Steel Bridge Quality Management in Japan

Selamat sore

JAPAN BRIDGE ASSOCIATION

Variety of Bridges

Plain

Mountainous Area

River & Strait

Japan Bridge Association
Over 100 years Bridges

Dejima Bridge (1890) Nagasaki Pref.
Mogamigawa Bridge (1886) Yamagata Pref.
Minami-Takabashi Bridge (1904) Tokyo
Hachiman Bridge (1878) Tokyo

Japan Bridge Association

Strait Crossing Bridges (Over 20 years.)

Kanmonkyo Bridge (1973) Yamaguchi Pref.

- Quality Control through Construction phase to Operation phase
- Record and maintain Result of Quality Control
  - - Traceability - -

Japan Bridge Association
Work Flow of Construction

- Full-Size Drawing
- Material Procurement
- Marking / Cutting
- Assembly / Welding
- Temporary Erection
- Shop Painting
- Erection
- Inspection / Repair

Double check

Mutual check

Next process

Supplier

Previous process

Record & Document

Japan Bridge Association
Full-Size Drawing

- developed from information presented on the contract drawings
- contains
  
  basic bridge geometry
  sub-structure locations
  sizes of all material
  weld and bolt sizes
  basic connection information
  etc.

3D-computer generated model

Record and document the information
Material Procurement

- Tensile Strength Testing -
  measure Tensile Strength

- V-Notch Testing -
  measure brittle toughness

- Double-check -
  Certificates
  Actual testings
Welding

Individual Panel Assemblies  Assembled into Girder

Arrangement

Items factored in
- Welding type
- Welding Processes, position
- Thickness of base material

Japan Bridge Association

Welding / Types

Fatigue (cycle) Testing

- to study Characteristics
  Durability of each welding types

Application of types

Groove welding  Fillet welding

Japan Bridge Association
### Welding / Operation

#### Preparation for Welding
- Checking gap

#### During Welding
- Observe and control
  - Interpass temperature to prevent cracking
  - Heat input to prevent getting brittle

#### Preheating
- Better quality
- Minimum level

#### Nondestructive Testing (NDT)
- Detect Embedded Flaws
  - Radiographic Testing
  - Ultrasonic Testing
- Flaw detection

---

[Japan Bridge Association]
Nondestructive Testing (NDT) (Detect Flaws on the weld)

Magnetic Particle
invisible

Dye Penetrant
invisible

visible

Flaw

Tokyo Gate Bridge
High Durability & Smooth Exterior

Japan Bridge Association
Temporary Erection
Conform with fabrication tolerance

Computer Simulation

Shop Painting / Blast
Blast cleaning
- is to clean prior to painting
- is to shoot a mixture of steel particles
Shop painting

Brush painting
- Narrow spaces
- Material edges

- Fluorine resin paint material is generally used
- 40 years Durability

Spray painting

Japan Bridge Association

Check Temperature / Humidity
- Temperature affects Drying and Curing times
- Humidity affects Condensation

Measure Thickness
(Each coating ‘layer’) to obtain evenness of the paint

Japan Bridge Association
Site Joint / Torque control bolt

High strength bolt
- Torque control bolt

Spline

Snaps off

Appropriate tension force

Site Joint / Torque control bolt

- must be used in as-received condition
- needs special attention on cleanliness

100% Visual Inspection
Storage of Information

Design Reports
Drawings
Fabrication Information
Testing Results
Electronic Files
Microfilms

Inspections

- Ordinary Inspection
- Periodical Inspection
- Intermediate Inspection
- Specific Inspection
- Inspection after Extreme Event such as Earthquake

Future Inspections
Repair works
Data Storage

Japan Bridge Association
Summary

In Japan,

- Construction processes are operated under well controlled condition
- Results of operations are confirmed before going next step
- Reports are recorded and documented to secure the traceability
to guarantee the quality of the product at the time of completion
also
to keep infrastructures in proper condition

Terima kasih
Thank you
Advantages of Accelerated construction

1. **Accelerated construction in urban areas**
   - Reduction of traffic jam by early opening of a traffic network
   - Load reduction on current road networks via fewer traffic controls at time of installation
   - Reduction of loads on local residents by pre-casting

2. **Accelerated construction in mountainous area**
   - Economic impact by maintaining road networks soon.
   - Rise in convenience by introducing bypass roads soon.

