Bridges in Indonesia: Present and Future

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International Forum,
JSCE Century Anniversary
Tokyo – Japan, 2014

Outline

• Introduction
• Database of Bridges in Indonesia
• Standards, Norms, Manuals and Guidelines
• Current Inspection and Maintenance Strategies
• Future Developments
• Closure
INTRODUCTION

• Indonesia is an archipelago country, consisting of 17,508 islands. The total area of Indonesia is 1,904,569 square meter, of which 80% is water. A wide and long rivers characterize some of the islands in Indonesia.

• Because of those characteristics, the need for bridges is high in Indonesia in order to achieve connectivity between centers of economy.

• This need is relevant with MP3EI program (with an objective to improve connectivity among centers of economy in Indonesia).
DATABASE OF BRIDGES IN INDONESIA

Bridges in Indonesia

Total 93,000 bridges (1138 km) in Indonesia, comprising of:
- 72,000 bridges (734 km) → a part of provincial roads & regency/city roads
- 21,000 bridges (404 km) → a part of national roads

1. Bridge Span/Length (National roads)

<table>
<thead>
<tr>
<th>Span (m)</th>
<th>Length (m)</th>
<th>%</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 - 20</td>
<td>124,376</td>
<td>31</td>
<td>36,759</td>
<td>73.7</td>
</tr>
<tr>
<td>20 - 40</td>
<td>87,391</td>
<td>21</td>
<td>3,366</td>
<td>15.7</td>
</tr>
<tr>
<td>40 - 60</td>
<td>48,234</td>
<td>12</td>
<td>1,041</td>
<td>4.9</td>
</tr>
<tr>
<td>60 - 100</td>
<td>47,051</td>
<td>12</td>
<td>658</td>
<td>3.1</td>
</tr>
<tr>
<td>&gt; 100</td>
<td>96,783</td>
<td>24</td>
<td>547</td>
<td>2.6</td>
</tr>
</tbody>
</table>

2. Superstructure Types (National roads)

- Concrete girder (123 km, 75 %)
- Steel girder (41 km, 25 %)
Special Bridges

A. Continuous Concrete Box Girder

<table>
<thead>
<tr>
<th>No</th>
<th>Bridge Name</th>
<th>Total Span (m)</th>
<th>Main-Span (m)</th>
<th>Year of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rantau Berangin, Riau</td>
<td>200</td>
<td>121</td>
<td>1972-1974</td>
</tr>
<tr>
<td>2</td>
<td>Rajamandala, Jabar</td>
<td>222</td>
<td>132</td>
<td>1972-1979</td>
</tr>
<tr>
<td>3</td>
<td>Serayu Kesughian, Jateng</td>
<td>274</td>
<td>128</td>
<td>1978-1985</td>
</tr>
<tr>
<td>4</td>
<td>Mojokerto, Jatim</td>
<td>230</td>
<td>62</td>
<td>1975-1977</td>
</tr>
<tr>
<td>5</td>
<td>Arakundo, Aceh</td>
<td>210</td>
<td>95</td>
<td>1987-1990</td>
</tr>
<tr>
<td>6</td>
<td>Tonton Nipah, Batam</td>
<td>420</td>
<td>160</td>
<td>1995-1998</td>
</tr>
<tr>
<td>7</td>
<td>Setok-Rembang, Batam</td>
<td>365</td>
<td>145</td>
<td>1994-1997</td>
</tr>
<tr>
<td>8</td>
<td>Siti Nurbaya, Sumbar</td>
<td>156</td>
<td>76</td>
<td>1995-2002</td>
</tr>
<tr>
<td>9</td>
<td>Tukat Bangkung, Bali</td>
<td>240</td>
<td>120</td>
<td>2006</td>
</tr>
<tr>
<td>10</td>
<td>Air Teluk II, Sumsel</td>
<td>208</td>
<td>104</td>
<td>2006</td>
</tr>
<tr>
<td>11</td>
<td>Perawang, Riau</td>
<td>1473</td>
<td>180</td>
<td>2007</td>
</tr>
</tbody>
</table>

