


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

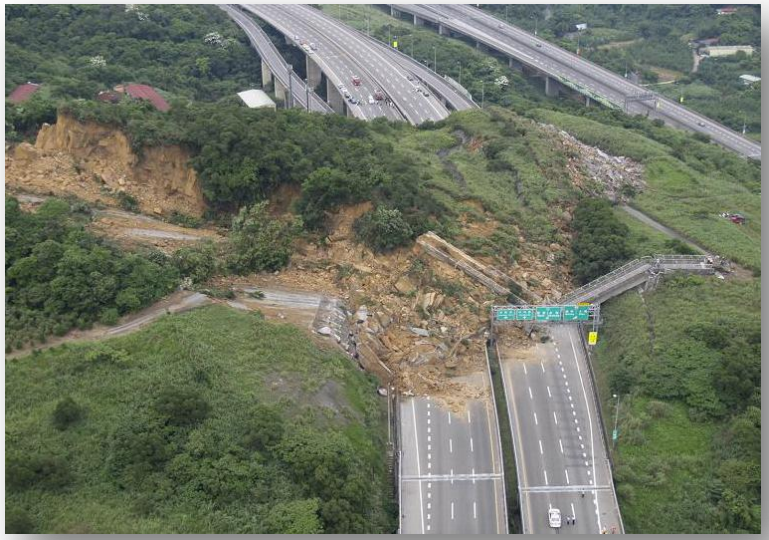
◆ Bridges in Taiwan are in a typical multi-hazard situations:
Typhoons, Scouring, Earthquakes, Traffic Overloading, etc.

➢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 r ainfall or possibly over-saturate d soil
- A large scale landslide occurre d in northern Taiwan (3.1k) in A pril 2010
- Affecting area of over 22,800 m^2, total mass of landslide ove r 20,000 m^3



Slopes (continued)

Emergency recovery (2010)

April 25	May 1 (6 days)	June 1 (37 days)	June 19 (55 days)
Landslide occurred	Rescue and remove of debris	and repair; partly traffic allowed	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**

Maintenance Specifications and Manuals

Ministry of Transportation

2011. 3. Update and amendment 「Highway Maintenance Specifications 」

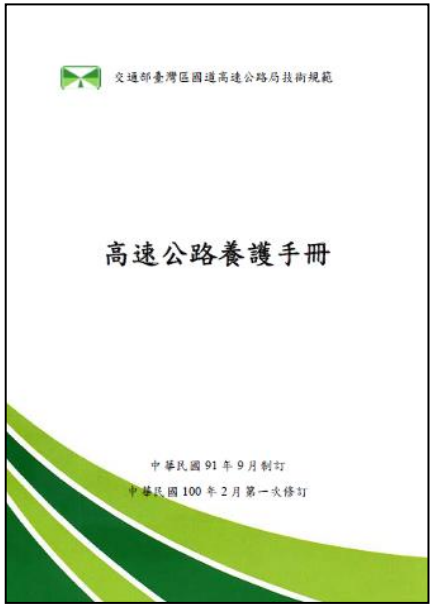
National Freeway Bureau

2011.8 Amendment 「Expressway Maintenance Manuals 」

Chapter V of the “slope"

Chapter VII of the "bridge"

NEW



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-Kuohsing Viaduct

The Practice of Bridge Monitoring

Flood Disaster Prevention

- **Regular Inspection and Maintenance Operations**
- **River Cross-Section Measurements**
- **Coordination between the Bridge Authority an the River Authority**
- **Research Projects and Training**

The Practice of Bridge Monitoring

Research projects and training

- Study on I-Lan Bridge Management and Maintenance System (2010~2011)
- 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 Maintennance