3. **Accelerated construction of large bridges**
   - Contributes to economic development by connecting soon to economics that are separated by strait, etc.
Advantages of rapid construction of elevated bridges in urban areas

- U-beam lifting erection method
- Span-by-span construction method using U-shaped cross sections

<Effects>
- Reduction of traffic jam by early opening of a traffic network.
- Load reduction on current road networks via fewer traffic controls at time of installation.
- Reduction of loads on local residents by pre-casting

1. U-beam lifting erection method

Nasudukuri Viaduct
PC 20-span continuous box-girder bridge
Completed in 2009
Overview of U-girder lifting erection method

- Cast-in-Place slab
- Precast Panel
- U Shaped Precast Beam
- Precast Pier Head
- Lifting Girder

Precast in Site

- U Shaped beam: L=30～38m (Wmax=240t), H=2.64m
- Pier Head: L=4m (W=45t)

Onsite transportation of 2400kN weight beams

Japan Prestressed Concrete Contractors Association
Lifting U-beam

Comparison to ordinary methods

<table>
<thead>
<tr>
<th>Construction method</th>
<th>U-Beam lifting</th>
<th>Ordinarily girder lifting</th>
<th>Span-by-span method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>With fabrication yard of Precast beam on site</td>
<td>Without fabrication yard</td>
<td></td>
</tr>
<tr>
<td>Method Outline</td>
<td>Consentrated load at the ends</td>
<td></td>
<td>Distributed load</td>
</tr>
<tr>
<td>Cross Section</td>
<td>Composite Section (U Beam + Cast-in-place slab)</td>
<td>Box Girder Section</td>
<td>Box Girder Section</td>
</tr>
<tr>
<td>Moment of the girder</td>
<td>18%</td>
<td>30%</td>
<td>100%</td>
</tr>
<tr>
<td>Design Method</td>
<td>Percially prestressed concrete</td>
<td>Percially prestressed concrete</td>
<td>Need to be Fully prestressed concrete</td>
</tr>
</tbody>
</table>

- Construction period is 1/2 of ordinary span-by-span method
- Erected girder is 80% lighter → Cost reduction achieved
2. Span-by-span erection method by U-shaped segments

Furukawa Viaduct
PC9+9+13+10 span continuous box-girder bridge

Completed in 2002

Shape of segment

Factory-fabricated precast segment

U-shape core segment with horizontal rib

- Normally a 65% reduction in number of segments per span
Installation in steps

Segments fabrication
Transport and Install

Lay down precast panel

Case-in-place of deck slab

Bridge face construction

Over view of Erection Method

Cast-in-place deck slab
Erection girder
Precast panel
U-shaped core segment
Cast-in-place deck slab
Precast panel
Pier head segment
Span-by-span erection

- 5 days for segment erection per span
- Erection girder weight was lightened by up to 60%
- 5 days also per span construction of add-on deck slab
  → Normal construction period reduced by 70%

Accelerated construction of bridges in mountainous area

Streamlined construction method of corrugated steel web bridge

<Effects>
- Economic impact by maintaining road networks soon
- Rise in convenience by introducing bypass roads soon
3. Streamlined construction method of corrugated steel web bridge

Akabuchigawa Bridge
PC6+5-span continuous corrugated steel web bridge
Completed in 2008

Construction method of C.S.W Bridge

Corrugated Steel Web Bridges are normally constructed by balanced cantilever construction method.
Rapid construction method using corrugated steel web

