Rating of Highway Bridges in Lahore - Pakistan

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Lahore

Second Largest city of Pakistan (10 M)

Founded by Prince Daud, Son of Sita and Rama
Background

- Reactive Approach of agencies in Pakistan
- Lack of Planning

- Bridge over BRB link Canal
  Poor Maintenance of Exp. Joint

- Bridge over MR link Canal
  Inadequate cover
OBJECTIVES

➢ To emphasize on Pro-Active approach for bridge evaluation and maintenance

➢ To propose an Index to determine the overall Condition of bridge
SCOPE OF WORK

To carry out the Condition Rating of the two Overhead Bridges.

Sherpao Bridge (1974)

Span = 85, PC Girders
**SCOPE OF WORK**

**Mian Meer Bridge (1974)**

*Span = 59, RC Girders*
**NBIS:**

Sufficiency Rating = $S_1 + S_2 + S_3 - S_4 < 100\%$

**NYS DOT**

Condition Rating, $R = \frac{\Sigma R_i W_i}{\Sigma W_i}$

NYS Inspectors must assign to the bridge a general recommendation integer rating between 1 and 7 independent of the condition rating.
Previous Work

- **Japan:**
  - Deficiency Rating > Demerit Rating
  
  \[ d_{II} = d_1 \times \alpha \quad \text{Subtracted from 100} \]

- **UK**
  - Bridge Condition Index

- **Surrey, UK**
  - Maintenance Priority Number
  
  \[ MPN = CF \times LF \times RF / 14 \]
**METHODOLGY**

**Step 1**
- Preliminary inspection, Development of as-built drawings, Coding of all members

**Step 1**
- Condition Rating of all members

**Step 3**
- Development of bridge Performance Index
M i a n M e e r B r i d g e

A S B U I L T C R O S S S E C T I O N
Sherpao Bridge
# Condition Ratings

**Federal Highway Administration (FHWA) Rating System**

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td><strong>Excellent</strong> No Aesthetic &amp; Structural Problem</td>
</tr>
<tr>
<td>8</td>
<td><strong>Very Good</strong> Minor Aesthetic Problem</td>
</tr>
<tr>
<td>7</td>
<td><strong>Good</strong> (Thermal/Plastic Hairline Cracks Minor Problems)</td>
</tr>
<tr>
<td>6</td>
<td><strong>Satisfactory</strong> (Structural cracks within limits, Light Scaling, Spalling, etc)</td>
</tr>
<tr>
<td>5</td>
<td><strong>Fair</strong> (Patterned structural cracks, medium Scaling)</td>
</tr>
<tr>
<td>4</td>
<td><strong>Poor</strong> (Wide Structural cracks, Heavy scaling)</td>
</tr>
<tr>
<td>3</td>
<td><strong>Serious</strong> (Severe spalling and section lost, Local failure possibility)</td>
</tr>
<tr>
<td>2</td>
<td><strong>Critical</strong> (Severe Structural loss in Primary structural element serious deterioration)</td>
</tr>
</tbody>
</table>
### Condition Evaluation Performa for Deck Slab (DS):

Deterioration of deck slab normally starts from top, therefore minor cracks at bottom of slab indicates much higher deterioration of slab and slab should be rated accordingly.

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>CAUSE</th>
<th>RIGHT C/WAY (City to Cantt)</th>
<th>LEFT C/WAY (Cantt to City)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Collision/fire damage</td>
<td>NO</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>• Deflection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Efflorescence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Internal feature with sounding</td>
<td>Sound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Spall/Scaling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Drain</td>
<td>blocked/open</td>
<td>blocked/open</td>
<td></td>
</tr>
<tr>
<td>• Rebar exposure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Flexural/Shear Cracks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Section lost</td>
<td>NO</td>
<td>NO</td>
<td></td>
</tr>
</tbody>
</table>

**Rating of Deck Slab:**
- RIGHT C/WAY: 6
- LEFT C/WAY: 5
**RAILING & BARRIER**

**Mian Meer Bridge**
- **Avg. Condition Rating** = 8
- **4’-2” High RCC Rail ing**
- **Total area inspected** = 10937 SFT
- **No cracking or tilting**
- **Deterioration** = 10 SFT

**Sherpao Bridge**
- **%age Deterioration** = 0.09%
- **Avg. Condition Rating** = 7
- **NJ Barrier, 3 ft. high**
- **2 ft. high steel pipe railing**
- **Total area inspected** = 9254 SFT
- **Deterioration** = 900 SFT
Si d e w a l k & C u r b

M i a n M e e r B r i d g e

- T u f f t i l e s h a v e n o t b e e n p r o p e r l y l e v e l e d.
- W a t e r p e n e t r a t i o n a n d s t a g n a t i o n
- D a m p n e s s a n d u n e v e n n e s s

- T O T A L A R E A I N S P E C T E D = 2 8 5 4 5 S F T
- D E T E R I O R A T E D = 3 4 8 S F T
- A v g . C o n d i t i o n R a t i n g = 6
- % A G E D E T E R I O R A T I O N = 1 . 2 %
Wearing Surface