Number expansion joints

Grouting in bridge concrete slab

Repair expansion joint

Bridge railing replacement

Beam repair

Additional maintenance ladder

Bridge Maintennance

Pier maintenance

Expansion joint replacement

Scuppers cleaning

Safety net setting

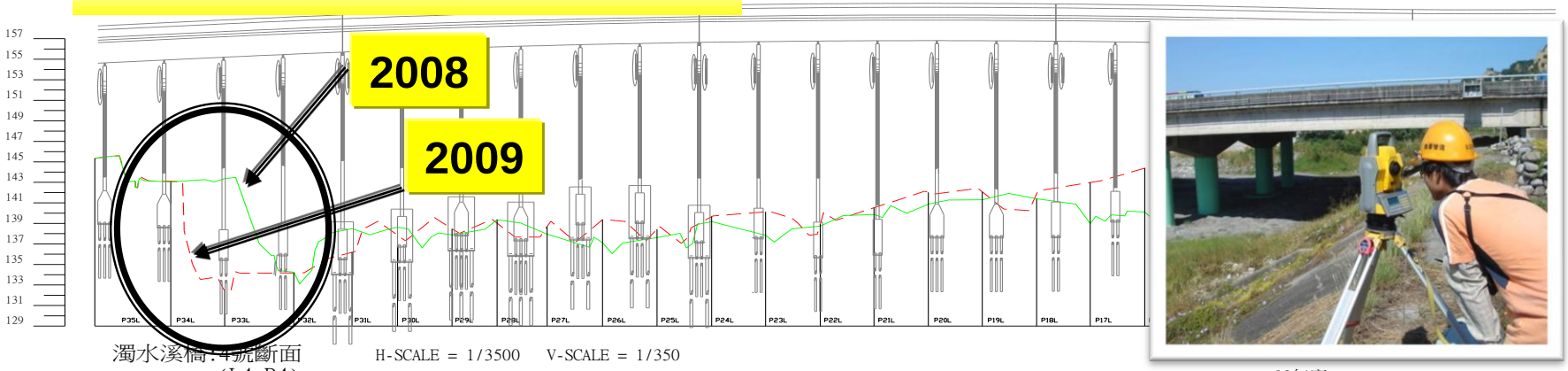
Pier steel plate paint

Shock rod Repair

Emergency repair cases : Choshui River Bridge on National Freeway #3

Before the flood season in 2009

Pier base erosion



濁水溪橋:4號斷面
(L4-R4)

H-SCALE = 1/3500 V-SCALE = 1/350

98年度：
97年度：

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

After construction (2009.7.28)

Morakot struck (2009.8.9)

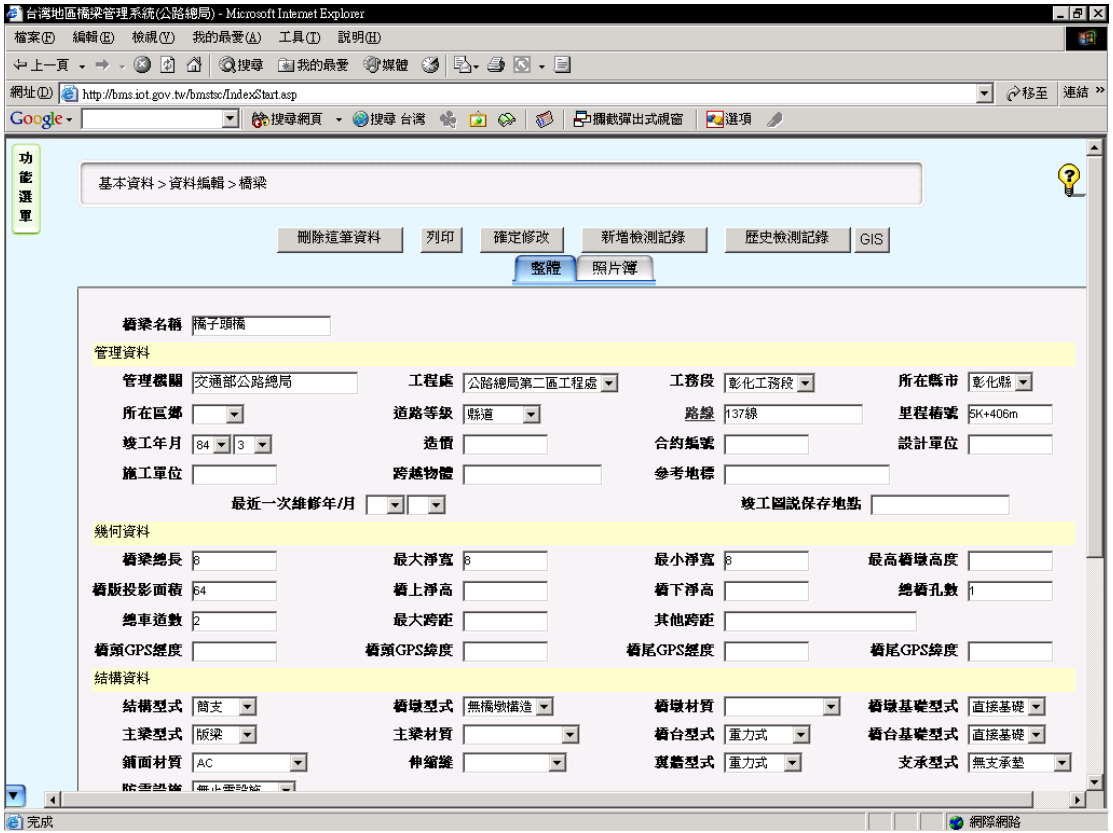
After Morakot(2009.8.9)