Traveler weight 2/3 of usual

Cast-in-Place Concrete

1. Movement of the form traveler

Rapid construction method for balanced cantilever erection
Rapid construction method for balanced cantilever erection

2. Corrugated steel paneled erection
   Precast rib erection

Rapid construction method for balanced cantilever erection

3. Precast panels setup,
   Re-bar and PC assembly
Rapid construction method for balanced cantilever erection

4. Casting concrete on upper and lower deck

Comparison of overhangs erection speed

Cycle stages were cut by approx 40%

Rapid construction
- 8 days per segment

Conventional construction
- 13 days per segment
Accelerated construction of long and large bridges

Concrete-steel composite extradosed bridges

- Precast segmental method
- Steel-beam large-block erection method

<Effects>
- Contribution to economic development by early consolidation of economies separated by strait, etc

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4. Steel concrete composite extradosed bridges

Ibi River Bridge / Kiso River Bridge
6 span (5span)-continuous
PC-Steel composite extradosed bridge
Completed in 2001
Fabricated by short-line and match-cast

- 357 segments, Maximum weight 4,000 kN
- Seaside yard and transported by barges
- Short-line match-cast

Labor saving in precast segment fabrication

Pre-assembling of re-bar cage for labor saving and rapidness

Final shape checking by using CCD camera system

→ labor saving, rapidness and accuracy
Erection using a large floating-cranecrane

Erection of pier-head section segment using a large FC ship → segmentation → Rapid const.

Rapid construction with precast segment

Precast for concrete section → More durable, Rapid construction
Rationalization for composite structure

- High compression area, near piers: Concrete structure
- High bending moment area, span centers: Steel structure

→ Realized an extradosed structure with long multiple span

Construction period was 2 years 4 months

The technology about Accelerated Construction of PC Bridges will contribute the infrastructure supply
Technology of low carbon asphalt pavement and recycled asphalt pavement (RAP) in JAPAN

Japan Road Contractors Association

TOA ROAD CORPRATION, Technical Department
General Manager, Nagato ABE

Overview

- Low carbon asphalt pavement (Warm-mix) Technology overview and application
- Other pavement technology to reduce CO₂ emission Technology overview, etc.
- Recycled asphalt pavement (RAP) Technology overview and application
Outline of Warm-mix Technology

- **Special additive**: foaming, visco-elasticity adjustment, lubricant (surfactant)

  - **Foaming** *(generating and dispersing foam in asphalt mortar)*
    - Concept of foaming mechanism *(Compaction: bearing effect)*
      - Added by plant-mix
    - **Visco-elasticity** *(adjusting mixture consistency at high temperature)*
      - Special additive: Similar composition of asphalt
        - Lowers consistency of mix during mixing and paving at high temperature
      - Added by plant-mix
  - **Lubricant or surfactant** *(improves lubrication of asphalt and aggregate interface)*
    - Added by premix or plant-mix
Reduction of compacting temperature (major effect)

- Initial compaction at 120°C
- Ensure compaction degree of thin layer mix
- Ensure compaction degree in winter
- Ensure compaction degree when paved manually
- Improving workability (ensuring quality)

(T. Hirato, M. Murayama: Development and Evaluation of surfactant for Warm-mix asphalt, Road Construction, July 2010)

Lowers Temperature at Compaction (secondary effect)

- Can be compacted at 120°C at initial compaction
- No asphalt mix disposal caused by temperature decline
- Among 3R (Reduce, Reuse, Recycling) in recycling-based society, it contributes Reduce.
- Effective for environmental measure
Outline of Warm-mix Technology

Application example: same as conventional asphalt paving

Asphalt mix is “smooth”, and easy to apply manually at beginning and end of section.

