Road Maintenance in Japan: Problems and Solutions
The total road length in Japan is ca. 1.21 million km. Municipal roads account for 80% of total length.

【Road types and their percentages in Japan】

<table>
<thead>
<tr>
<th>Road Type</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expressway</td>
<td>ca. 8000km</td>
</tr>
<tr>
<td>National Highway under jurisdiction of MLIT</td>
<td>ca. 20,000km</td>
</tr>
<tr>
<td>National Highway under jurisdiction of Pref.</td>
<td>ca. 30,000km</td>
</tr>
<tr>
<td>Prefectural Road</td>
<td>ca. 130,000km</td>
</tr>
<tr>
<td>Municipal Roads</td>
<td>ca. 1.02 million km</td>
</tr>
</tbody>
</table>

Total: ca. 1.21 million km
Ca. 70% of total 700,000 bridges are on municipal roads.

Number of bridges by road type:

- Municipal Roads: ca. 520,000 (ca. 75%)
- Expressway: ca. 14,000 bridges (ca. 2%)
- National Highways u. jurisdiction of MLIT: ca. 30,000 (ca. 4%)
- National Highways u. jurisdiction of Pref.: ca. 30,000 (ca. 4%)
- Pref. Roads: ca. 1,000,000 (ca. 15%)
There are ca. 700,000 bridges in Japan. The percentage of bridges that are 50 years old from date of construction increases to 43% within 10 years.
Traffic restrictions on municipality administration bridges have increased more than 2 times in the last 5 years.

Traffic restrictions on municipality administration bridges (longer than 2m)

<table>
<thead>
<tr>
<th>Year</th>
<th>Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>H20</td>
<td>977</td>
</tr>
<tr>
<td>H21</td>
<td>1,000</td>
</tr>
<tr>
<td>H22</td>
<td>1,500</td>
</tr>
<tr>
<td>H23</td>
<td>1,500</td>
</tr>
<tr>
<td>H24</td>
<td>2,000</td>
</tr>
<tr>
<td>H25</td>
<td>2,104</td>
</tr>
</tbody>
</table>

More than doubled
Example of Severe Damage

Deformation due to aging has become obvious in some parts of the structures, especially in those that are constructed rapidly or that are located in severe environments.

Miharashi-bridge (Shin Yamashita, municipal road 8, Central-ward, Yokohama City) Damage is detected 37 years after construction.
Example of Bridge Life Extension

This bridge has been functioning more than 80 years without major damage due to proper repairs and enhancements.

- **Saigawa-Ohashi (National Highway 157, Kanazawa City)**
  Opened in 1924
80% of the Manuals on Bridge Inspection developed by municipalities stipulated visual checks from a distance as an appropriate inspection method, but the quality of that inspection can be problematic.

Method of Inspection stipulated in their manuals on bridge inspection:

- Visual check from a distance: 76% (135)
- Close visual check for all elements: 22% (38)

Municipalities: 173
Necessity of Close Visual Checking

- Examples of blind spots
- Loosen/detached bolts

Risk of overlooking does exist

Detachment of high-strength bolt

Loosening of anchor bolt at shoe
Ceiling Panel Collapse in the SASAGOG Tunnel

- December 2, 2012
- Tunnel opened: 1977 (35 years old)
- Daily Traffic Volume: 40,576 (both directions, as of 2010)
- 3 vehicles involved, 9 dead, 2 injured
- Dec. 29: Re-opened a single-lane in each direction
- Feb. 8, 2013: Fully re-opened
Urgent and Concentrated Inspection

Urgent inspections were implemented, and confirmed the minimum safety necessary to prevent damage to a third party.

【Urgent Inspections】
Equipment within the tunnels (jet fan, lighting, sign)

【Concentrated Inspections】
Bridges and tunnels on major arterial highways

Inspection of tunnel equipment  Bridge Inspection
“America in Ruins” in the 1980s

In June 1981, cables on the aging Brooklyn Bridge broke and a pedestrian was hit, killing him.

- On the afternoon of June 28th, 1981, two cables (length: 180cm, diameter: 5cm) on the Brooklyn Bridge broke.
- One of the cables made holes in the walkway and the other cable hit a pedestrian.
- It was the first fatal pedestrian accident in the 100 years of the Brooklyn Bridge’s history.
A number of U.S. bridges started deteriorating in the 1980s, 30 years earlier than bridges in Japan.