3 Maintenance Management for Bridges

Introduction of Bridge Management System

1. General Information System

- Database
  - Administration
  - Geometry
  - Structure
  - Design
  - Photos
  - Misc



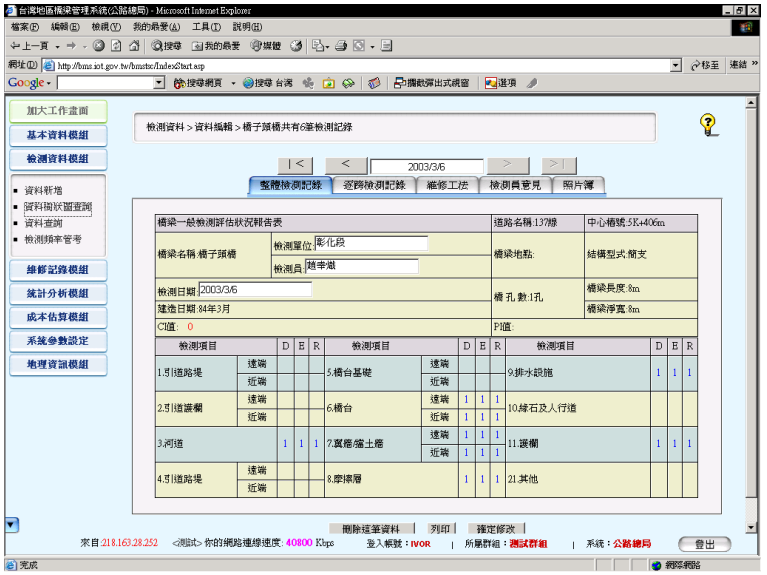
2. Statistics and Analysis Module

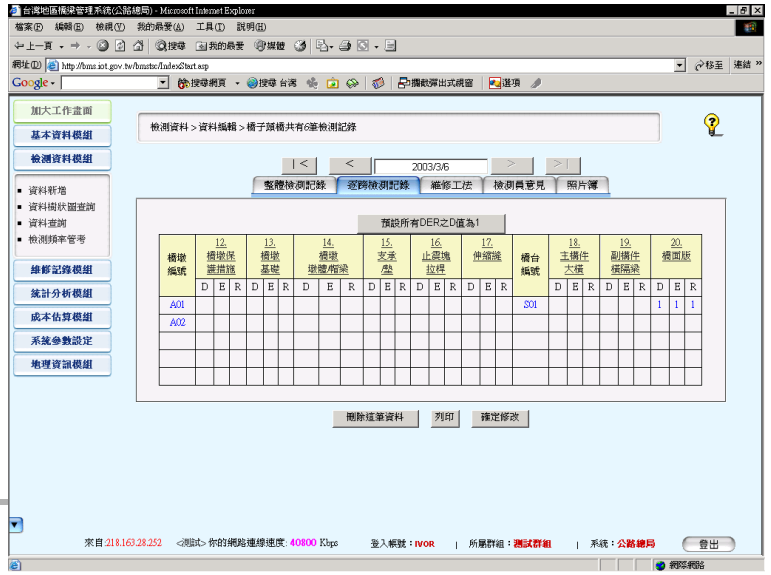
- Management Administration
  - Historical records
  - Locations
  - General Inventory

- 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.