Continuous Concrete Box Girder

Rajamandala Bridge

West Java, 1979

Main span 132 meter dan side span (simetry) 45 meter (Total span 222 meter).
Continuous Concrete Box Girder

Teluk Efil Bridge

Sekayu, Sumatera Selatan,
Concrete Box Girder, Balanced Cantilever
Total Span 52 + 104 + 52 meter

Special Bridges

B. Continuous Steel Bridges

<table>
<thead>
<tr>
<th>No</th>
<th>Bridge Name</th>
<th>Total Span (m)</th>
<th>Main-Span (m)</th>
<th>Year of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ampera, Sumsel</td>
<td>354</td>
<td>75</td>
<td>1962-1965</td>
</tr>
<tr>
<td>2</td>
<td>Danau Bingkuang, Riau</td>
<td>200</td>
<td>120</td>
<td>1968-1970</td>
</tr>
<tr>
<td>3</td>
<td>Siak I, Riau</td>
<td>350</td>
<td>52</td>
<td>1975-1977</td>
</tr>
<tr>
<td>4</td>
<td>Kapuas Timpah</td>
<td>255</td>
<td>105</td>
<td>2010</td>
</tr>
</tbody>
</table>

C. Concrete Arch Bridges

<table>
<thead>
<tr>
<th>No</th>
<th>Bridge Name</th>
<th>Total Span (m)</th>
<th>Main-Span (m)</th>
<th>Year of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rempang-Galang, Batam</td>
<td>385</td>
<td>245</td>
<td>1995-1998</td>
</tr>
<tr>
<td>2</td>
<td>Serayu Cindaga, Jateng</td>
<td>150</td>
<td>90</td>
<td>1996</td>
</tr>
<tr>
<td>3</td>
<td>Besok Koboan Jatim</td>
<td>125</td>
<td>89</td>
<td>2000</td>
</tr>
<tr>
<td>4</td>
<td>Bajalmat, Jatim</td>
<td>90</td>
<td>60</td>
<td>2007</td>
</tr>
<tr>
<td>5</td>
<td>Karebke</td>
<td>60</td>
<td>60</td>
<td>1998</td>
</tr>
<tr>
<td>6</td>
<td>Pangkep</td>
<td>84</td>
<td>60</td>
<td>2006</td>
</tr>
</tbody>
</table>
Continuous Steel Bridge

Ampersa

Palembang, South Sumatra, 1962-1965
Main Span 75 m (Classical Continuous Steel Girder Bridge)
Total Span = 354 meter

Concrete Arch Bridge

Besok Koboan Bridge

Lumajang, Jawa Timur, 2000
Main Span 80 meter, Total Span 125 meter
Concrete Arch Bridge

Bajulmati Bridge
Malang, Jawa Timur
Single Plane Concrete Arch
Span 15 + 60 + 15 meter

Serayu Cindaga Bridge
Jawa Tengah, 1979
Double Plane Concrete Arch Bridge,
Main Span 90 meter.

Concrete Arch Bridge

Kelok 9 Bridge
Bukit Tinggi, Sumatera Barat,
Concrete Arch Bridge,
Main Span 80 meter.
### Special Bridges