Main Meer Bridge

- Very good riding quality of Asphalt concrete. No potholes. No patch work

  Total Area Inspected = 110242 SFT

  Avg. Condition Rating = 8

  Deep Expansion Joints

  Longitudinal Crack

  Avg. Condition Rating = 7

Sheep Bridge

- Deep Expansion Joints

  Total Area Inspected = 170875 SFT

  Deterioration = Negligible
EXPANSION JOINTS

Mian Meer Bridge

- Concealed joints
- Water penetration into the structure

Avg. Condition Rating = 6
Total Joints = 122 Nos
Deterioration = 24 Nos

Sher Pao Bridge

- Joints have been severely worn out
- Great discomfort and noise

Avg. Condition Rating = 5
Total Joints = 35 Nos
Deterioration = 30 Nos
DRAINAGE SYSTEM

**Mian Meer Bridge**
- Most critical non-structural system
- Dampeness, Concrete spall
  - Avg. Condition Rating = 5
  - Total Joints = 236 Nos
  - Deterioration = 60 Nos

**Sher-Pao Bridge**
- Severe dampness in arch rings
- Debris and water stagnation due to clogging
  - Total Joints = 163 Nos
  - Deterioration = 40 Nos
  - Avg. Condition Rating = 5
DECK SLAB

MIAN MEER BRIDGE

- Oxidation of reinforcement due to severe dampness
- Span 6 on Right C/Way is most critical
- Total Area inspected = 138786 Sft
- Worst Condition Rating is = 4

POOR DRAINAGE is main cause of efflorescence in deck slab

- Total Area inspected = 180792 Sft
- Deteriorated = 3615 Sft (0.2%)
Girders

Mian Meer Bridge

RCC T-Beam

- RCC beams are in good condition, No Cracking
- Avg. Condition Rating = 7

Post-Tensioned Beam

- Railway Span Girders are in good condition
- Broken Cover in Ext. Girder
- Avg. Condition
GIRDERS
SHER-PAO BRIDGE

RCC GIRDERS
- Girders are in good condition
- Avg. Condition Rating = 7

PRE-STRESSED GIRDERS
- Cover Intact
- No cracking, no Spalling
- Avg. Condition Rating = 7
**Bearings System & Pier Cap**

**Mian Meer Bridge**
- Bearings have been jammed
- Concrete has bursted
- Total Nos inspected = 1920 Nos
- Avg. Condition Rating = 5

**Sher-Pao Bridge**
- Neoprene Pads for PT Girders
- Steel Sliding Plate Bearing Pads for RCC Girders
- Total Area inspected = 166 Nos
- Deteriorated = Negligible
- Avg. Condition Rating = 7
PIERS

MIAN MEER BRIDGE

- Rectangular Piers in good condition. Moderate Scaling in piers of railway spans.
- Total Area inspected = 2,600 SFT
- Avg. condition Rating = 7

SHER-PAP BRIDGE

- Rectangular Pier of 5 ft x 5 ft
- Some Arch piers have collision marks
- Total Area inspected = 10,113 SFT
- Deteriorated = 10,100 SFT (1%)
- Avg. condition Rating = 7
BRIDGE PERFORMANCE INDEX (BPI)

An index from 0 - 10, designed to indicate the overall condition and performance of the bridges based on:

+ Structural
+ Non-Structural
+ Geometrical and Safety features of the bridge.
+ It is sum of weighted number assigned to various bridge elements.
<table>
<thead>
<tr>
<th>Description</th>
<th>Element</th>
<th>Importance</th>
<th>Mian Meer Weighted Number</th>
<th>Sherpao Weighted Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structural</strong></td>
<td>Girders + Diaphragm</td>
<td>15%</td>
<td>1.17</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>Deck + Wearing</td>
<td>5%</td>
<td>0.4</td>
<td>0.35</td>
</tr>
<tr>
<td></td>
<td>Bearings</td>
<td>10%</td>
<td>0.5</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>Pier Cap</td>
<td>10%</td>
<td>0.55</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>Piers + Foundation</td>
<td>10%</td>
<td>0.75</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Drainage</td>
<td>10%</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Non-Structural</strong></td>
<td>Exp. Joint</td>
<td>10%</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Misc (Pole tilting, etc)</td>
<td>5%</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Traffic Capacity</td>
<td>10%</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>Geometry/Shape</td>
<td>10%</td>
<td>0.8</td>
<td>0.75</td>
</tr>
</tbody>
</table>
Bridge Performance Index for Manc E Index

- **BPI > 7**, Bridge is in Very Good Condition, Satisfying Present Need of Commuters.

- **BPI > 5**, Bridge is in Fair Condition, Requiring Minor Repair

- **BPI < 3**, Bridge is in Critical Condition, requiring Urgent Rehabilitation. Should be closed for Service
Conclusions

- Improper functioning of expansion joints, bearing system and drainage system are the primary contributors of the bridge deterioration.

- A bridge component which is not visible is generally ignored by the maintenance agencies e.g. bearing systems. Most of the maintenance and repair funds are utilized on cosmetics. Very limited awareness of Bridge Rating exists at present in the country.

- Bridge performance index (BPI) can serve as an effective tool to evaluate the overall condition of the bridges. Compared to
THANK YOU!