Introduction of Maintenance Management for Bridge and Slope of National Freeway in Taiwan

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Outline

1. Foreword

2. Introduction of Freeway Management System in Taiwan

3. Maintenance and Management for Bridges

4. Maintenance and Management for Slope

5. Closing Remarks
1. Foreword
Bridges

Bridges in Taiwan are in a typical multi-hazard situations: Typhoons, Scouring, Earthquakes, Traffic Overloading, etc.

- Inspection and maintenance of bridges need to be carried out in a very frequent manner

- Monitoring systems: Scour monitoring system, early warning system, etc.
Slopes

- Local landslides due to heavy rainfall or possibly over-saturated soil
- A large scale landslide occurred in northern Taiwan (3.1k) in April 2010
- Affecting area of over 22,800 m², total mass of landslide over 20,000 m³
Slopes (continued)

Emergency recovery (2010)

- April 25: Landslide occurred
- May 1 (6 days): Rescue and remove of debris
- June 1 (37 days): and repair; partly traffic allowed
- June 19 (55 days): Full functioning recovered
2. Introduction of Freeway Management System in Taiwan
Introduction of Taiwan Area National Freeway Bureau (TANFB)

- Taiwan Area National Freeway Engineering Bureau Established in Jun 1970
- Operation of National Freeway #1 in Oct. 1978
- Operation of National Freeway #3 in Jan. 2004
- Operation of National Freeway #6 in Mar. 2009

◆ National Freeway #7 under planning: one of the major recent new project
2011.3. Update and amendment 「Highway Maintenance Specifications」

2011.8 Amendment 「Expressway Maintenance Manuals」

Chapter V of the “slope"

Chapter VII of the "bridge"
3 Maintenance and Management for Bridges
Operations of Bridge Inspection

Annual contract for inspection works:

1. Half-year Inspection
2. Periodic Inspection
3. Special Inspection
4. Detailed Inspection
5. Non-destructive testing
6. Riverbed cross-section measurements
Bridge Inspection

- Box girder internal
- Viscous dampers
- Expansion joints
- Box girder internal
- Supporting bear
- Riverbed cross-section measurements
Bridge Inspection

- Pier crack
- Substructure
- Pier base erosion
- Expansion joints
- Concrete crack
- Groundsill works
The Highest Piers in Taiwan (h=68m)
No.6 National Freeway-Kuo hsing Viaduct
The Practice of Bridge Monitoring

Flood Disaster Prevention

- Regular Inspection and Maintenance Operations
- River Cross-Section Measurements
- Coordination between the Bridge Authority and the River Authority
- Research Projects and Training
The Practice of Bridge Monitoring

Research projects and training


◆ Experimental Study on an Innovative Bridge Monitoring System (2009~2012)

◆ Establishment of Historical Database of the Scoured National Freeway Bridges (2009~2011)

◆ Research on Scouring Depth Monitoring of Choshui River Bridge on National Freeway No.3 (2009~2010)

◆ Research on Continued Scouring Depth Monitoring of Choshui River Bridge on National Freeway 3 (2011)
Bridge Maintenance

- Number expansion joints
- Grouting in bridge concrete slab
- Repair expansion joint
- Bridge railing replacement
- Beam repair
- Additional maintenance ladder
Bridge Maintenance

- Pier maintenance
- Expansion joint replacement
- Scuppers cleaning
- Safety net setting
- Pier steel plate paint
- Shock rod Repair
Emergency repair cases: Choshui River Bridge on National Freeway #3

Before the flood season in 2009

Pier base erosion

Riverbed cross-section measurements
Shift of the Watercourse of Choshui River

Before the Typhoon Morakot In 2009

After the typhoon Morakot in 2009
Emergency repair cases: Choshui River Bridge on National Freeway N0.3

Pre-construction (2008.12.9)  Weaving laying (2009.7.1)  Block dipping

3 Maintenance Management for Bridges

Introduction of Bridge Management System
1. General Information System

- Database
- Administration
- Geometry
- Structure
- Design
- Photos
- Misc
2. Statistics and Analysis Module

- Management Administration
  - Historical records
  - Locations
  - General Inventory

- Fundamental Database
  - General Information
  - Inspection records
3. Inspection Data Module

- General system
- Crew records
  - Operation
  - Deterioration observed
- Evaluation of design
  - Performance
  - Loading Capacity
- Traffic servicability
- Maintenance Strategy
- Cost and Budget System
- D.E.R. & U.
4. Repair Cost Estimation Module

- Requirements for full inspection
- Evaluation and priority
- Cost of repair and maintenance
- Repair methods selection and basic design
5. Maintenance Records Module

- Major functions
  - Tracking of maintenance and inspection works
  - Life-time serviceability history
  - Decision making for engineers
6. GIS Analysis Module

- Main function
  - Map layout
  - Bridge inquiry
  - Emergency service
  - Path planning
  - Space analysis
4 Maintenance Management for Slopes
Comprehensive Freeway Inspection and Monitoring

2010 (Monitoring)
- 262 sites of slope
- 912 monitoring sys. installed
- 3 million data per year
- 2010. July  Installation of instruments at 32 sites of dip slope
- 2010. Oct.  Monitoring system developed
- 2010. Nov.  SOP and practice manuals

2011 (Inspection)
- 939 sites of slope
- Over 20,000 ground anchors
- 2011. June.  Inspection of all rock anchors

2012 (Manag. system)
- Freeway Life-cycle maintenance and Management system
- 100 various types of monitoring equipment
- 2012. May.  Automation and standardization of slope monitoring and inspection
Platform and System for Monitoring

Development of National Freeway Slope Monitoring and Management System

- Classification of instruments for slope monitoring
- Format and transmission of data
- Display and exchange system
Standardization of Monitoring Operation of Freeway Slopes

- Specification
- Installation
- Measurement
- Output and transmission
- Remote monitoring

- Inclinometer
- GW level Detector
- GA load cell
- Distributed inclinometers
- Rain Detector
- Potential surface of sliding
- Groundwater level
- Prestressed ground anchors
4 Maintenance Management for Slopes

The Practice of Slope Maintenance
Evaluation and Ranking of Safety of Slopes

**Evaluation and ranking of slopes**
- Routine inspections
- Periodic measurements
- Ground anchor check-up

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<th>R</th>
<th>Characteristics</th>
<th>Response</th>
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<tr>
<td>A</td>
<td>Sig. unstable</td>
<td>Immed. action</td>
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<td>B</td>
<td>Somewhat unstable</td>
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<td>D</td>
<td>Stable</td>
<td>Regular inspec.</td>
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Rank B

Rank C

Rank D
Examples of Slope Repair

Mini-piles

Intercepting Ditch
Examples of Slope Repair

All casing concrete piles

Rock anchors with shotcrete grids
Examples of Slope Repair

Retaining wall with piles

Berm ditch with mini-piles
4 Maintenance Management for Freeway Slopes

Introduction of Slope Management System
Significance

- Comprehensive history and traceability system
- Automation of data processing and graphical interface
- Real-time monitoring
Full Life-span Management System of National Freeway Slopes
### Automation and Graphical Interface

#### Display of Acting Slope Monitoring Instruments

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<th>SIS Inclinometer</th>
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Real-time Monitoring

3D Management System

Real-time video

Location indication

Display and status
4. Conclusions
Closing Remarks

- Bridge and Slope Inspection and Maintenance Systems
- Establishment of Full Life-Span Management of the Bridge and Slope
- Automation and Real-time monitoring for Early Warning System
Thank for your attention