#### D. Steel Arch Bridge

<table>
<thead>
<tr>
<th>No</th>
<th>Bridge Name</th>
<th>Total Span (m)</th>
<th>Main-Span (m)</th>
<th>Year of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kahayan, Kalteng</td>
<td>150</td>
<td>150</td>
<td>1995-2000</td>
</tr>
<tr>
<td>2</td>
<td>Martadipura, Kaltim</td>
<td>560</td>
<td>200</td>
<td>2004</td>
</tr>
<tr>
<td>3</td>
<td>Rumbai Jaya, Riau</td>
<td>150</td>
<td>150</td>
<td>2002</td>
</tr>
<tr>
<td>4</td>
<td>Rumpiang, Kaltim</td>
<td>754</td>
<td>200</td>
<td>2008</td>
</tr>
<tr>
<td>5</td>
<td>Batang Hari II</td>
<td>804</td>
<td>150</td>
<td>2009</td>
</tr>
<tr>
<td>6</td>
<td>Slak III, Riau</td>
<td>520</td>
<td>15+120+15</td>
<td>2011</td>
</tr>
<tr>
<td>7</td>
<td>Teuk Mesjid, Riau</td>
<td>1500</td>
<td>90+250+90</td>
<td>20012</td>
</tr>
<tr>
<td>8</td>
<td>Malo</td>
<td>178</td>
<td>128</td>
<td>2007</td>
</tr>
<tr>
<td>9</td>
<td>Ogan Pelengkung</td>
<td>100</td>
<td>100</td>
<td>2008</td>
</tr>
<tr>
<td>10</td>
<td>Kahayan Hulu</td>
<td>640</td>
<td>150</td>
<td>1995-2000</td>
</tr>
<tr>
<td>11</td>
<td>Bento Hulu, Kalteng</td>
<td>561</td>
<td>150</td>
<td>2004</td>
</tr>
<tr>
<td>12</td>
<td>Mahulu, Kaltim</td>
<td>800</td>
<td>200</td>
<td>2003</td>
</tr>
<tr>
<td>13</td>
<td>Palu IV, Sulteng</td>
<td>300</td>
<td>125</td>
<td>2006</td>
</tr>
<tr>
<td>14</td>
<td>Pela, Kaltim</td>
<td>420</td>
<td>150</td>
<td>2010</td>
</tr>
<tr>
<td>15</td>
<td>Sei Tayan, Kalsar</td>
<td>1420</td>
<td>75+200+75</td>
<td>On Going</td>
</tr>
</tbody>
</table>

### Steel Arch Bridge

#### Kahayan Bridge

- **Location:** Palangkaraya, Kalimantan Tengah, 2000
- **Type:** Main Span Arch Steel Box
- **Details:** Span 150 meter, Total Span 635 meter
Steel Arch Bridge

Martadipura Bridge

Kotabangun, Kalimantan Timur, 2004
Main Span Steel Truss Arch Bridge
Span 200 meter, Total Span 560 meter

Rumbai Jaya Bridge

Teluk Masjid Bridge

Riau, 2002
Main Span 150 meter and Total Span 450 meter

Siak Indrapura, Riau
Continuous Steel Arch Bridge
(90+250+90m), Total Span 1500 m
### Special Bridges

#### E. Cable-Stayed Bridge

<table>
<thead>
<tr>
<th>No</th>
<th>Bridge Name</th>
<th>Total Span (m)</th>
<th>Main-Span (m)</th>
<th>Year of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Batam-Tonton, Batam</td>
<td>350</td>
<td>1998</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Pasopati, Bandung</td>
<td>106</td>
<td>2005</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Siak Indrapura, Riau</td>
<td>200</td>
<td>2007</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Grand Wisata Overpass</td>
<td>81</td>
<td>2007</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Suramadu, Jatim</td>
<td>434</td>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Siak IV, Riau</td>
<td>156</td>
<td>On going</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Galalapoka</td>
<td>150</td>
<td>On going</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Melak</td>
<td>340</td>
<td>On going</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Sukuara, Menado</td>
<td>110</td>
<td>On going</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Mahkota II, Kaltim</td>
<td>370</td>
<td>On going</td>
<td></td>
</tr>
</tbody>
</table>

Bridge Span (147 + 350 + 147 meter) = 664 meter.