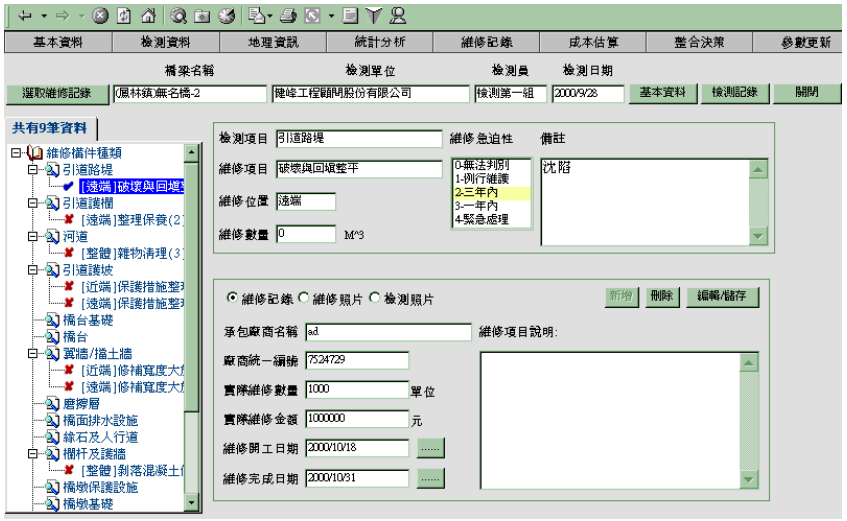


4. Repair Cost Estimation Module

- Requirements for full inspection
- Evaluation and priority
- Cost of repair and maintenance
- Repair methods selection and basic design

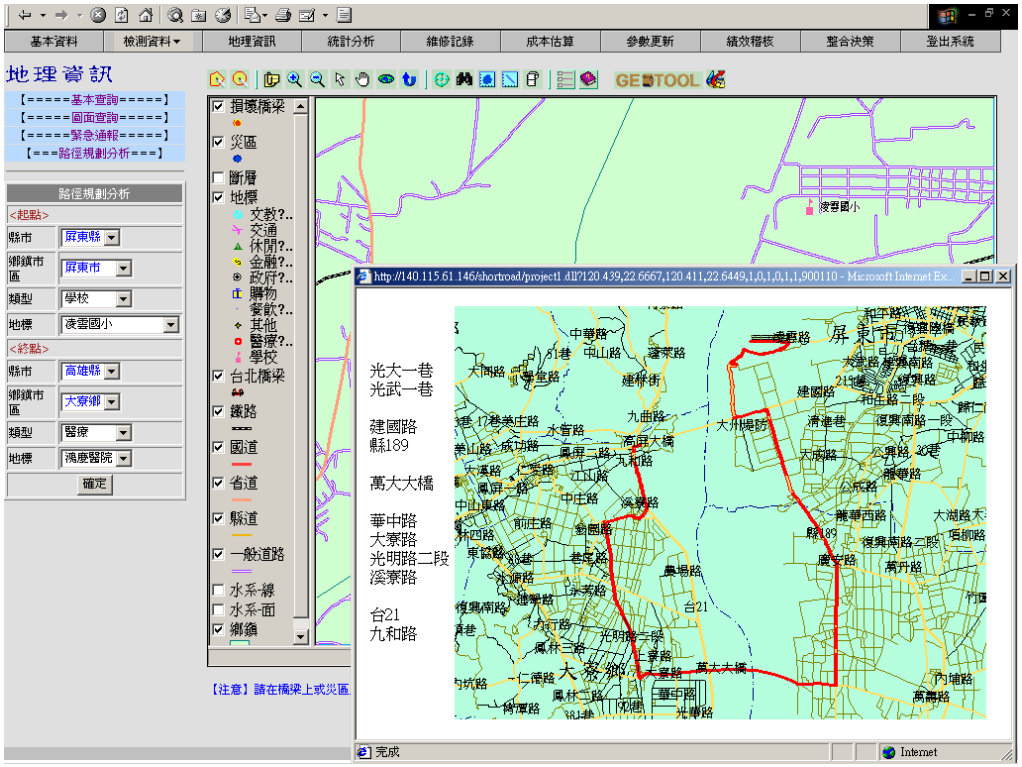
5. Maintenance Records Module

- 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)