Many of the bridges are expected to show signs of deterioration in the 1980s.

30 years behind U.S.

Many of the bridges are expected to show signs of deterioration in the 2010s.
Spending on national highways has reduced by 30% in the last 10 years. Although spending on maintenance and repairs should have increased, it has been reduced by 20%.

Spending on National Highways and their maintenance and repairs
(trillion JPY)

<table>
<thead>
<tr>
<th>Year</th>
<th>Reconstruction</th>
<th>Maintenance/repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>2 trillion JPY</td>
<td>320 billion JPY</td>
</tr>
<tr>
<td>2005</td>
<td>1.6 trillion JPY</td>
<td>250 billion JPY</td>
</tr>
<tr>
<td>2006</td>
<td>1.4 trillion JPY</td>
<td>200 billion JPY</td>
</tr>
<tr>
<td>2007</td>
<td>1.1 trillion JPY</td>
<td>150 billion JPY</td>
</tr>
<tr>
<td>2008</td>
<td>1 trillion JPY</td>
<td>100 billion JPY</td>
</tr>
<tr>
<td>2009</td>
<td>0.8 trillion JPY</td>
<td>75 billion JPY</td>
</tr>
<tr>
<td>2010</td>
<td>0.7 trillion JPY</td>
<td>60 billion JPY</td>
</tr>
<tr>
<td>2011</td>
<td>0.6 trillion JPY</td>
<td>45 billion JPY</td>
</tr>
<tr>
<td>2012</td>
<td>0.5 trillion JPY</td>
<td>30 billion JPY</td>
</tr>
<tr>
<td>2013</td>
<td>0.4 trillion JPY</td>
<td>20 billion JPY</td>
</tr>
</tbody>
</table>

30% reduction

20% reduction
50% of all towns and 70% of all villages in the country have no civil engineering technicians for bridge maintenance in their workforce.

Number of bridge maintenance engineers in the workforce of three types of municipal governments:

- **City & Ward**
  - 0 (14%) 0
  - 1~5 (55%) 1~5
  - 6~ (31%) 6~
  - Total: 391

- **Town**
  - 0 (46%) 0
  - 1~5 (52%) 1~5
  - 6~ (2%) 6~
  - Total: 367

- **Village**
  - 0 (70%) 0
  - 1~5 (30%) 1~5
  - 6~ (0%) 6~
  - Total: 90
Current Status of Road Structures

- 500,000 out of 700,000 bridges are maintained by municipalities.
- Deterioration of some bridges is already surfacing.
- The number of municipal bridges that have traffic restrictions has doubled in the last 5 years.
Aging Problem

Maintenance/repair spending for National Highways has reduced **by 20% in the last 10 years.**

50% of towns and 70% of villages have **no civil engineering technicians for bridge maintenance** in their workforce.

**Some municipal inspections include distant visual inspection that can prove problematic.**
Directions Ahead

Facilitate maintenance of municipal roads by focusing on the following 2 components:

1) Establish a maintenance cycle (clear responsibility for administrators)

Each road administrator takes charge of the whole maintenance cycle.

- Inspection
- Evaluation
- Action
- Record

2) Establish a mechanism to facilitate the maintenance cycle (support)

Establish a mechanism to facilitate the maintenance cycle in a sustainable way.

- Budget
- System
- Skill
- Public Acceptance/support
Implementation of Ministerial Ordinance and Public Notice and Notification of Inspection Guideline (Clear statement of responsibilities for road administrators)

[Inspection] Implement, once-every-five-years, a close visual inspection of all bridges and tunnels, according to the uniform national standard.

An excerpt from the Ordinance for Enforcement of Road Act (promulgated on Mar 31, 2014 and enacted on July 1)

(Technical standards for road maintenance and repair)
Basically, a close visual inspection shall be carried out once every five years.

Evaluation of structure conditions across the nation using a uniform standard.

The ministerial ordinance and notice for classification of tunnel conditions (promulgated on Mar 31, 2014 and enacted on July 1, 2014.)