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**Batam-Tonton Bridge**

*Batam, Kepulauan Riau, 1998*

Bridge Span (147 + 350 + 147 meter) = 664 meter.
Special Bridges

F. Suspension Bridges

<table>
<thead>
<tr>
<th>No</th>
<th>Bridge Name</th>
<th>Total Span (m)</th>
<th>Main-Span (m)</th>
<th>Year of Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Membramo, Irian Jaya</td>
<td>Suspension</td>
<td>235</td>
<td>1994</td>
</tr>
<tr>
<td>2</td>
<td>Barito, Kalsel</td>
<td>Suspension</td>
<td>240</td>
<td>1995</td>
</tr>
<tr>
<td>3</td>
<td>Mahakam II, Kaltim</td>
<td>Suspension</td>
<td>270</td>
<td>2001</td>
</tr>
</tbody>
</table>

Suspension Bridge

Jembatan Barito

Banjarmasin, Kalimantan Selatan, 1996
Main Span (Twin Suspension Bridge)
2 x (90 + 240 + 90), Total Span 1080 meter
STANDARDS, NORMS, MANUALS AND GUIDELINES

Norms, Standard, Guideline & Manual
(Design Standards)
Norms, Standard, Guideline & Manual
(Guideline for Routine and Periodical Maintenance)

PEDOMAN
Konstruksi Dan Bangunan

Pedoman Pemeliharaan Rutin Jembatan

KEMENTERIAN PEKERJAAN UMUM
DIREKTORAT JENDERAL BINA MARGA

Norms, Standard, Guideline & Manual
(Manual for Maintenance of Special Bridges)

MANUAL
Pemeliharaan Jembatan Box Girder Bridge

KEMENTERIAN PEKERJAAN UMUM
DIREKTORAT JENDERAL BINA MARGA

MANUAL
Pemeliharaan Jembatan Steel Box Bridge

KEMENTERIAN PEKERJAAN UMUM
DIREKTORAT JENDERAL BINA MARGA

MANUAL
Pemeliharaan Jembatan Cable Stayed

KEMENTERIAN PEKERJAAN UMUM
DIREKTORAT JENDERAL BINA MARGA
CURRENT INSPECTION AND MAINTENANCE STRATEGIES

Current Condition of Bridges Construction in Indonesia

Some bridges have a sub-standard performances due to improper design, construction and operational/maintenance

Why?
The Collapse of Kukar Bridge

(Ref: H. Vaza dan I. Suhendra, 2002)
Problems of SIAK 3 Bridge

Deformation Problems in SIAK 3 Bridge
### Problems

#### Complex Bridges with span ≥ 150 m

1. Lack of human resources development.
2. Lack of coordination between units.

#### Standard Bridges with span between 100 - 150 m

1. Lack of human resources development.
2. Lack of coordination between units.
3. Lack of knowledge on construction technology.

#### Organization of Bridge Safety Committee

**BRIDGE SAFETY COMMITTEE**

- **Chairman**
- **Secretary**
- **Expert Panel**
- **Member**

**BRIDGE SAFETY UNIT**

- **Chairman**
- **Expert Panel**
- **Member**
Bridge construction in Indonesia is managed through Bridge Management System (BMS), and it comprises of planning/programming, feasibility study, design, construction, operation and maintenance.
# Bridges Condition Inspection Procedure

**BMS 1992**

<table>
<thead>
<tr>
<th>Parameter Evaluation</th>
<th>Criteria</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>S (structure)</td>
<td>Are the defects harmful or otherwise?</td>
<td>0, 1</td>
</tr>
<tr>
<td>R (rating)</td>
<td>What is the level of defect, severe or mild?</td>
<td>0, 1</td>
</tr>
<tr>
<td>K (quantity)</td>
<td>Is the defect extensive (widespread) or localized?</td>
<td>0, 1</td>
</tr>
<tr>
<td>F (function)</td>
<td>Do these elements still function?</td>
<td>0, 1</td>
</tr>
<tr>
<td>P (effect)</td>
<td>Whether the defects seriously affect other elements or traffic flow?</td>
<td>0, 1</td>
</tr>
</tbody>
</table>

Bridge Rating: \( Br = S + R + K + F + P \)  

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>S (structure)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>R (rating)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>K (quantity)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>F (function)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>P (effect)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Bridge Rating: Br = S + R + K + F + P</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

