Proceeding of International Workshop on Disaster Management for Roads

ORGANIZED BY PIARC TC E.3, REAAA, JRA and Hanshin expressway

Tokyo, JAPAN, May 31, 2017,
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1. Workshop Program

(1) OUTLINE OF THE WORKSHOP

Workshop Theme: International Workshop on Disaster Management for Roads

Co-organized by: PIARC TC E.3 “Disaster Management”

Supported by: REAAA

JRA

Hanshin Expressway

Date: May 31, 2017

Venue: Iidabashi Rainbow building, Tokyo, JAPAN

Workshop schedule

May 31, 2017 Oral presentations and discussions

June 1 and 2, 2017 Technical Visit
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 – 10:30</td>
<td>Opening Remarks – Moderated by ADACHI, Y (Hanshin expressway - JPN)</td>
</tr>
<tr>
<td></td>
<td>• Welcome Address - TANIGUCHI, H., President, JARA</td>
</tr>
<tr>
<td></td>
<td>• Welcome Address - KIKUKAWA, S., Vice President, PIARC</td>
</tr>
<tr>
<td></td>
<td>• Welcome Address - HASHIBA, K., Vice President, REAAA</td>
</tr>
<tr>
<td></td>
<td>• Opening Remarks - TAMURA, K., Chair, TC E.3, PIARC</td>
</tr>
<tr>
<td>10:30 – 11:45</td>
<td>Session #1 – Moderator: GRUBER, J. (Department of Transportation - CZE)</td>
</tr>
<tr>
<td></td>
<td>• KIYASU, K. (National Institute for Land and Infrastructure Management - JPN) – “Efforts for Recovery of Roads from the 2016 Kumamoto Earthquake”</td>
</tr>
<tr>
<td></td>
<td>• LISSADE, H. (Caltrans - USA) – “Emergency Management and Resilience in Transportation”</td>
</tr>
<tr>
<td>11:45 – 13:15</td>
<td>Lunch</td>
</tr>
<tr>
<td>13:15 – 14:05</td>
<td>Keynote Session – Moderator: TAMURA, K. (Kyoto University - JPN)</td>
</tr>
<tr>
<td></td>
<td>• OKADA, N. (Kwansei-Gakuin University - JPN) – “The Age of Mega Disaster and Risk Governance - Thinking Creative for Road and Other Infrastructures”</td>
</tr>
<tr>
<td></td>
<td>• GRUBER, J. (DOT, CZE) - “Strategy of the Use of Temporary Bridges in Crisis Situations”</td>
</tr>
<tr>
<td></td>
<td>• ADACHI, Y. (Hanshin expressway - JPN) – “Disaster Management Using GIS Technology”</td>
</tr>
<tr>
<td></td>
<td>• ZHANG, J. (Changsha University of Science and Technology - CHN) – “Prediction and Enhancement of Resistance of RC Bridge during Service”</td>
</tr>
<tr>
<td>15:20 – 15:40</td>
<td>Coffee break</td>
</tr>
<tr>
<td></td>
<td>• ONISHI, M. (Kyoto University, - JPN) - “A Methodology for Emergency Response Decision-Makings with the Consideration of the Unexpected Contingencies”</td>
</tr>
<tr>
<td></td>
<td>• GUSYEY, M. (ICHARM, MLIT - UKR) – “ICHARM's Practices of Flood Hazard and Risk Assessment”</td>
</tr>
<tr>
<td></td>
<td>• ELLIOTT, J. (Elliott asset management - UK) – “‘Future Ready' Impacts and What They Mean to Our Highway Networks”</td>
</tr>
<tr>
<td>17:20 – 17:30</td>
<td>Closing session</td>
</tr>
<tr>
<td></td>
<td>• Closing Remarks - SEKIMOTO, H. (Executive Director, Hanshin Expressway)</td>
</tr>
<tr>
<td></td>
<td>• Closing Remarks - TAMURA, K., Chair, TC E.3, PIARC</td>
</tr>
</tbody>
</table>
(3) PHOTO ALBUM

WORKSHOP

Workshop venue

Opening Session

Plenary Photo
Visit to Tokyo Aqua Line Tunnel (pressured TBM tunnel)