2. Major effect by application

- Decreasing CO₂ emission
  - Decrease fuel consumption at mixing plant by manufacturing HMA at lower temperature.
  - Decrease fuel consumption of rolling equipment at usual manufacturing temperature.
- Earlier traffic opening
  - Lowering temperature shortens traffic control time at rehabilitation work. Restraining initial crack.
- Improving workability during cold season
  - In case of usual manufacturing temperature, it gains higher compaction ability.
  - It is effective to apply to bridge deck pavement or thin layer pavement where rapid temperature dropping is concerned.
Application Example

○ Reducing CO₂ emission at manufacturing HMA

*Example 1 (Warm-mix: 30 – 50°C lower than conventional)

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mixing temp. (°C)</th>
<th>Manufacturing quantity (t)</th>
<th>Fuel oil amount of consumption (ℓ/ t)</th>
<th>CO₂ emission (kg-C/t)</th>
<th>CO₂ amount of reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>160</td>
<td>443</td>
<td>7.5</td>
<td>5.52</td>
<td>0.0</td>
</tr>
<tr>
<td>2</td>
<td>130</td>
<td>243</td>
<td>6.0</td>
<td>4.41</td>
<td>20.1</td>
</tr>
<tr>
<td>3</td>
<td>110</td>
<td>63</td>
<td>5.1</td>
<td>3.75</td>
<td>32.0</td>
</tr>
</tbody>
</table>

* : Aggregate moisture-ratio : 4.4%, CO₂ discharge basic unit of fuel oil : 0.7357 (kg-C/ℓ)


Effect: 20.1% at 30°C reduction, 32.0% at 50°C reduction.

• Example 2 (Warm-mix: 30 °C lower than conventional)

Effect: 18%

<table>
<thead>
<tr>
<th>Item</th>
<th>PMA type II</th>
<th>PMA type II + Warm-agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>A fuel oil amount of consumption</td>
<td>7.7</td>
<td>6.3</td>
</tr>
<tr>
<td>Basic unit of A fuel oil</td>
<td>2.71</td>
<td>5.38</td>
</tr>
<tr>
<td>Basic unit of warm-agent</td>
<td>0</td>
<td>0.085</td>
</tr>
<tr>
<td>The amount of the warm-agent</td>
<td>0</td>
<td>1.3</td>
</tr>
<tr>
<td>CO₂ increase due warm-agent</td>
<td>----</td>
<td>0.085</td>
</tr>
<tr>
<td>CO₂ emissions</td>
<td>20.9</td>
<td>17.2</td>
</tr>
</tbody>
</table>


Application Example

2. Apply for earlier traffic opening

○ Rehabilitation work on pavement

• Warm-mix: 30°C lower than conventional HMA

Effect: Shorten 70 minutes until the internal temperature of surface layer falls to 60°C

(Kobayashi, et al, “Examination on restraining temperature at traffic open by cutting and overlay” 22nd Japan Road Conference, 1997.10)
Effect of Mixing Ratio of Recycled Aggregate

- Warm-mix binder (Straight Asphalt type) is different depends on mixing ratio of recycled aggregate. When the ratio of aged asphalt increase, it becomes difficult to decline the temperature.

- It declines temperature by 30°C when using 30% of recycled aggregate. Using 50% of recycled aggregate, it declines the temperature by 15°C.

![Graph showing compaction temperature range](image)

Difference in Price of Asphalt Mix

- Asphalt content: 5.2~5.5%
- Rises JPY1,000~1,300/ton
- Future subject is to retain cost increase of mix by making effort on application as increase paving volume per day from earlier traffic open, and decreasing wasted mix (decreasing loss rate).
Other Technology to Reduce CO₂ Emission

○ Existing technology of cold mix to reduce CO₂ emission
  - Chip seal (Seal coat, Armor coat)
  - In-place base course recycling with cement and asphalt emulsion
  - Cold in-place surface recycling

(Japan Emulsified Asphalt Association: Basics of asphalt emulsion and its application, 2006.2)

Other Technology to Reduce CO₂ Emission

○ Other existing pavement technology to reduce CO₂ emission
  - Cold Recycling Mix
    - Cold recycling mix can be manufactured easily with asphalt emulsion mix and it can be stored for long time.
    - It can be applied in the place where is too far to deliver HMA from the plant.
    - Using modified asphalt emulsion, it ensures equivalent strength as HMA.
    - The basic cost CO₂ is 50% of that of HMA, it is effective to low carbon.