## Category of Performance

Each bridge element is individually assessed with the same evaluation parameters up to the highest hierarchy element of the bridge as a whole unit. The elements of conditions assessment system can be described as follows:

1. Elements/bridges in good condition and without damage
2. Elements/bridges suffered minor damage, only require routine maintenance
3. Elements/bridges damage that requires monitoring or periodic maintenance
4. Elements/bridges damage that requires immediate action
5. Elements/bridges in critical condition
6. Elements/bridges is not functioning or collapse
Problems During Inspection

1) Lack of understanding of the inspector on bridge elements (elements name, function, etc.)
2) Lack of understanding on type of damages (types, causes, and impacts)
3) Lack of experience in using BMS’92 guidelines.
4) Lack of accuracy of the inspector in finding damages to the bridge elements.
5) Method of bridge inspection does not comply with the guidelines.
6) No access for inspector and bridge inspection tools to the sites.

FUTURE DEVELOPMENT
FUTURE DEVELOPMENT

- Many bridges, including special bridges, are still needed to bridge rivers, valleys in Indonesia

- With the autonomous system adopted in the local government, the demand for new bridges construction to connect isolated area is increasing the last ten years

- Because of that, in near future, Indonesia is going to have increasing numbers of long-span bridges

SEI TAYAN BRIDGE

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Bridge Type</th>
<th>Bridge Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 A</td>
<td>Steel Girder Composite</td>
<td>180 m (3 @ 60m)</td>
</tr>
<tr>
<td>2 B</td>
<td>Continuous Steel Girder Composite</td>
<td>600 m (4 @ 150m - 150m)</td>
</tr>
<tr>
<td>2 C</td>
<td>Continuous Steel Arch</td>
<td>225 m (75m - 225m - 75m)</td>
</tr>
<tr>
<td>2 D</td>
<td>Prestressed</td>
<td>150 m (5 @ 30m)</td>
</tr>
</tbody>
</table>

MAIN SPAN = 200.00 m
SIDE SPAN = 75000

APPROACH SPAN = 492101

M A R S C H 6000
MUSI II BRIDGE

Main Bridge Span:
Steel Arch Rib 60 m + 60 m + 100 m + 60 m + 60 m

NGARAI SIANOK BRIDGE

- Bridge Type: Concrete Cable-Stayed Bridge (4 Pylons)
- Construction Method:
  - Central Span: FCM Method using F/T
  - Side Span: FSM Method using temporary bent
- Span Composition: 87.5 m + 3 × 170.0 m + 87.5 m = 685.0 m
- Width: B = 24.0 m (4 Lanes – 2way)
OTHER DEVELOPMENT

• The desire to connect big islands in Indonesia, such as between Sumatera and Java Islands

• This is relevant with MP3EI program (to improve connectivity among centers of economy in Indonesia)

• The first interisland connectivity has been constructed in 2009, i.e. Java and Madura Bridges

• The next one will be the Sunda strait bridges, connecting Sumatera and Java Islands

Cable-Stayed Bridge
The First Interisland Bridge Connecting Java & Madura Islands

Suramadu Bridge

Surabaya, Jawa Timur
Main Span (Cable-Stayed Bridge)
192 + 434 + 192 meter, Total Span 5400 meter
SUNDA STRAIT BRIDGES

Wangsadinata Trace, 2009
Proposed Trace, 2011 (Binamarga)

Main bridge span: 5000 m
Tension height: 250 m
Deck width: 35 m
Deck height: 5 m
Prompt load: 200 kN/m

SUNDA STRAIT BRIDGES

Main bridge span: 5000 m
Hanger interval: 200 m
Hanger: 205 m
Suspension: 136 m
Stay cable: 126 m
Stay cabling: 126 m
There are still many things to be done to prepare our construction industries in designing, constructing and maintaining bridges.

We need to compile best practices from all over the world regarding designing, constructing and maintaining the special types of bridges.

We know that many other countries have progressed far ahead of us in the state of the art of bridge constructions and maintenance.

Networking with other countries that have more experiences and knowledge has to be established.
THANKYOU