- 202 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

2011. Dec. Safety evaluation of freeway slopes

2012 (Manag. system)

- Freeway Life-cycle maintenance and Management system
- 100 various types of monitoring equipment

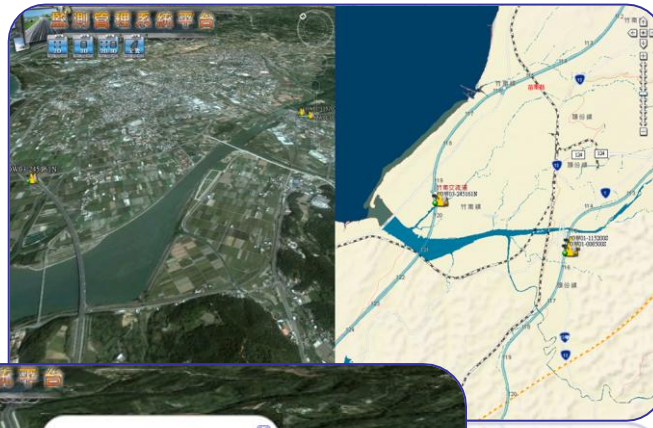
2012. Jan. Integration of life-span management system

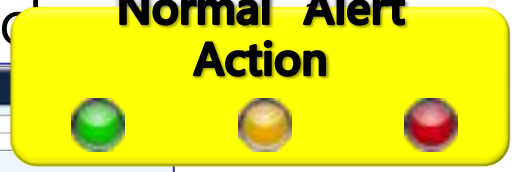
2012. May. Automation and standardization of slope monitoring and inspectio

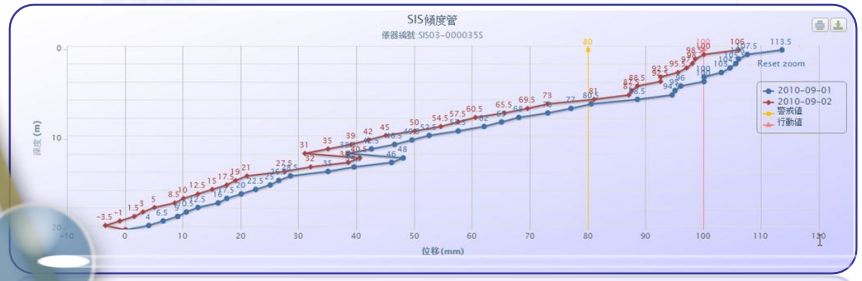
Platform and System for Monitoring

Development of National Freeway Slope Monitoring and Management System

- Classification of instruments for slope monitoring
- Format and transmission of data
- Display and exc