Tunnel evaluation results shall be classified into the following categories according to their conditions:

<table>
<thead>
<tr>
<th>Category</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>No structural deficiency</td>
</tr>
<tr>
<td>II</td>
<td>Preventive maintenance</td>
</tr>
<tr>
<td></td>
<td>Preventive maintenance is desirable, although no structural deficiency is found.</td>
</tr>
<tr>
<td>III</td>
<td>Early rehabilitation</td>
</tr>
<tr>
<td></td>
<td>The structure needs early rehabilitation, or it can become deficient</td>
</tr>
<tr>
<td>IV</td>
<td>Emergency rehabilitation</td>
</tr>
<tr>
<td></td>
<td>The structure needs emergency rehabilitation, because it is deficient or it will most likely become deficient.</td>
</tr>
</tbody>
</table>
MLIT has developed a periodic inspection guideline containing types of bridge deformations to be looking for and case examples to technically assist municipalities in carrying out their inspections.

### Damage on concrete parts

#### 4. Cracking

<table>
<thead>
<tr>
<th>Damage Category</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV</td>
<td>Main girder has prominent cracks near the fulcrum, which substantially deteriorates the supporting capability of the girder.</td>
</tr>
<tr>
<td></td>
<td>Main parts have a significant number of cracks, showing the possibility of a fracture inside steel.</td>
</tr>
<tr>
<td></td>
<td>Receiving beam and other critical parts have prominent cracks, which can cause a bridge collapse.</td>
</tr>
<tr>
<td></td>
<td>Girders and pillars in the substructure have prominent cracks, which can cause a bridge collapse if the deterioration proceeds.</td>
</tr>
</tbody>
</table>

**Remark:** If cause of cracks and influences on the parts are not easily determined, further detailed inspection should be done.
Saving Life Cycle Costs through Preventive Maintenance

Source: 2008 White paper on land, infrastructure, transport and tourism in Japan
Periodic inspection and evaluation: Identify what is causing the damage
Life-Extending Repair Plan: Specify countermeasures and frequencies/timing for their implementation
Prioritizing countermeasures will reduce the total cost and the level of annual expenses

Life Extending Cycle

- Periodic inspection and evaluation: Identify what is causing the damage
- Life-Extending Repair Plan: Specify countermeasures and frequencies/timing for their implementation
- Prioritizing countermeasures will reduce the total cost and the level of annual expenses

Dejima Bridge (Nagasaki Pref.)
Built in 1910 (about 102 years old)
Road Maintenance Panels were launched to facilitate cooperation between interested parties, to grasp and share the current issues, and to assist with creating effective measures for aging roads.

**Members**
- Regional Development Bureau (under MLIT)
- Municipalities (prefectures, cities, towns and villages)
- Expressway companies (NEXCOs, Tokyo Metropolitan Expressways, and others) and Prefectural Road Public Corporation

**Roles**
1. Facilitate training and dissemination of inspection standards.
2. Selection and confirmation of prioritized roads for inspection and repair.
3. Organization, evaluation, and publication of current inspection and repair work.
4. Assistance for area-wide package ordering of inspection work.
5. Technical assistance.

Miyazaki Prefecture road maintenance panel meeting on May 28, 2014
Raise public awareness of aging roads and countermeasures by holding an on-site tour.

**On-site tour**

Facilitate a bridge tour for the local residents and students in cooperation with universities.

[1st On-site tour for road maintenance in Fukui Pref.]
- Date: Thursday, May 29, 2014
- Participants: Fukui Office of River and National Highway, Kinki Regional Development Bureau, Kanazawa Branch of NEXCO Central, several civil engineering offices, municipalities in the prefecture, construction technology research center of Fukui Pref., Fukui prefectural public corporation for construction technology, Fukui University (46 participants) and 3 other companies (Fukui Shimbun, Engineering & Construction News and Fukui Television).
Impact of Heavy Goods Vehicle Traffic on Roads

Overweight HGVs, accounting for only 0.3% of all traffic, are responsible for 90% of road bridge deterioration.

1. A national experiment found that deterioration of the RC floor slab of a road bridge is proportional to a vehicle's weight to the power of 12.
2. The impact of a truck with a 20t axle load on a road bridge is equivalent to 4,000 trucks with 10t of axle load.

Source: estimated from Weigh-in-Motion measurement data (39 locations across the country)
Thank you for listening