffeners are included in modeling.
- Vehicles are placed in traffic lanes and tire contact area is considered.
LIVE LOAD POSITION

Interior Lane

Exterior Lane
DEFORMED MESH – LIVE LOAD

Stress Concentration
<table>
<thead>
<tr>
<th>Location</th>
<th>Truck on exterior lane</th>
<th>Truck on Interior lane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without IM</td>
<td>With IM</td>
</tr>
<tr>
<td>Exterior side</td>
<td>15.46</td>
<td>17.78</td>
</tr>
<tr>
<td>Interior side</td>
<td>2.1</td>
<td>2.42</td>
</tr>
</tbody>
</table>

\[(\Delta F)_TH = 10 \text{ ksi for Category C detail}\]
Fatigue Life = 12.2 years
Max. Stress = 2.33 ksi
SOLUTION FOR STEEL CRACKING

ORTHOTROPIC STEEL DECK PLATE, THICK. VARIES (% min.)

WORKING POINT

AREA TO BE REMOVED BY CUTTING

PORTION OF STIFFENER TO REMAIN

CUT LINE 1

CUT LINE 2

BOX GIRDER WEB PLATE

TRANSVERSE WEB STIFFENER
REPLACEMENT OF CONCRETE OVERLAY
DECK CONDITION BEFORE REHAB
DECK CONDITION BEFORE REHAB
POSSIBLE CAUSE OF CRACKING

• Thermal expansion of steel orthotropic deck
• Vibration of deck
• Thin thickness (2.5 inches)
FIBER REINFORCED CONCRETE

![Graph showing tensile load vs. deformation comparison between plain concrete and fiber reinforced concrete.]

- Tensile Load
- Deformation
- Plain concrete
- Fiber reinforced concrete
DECK OVERLAY REPLACEMENT

TYPICAL FINISHED OVERLAY SECTION
DECK OVERLAY REPLACEMENT
DECK OVERLAY REPLACEMENT
AS-REHABBED LOAD RATING
AS-REHABBED LOAD RATING
Comparison of Moment on Main Girders
FEM VS. Original Plans
# AS-REHABBED LOAD RATING

<table>
<thead>
<tr>
<th># of Lanes Loaded</th>
<th>Loaded Lanes</th>
<th>M.P.F*</th>
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<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>1.20</td>
</tr>
<tr>
<td>2</td>
<td>A,B,</td>
<td>1.00</td>
</tr>
<tr>
<td>3</td>
<td>A,B,C</td>
<td>0.85</td>
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<tr>
<td>4</td>
<td>A,B,C,D</td>
<td>0.65</td>
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<tr>
<td>5</td>
<td>A,B,C,D,E</td>
<td>0.65</td>
</tr>
<tr>
<td>6</td>
<td>A,B,C,D,E,F</td>
<td>0.65</td>
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</table>

* M.P.F: Multiple Presence Factor
<table>
<thead>
<tr>
<th>Superstructure Element</th>
<th>HL-93 (Inv.)</th>
<th>HL-93 (Opt.)</th>
<th>Legal Rating</th>
<th>Limit State</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>Cables</td>
<td>1.811</td>
<td>2.347</td>
<td>-</td>
<td>Strength-I Tension</td>
<td>Pier 3 – Cable V</td>
</tr>
<tr>
<td>Box Girders</td>
<td>1.323</td>
<td>1.716</td>
<td>-</td>
<td>Strength-I Shear</td>
<td>768.25’ @ Pier Tower 2</td>
</tr>
<tr>
<td>Cross Girders</td>
<td>1.311</td>
<td>1.699</td>
<td>-</td>
<td>Strength-I Flexure</td>
<td>17.875’</td>
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QUESTION?