(Kawaguchi, Yoshitake, “Development and application of recycled asphalt mix at ambient temperature”, Road Construction, 2011)
**CO₂ Emission in Hot Asphalt Mix Plant**

- The breakdown of CO₂ basic unit in conventional HMA is shown below from material and manufacturing.
- 60% of CO₂ emission is at manufacturing, most of them are occurred from fuel at heating and drying aggregate.
- Saving energy and decrease CO₂ emission.
- Heating and drying aggregate.

![Pie chart showing CO₂ emission breakdown](image)

<table>
<thead>
<tr>
<th>Type of manufacturing equipment</th>
<th>Installed Ratio in Japan* (%)</th>
<th>Standard mix ratio of recycled aggregate (%)</th>
<th>Outline of Mixing Method</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| Parallel hot mixing type        | 69.2                          | 20 - 60                                     | Dryer for recycled aggregate is parallely installed with batch plant and manufacture the mixture | - Both new and recycled mixture can be manufactured.  
- Larger capacity of drying and heating recycled aggregate  
- Available to manufacture various types with small quantity |
| Indirect hot mixing type        | 19.8                          | 30 or less                                  | Recycled aggregate is fed into heated new aggregate, then mixture is manufactured by heat exchange during mixing. | - Both new and recycled mixture can be manufactured.  
- Inexpensive plant cost  
- Available to manufacture various types with small quantity |
| Drum dryer mixing type          | 11.3                          | 60 or more                                  | New aggregate and recycled aggregate are mixed and heated in drum dryer to manufacture the mixture. | - Larger proportion of recycled aggregate  
- Inexpensive plant cost |

* Questionarries by Japan Asphalt Mixutre Association, 2009

**Manufacturing Equipment of Asphalt Mix**

There are 3 categories in manufacturing recycled asphalt mix. The share of equipment and type in Japan is shown in the table. Parallel hot mixing type (new plant with recycling dryer) is widely used.
Wasted asphalt pavement from job site is crushed and arrange particle size to use as recycled aggregate.

Old and aged asphalt adheres on recycled aggregate.

Therefore, 1) adding recycling agent to soften, then mix with new aggregate and new asphalt. 2) mix recycled aggregate and new aggregate, using new asphalt with high penetration.

Removal of damaged pavement

Integrated into the As mixture plant.

Crush the lump.

Classified and stored.
Current situation and orientation of pavement technology

- **Safety, comfortable, durable and economical pavement**
  - Service to vehicle, bicycle, pedestrians and ecological preservation
    → basis of pavement technology to be developed

- **Ecological road pavement**
  - Increase restraining against green house gas emission
    (decrease 25% from 1990)
  → develop and promotion of pavement materials and application method of less CO₂ emission

→ Expand WMA in manufacturing HMA: it can be expected decreasing 150,000t of CO₂ emission if applied to total HMA production (0.544 million ton in 2007)
→ JRCA is promoting in Technical and Application WG-1 “Survey and follow of low carbon asphalt”.

Thank you for your attention.
Deployment of ITS Infrastructure by PPP Approach

Case Study
Electronic Toll Collection (ETC) System for Indonesia

March 2014

MITSUBISHI HEAVY INDUSTRIES, LTD.
Land Transportation Systems Division

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ETC system in Japan (1)

Japanese ETC is recognized as one of the most successful ETC system in practice.