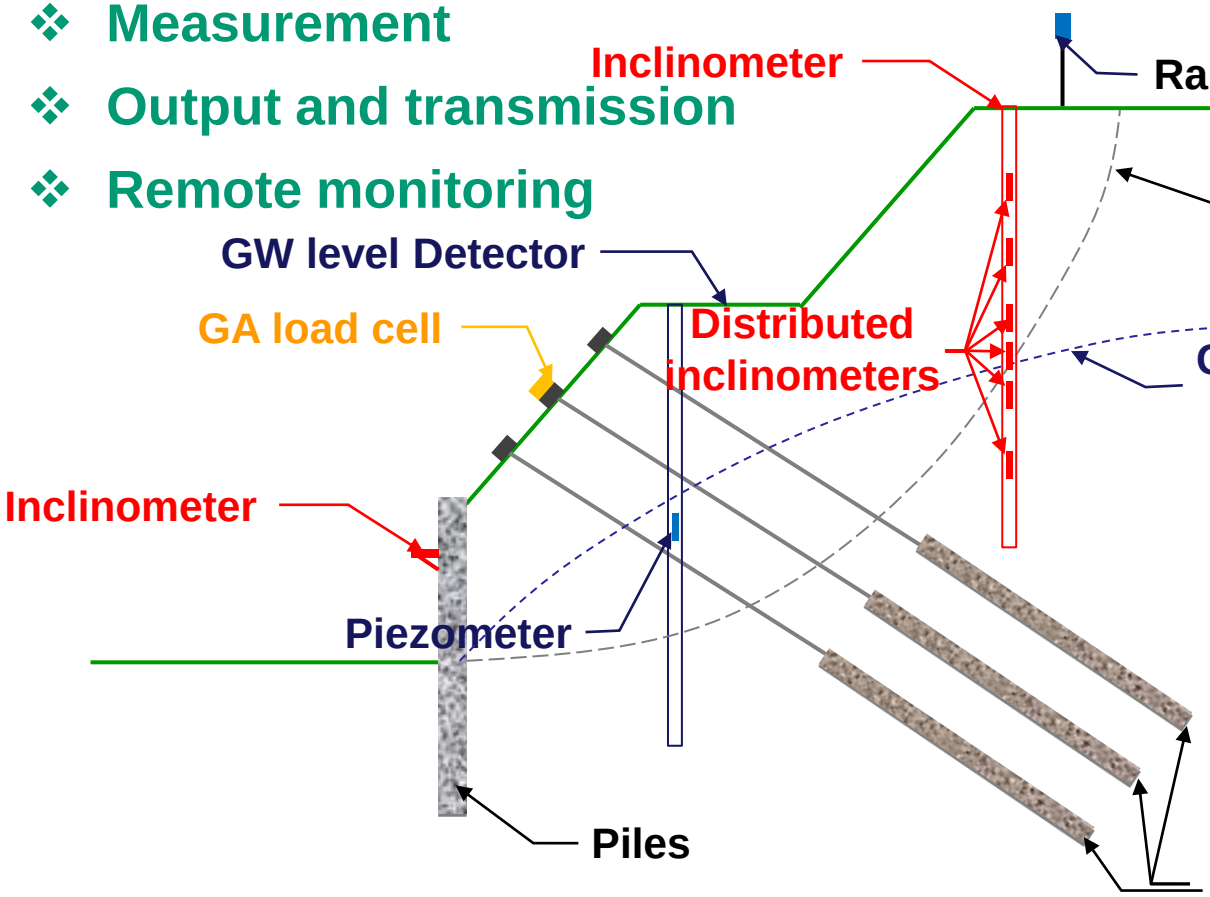






Standardization of Monitoring Operation of Freeway Slopes

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



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

R	Characteristics	Response
A	Sig. unstable	Immed. action
B	Somewhat unstable	Intensive monit.
C	No sig. us observed	Routinely monitoring
D	Stable	Regular inspec.

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



Full Life-span Management System of National Freeway Slopes

- Significance
  - Comprehensive history and traceabiltiy system
  - Automation of data processing and graphical interface
  - Real-time monitoring

Full Life-span Management System of National Freeway Slopes

Systematic manag.

Slope inventory

Graphical interface

Traceability

Multiple alerts

Real-time monitoring

資料同步

邊坡編碼關聯

Mobile Inquiry System

Integaration Platform

Automation and Graphical Interface

監測儀表板



邊坡	SIS傾度管	TI傾斜計	水位觀測井	地錨荷重計	雨量計
國道 5 號順向8k664m~8k788m	●				
國道 3 號逆向96k150m~96k600m	● ●	● ● ● ● ● ⚠	●		
國道 3 號逆向94k750m~96k150m	● ●	● ● ● ⚠	●		
國道 3 號逆向94k300m~94k750m	● ●	● ● ● ● ● ● ●	●		
國道 3 號逆向87k680m~88k300m	●				
國道 3 號逆向86k100m~86k450m	⚠		⚠		
國道 3 號逆向84k400m~84k600m	● ●	● ● ●	●		
國道 3 甲順向萬芳交流道0k180m0k350m	● ●	● ● ● ●			
國道 3 甲順向5k510m~5k570m	●	● ● ● ●	●		
國道 3 號雙向33k92m~33k108m	●		●		
國道 3 號雙向23k730m~23k750m	● ●		● ●		
國道 3 號雙向21k840m~21k890m	●	● ●	●		
國道 3 號順向21k520m~21k890m	● ● ● ●	● ● ● ●	● ● ●	●	
國道 3 號順向7k800m汐止隧道北側	●	⚠ ⚠			

Display of Acting Slope Monitoring Instruments

Real-time Monitoring

3D Management System

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