<table>
<thead>
<tr>
<th>ETC Usage Rate</th>
<th>89% (2013) since 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of On-board Unit</td>
<td>41million Users (2013)</td>
</tr>
<tr>
<td>Service Interoperability</td>
<td>Full interoperability among several operators and multi-suppliers</td>
</tr>
<tr>
<td>ETC Standard</td>
<td>International Open Standard (5.8GHz Microwave) as National Unified Standard</td>
</tr>
<tr>
<td>Communication Reliability</td>
<td>99.999%</td>
</tr>
</tbody>
</table>

Government’s strong initiative to set national unified standard and utilization promotion are the key success factors.

- National Unified Standard
  - Nation-wide Interoperability among multi suppliers
    - a single OBU supplied by any supplier can be used anywhere in the nation, regardless the difference between toll operators
  - Reliable System
    - 5.8GHz OBU

- Utilization Promotion led by government
  - Subsidy to purchase OBU for car users.
  - Subsidy to implement ETC for Toll Operators
  - Special Discount on ETC Toll fare up to 50%.

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Close cooperation among government and private sector has realized wide spread usage of ETC in Japan. ETC has been one of national agenda led by government.

1. Central Government (MLIT)
   - ETC service as national agenda
   - Review the policy of road tariff
   - Promote ETC usage

2. Toll Road Operators
   - Investment
   - Operation
   - Management
   - Toll Discount

3. System Suppliers
   - Provide ETC systems

4. OBU Suppliers
   - Sell On-Board-Unit

5. Credit Card Issuers (e.g. JCB, VISA, Master)
   - Issue ETC cards
   - Settle Payment with Drivers

ETC system in Indonesia, “e-Toll pass”, is managed under two different private entities, Bank Mandiri as investor of ETC and JasaMarga as road operator.

- ETC system in Indonesia, “e-Toll pass”, is managed under two different private entities, Bank Mandiri as investor of ETC and JasaMarga as road operator.
- There is no strong business incentive to invest in more ETC system in Indonesia.
Study Result (2) Proposed Business Model

- New independent SPC can enhance current business model in Indonesia.
- SPC dedicated for ETC service is established jointly by local companies and international companies those having knowledge and experience in successful ETC operation.
- Government’s support to SPC is essential as national agenda to promote ETC system.

Japanese Gov./JICA
- Finance
- Political dialog
  - Policy dialogue
  - ODA / Yen loan
  - Technical support

Indonesian Gov.
- ETC service as national agenda
- Review the policy of road tariff
- Promote ETC

NEXCO-West/JEXWAY
- Mgmt know-how of ETC
- Consulting
- Investment
- System

Drivers
- Issue e-Toll cards
- Payment

SPC (ETC service)
- Procurement
- Promotion
- Operation & Mgmt
- Outsourcing ETC
- Investment
- OBU sales

JasaMarga
- Operate toll roads

Bank MANDIRI
- ETC service as national agenda
- Review the policy of road tariff
- Issue e-Toll cards
- Payment

Drivers
- Use ETC

Component, Service
- Money

<Governmental Support>

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Study Result (3) Technical Demonstration

Demonstration show successfully that Japanese ETC (overseas specification version) can be operated by Bank Mandiri’s e-toll card and existing ETC system provided by local manufactures in Indonesia.

<table>
<thead>
<tr>
<th>Date</th>
<th>September 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Jakarta, Indonesia</td>
</tr>
<tr>
<td>Attendees at demonstration</td>
<td>(Bank) Bank Mandiri (Cooperation) PT. Module Intracs Yasatama (Performer) Nomura Research Institute, Mitsubishi Heavy Industries</td>
</tr>
<tr>
<td>Card used</td>
<td>e-Toll card</td>
</tr>
<tr>
<td>System configuration</td>
<td>Using the Japanese on-board ETC equipment and ETC antenna modified for reading the e-Toll card</td>
</tr>
<tr>
<td>Expected results</td>
<td>To demonstrate that the e-Toll card can be used in the Japanese ETC system.</td>
</tr>
<tr>
<td>Results of technical evaluation</td>
<td>All items came out successfully.</td>
</tr>
</tbody>
</table>

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