Visit to Kumamoto earthquake disaster site

Kumamoto Castle
Welcome and Opening Remarks

TANIGUCHI, Hiroaki
President, Japan Road Association

KIKUKAWA, Shigeru
Vice president, PIARC

HASHIBA, Katsuji
Vice president, REAAA

TAMURA, Keiichi
Chairman, TC E.3 PIARC
Adjunct Professor, Kyoto University,
Efforts for Recovery of Roads from the 2016 Kumamoto Earthquake

KIYASU, Kazuhide

NILIM, Ministry of Land, Infrastructure, transport and tourism
JAPAN
Efforts for Recovery of Roads from the 2016 Kumamoto Earthquake

May 31, 2017

Kazuhide KIYASU
Research Coordinator for Construction Management
Research Center for Infrastructure Management
National Institute for Land and Infrastructure Management
Ministry of Land, Infrastructure, Transport and Tourism

Overview

◆ Overview of the Kumamoto Earthquakes and the damage
◆ Disaster response by MLIT
◆ The efforts to restore roads

Damage caused by the Kumamoto Earthquake

- 50 deaths were caused directly by building collapse and sediment disasters. About 200,000 buildings were damaged.
- Roads, railways, water supply and sewage systems, electric power and other public services were severely damaged.

Occurrence of the Kumamoto Earthquake

- From April 14 to 16, 2016, a series of earthquakes ranging from M6.5 to M7.3 struck the Kumamoto Area.

Setting up of Disaster Countermeasure Headquarters

- Immediately after the earthquake on April 14, the Kyushu Regional Development Bureau set up the disaster countermeasure headquarters.
- At 23:00 on the same day, it held a TV conference with MLIT and shared information with the Minister.

NILIM SUPPORT FOR DISASTER RESPONSE

- The National Institute for Land and Infrastructure Management is the only national research organization in the housing and public capital field.
- "Disaster response support" is one of the major roles of NILIM.
- NILIM has sent experts to many areas affected by disasters including the Great East Japan Earthquake. To support restoration, in cooperation with the Public Works Research Institute.
On April 14, at the same time as the Kyushu Bureau set up the Disaster Countermeasure Headquarters, liaisons were sent to Kumamoto Prefecture, Kumamoto City, Mashiki Town, etc. The liaisons collected information, supported the disaster area.

The first 14-member TEC-FORCE was sent to Mashiki Town at 1:25 on April 15.

Disaster countermeasure vehicles such as lighting vehicles and information gathering vehicles were deployed to support various activities.

On the morning of April 15, The Kyushu Bureau started to survey the damage using their own helicopter.

On the day of the main shock, the Kyushu Bureau started to survey the damage and the opening of roads using the helicopter.

Assisting evacuees

In addition to TEC-FORCE of the Kyushu Bureau, up to about 440 TEC-FORCE members gathered from all over Japan.

TEC-FORCE conducted surveys on the damage situation etc. of infrastructure facilities.
The TEC-FORCE road-opening team surveyed the state of damage to national roads, prefectural roads, etc. They also helped with early restoration, such as road opening work in response to requests.

【National Route 443 opened on April 20】 【Prefectural Route 149 opened on April 17】

The TEC-FORCE road-opening team surveyed the state of damage to national roads, prefectural roads, etc. They also helped with early restoration, such as road opening work in response to requests.

Immediately after the earthquake, NILIM also set up a Disaster Countermeasure Headquarters and sent experts to Kumamoto as TEC-FORCE. TEC-FORCE of NILIM and PWRI gave advanced technological support with damage surveys and emergency restoration.

Up to 507 km of expressways in Kyushu were closed under the effects of the earthquake. On the Kyushu Expressway and Oita Expressway, bridges and slope faces were seriously damaged.

NEXCO West Japan performed emergency restoration, and opened all expressways by May 9, 2016. In part of the Kyushu Crossing Expressway in Kumamoto district, traffic was opened in 2 lanes out of 4, but all 4 lanes were completely restored and opened on April 28, 2017.

Between Kumamoto urban area and Aso area, roads were seriously damaged. National Route 57 and 325, Prefectural Route 28 were cut off traffic on these routes. These disasters had a major impact on inter-city traffic.

TEC-FORCE helped open the Prefectural Milk Road and the Green Road on April 22 in 2016. By these, detours on National Route 57 and Prefectural Route 28 were secured.
Cut Off National Route 57 and 325

- A landslide occurred in the area where National Route 57 and 325 meet. This cut off National Route 57 and the Hohi Line of the railway those link Kumamoto city with Oita.
- Also the Aso bridge on National Route 325 collapsed.

Sediment disaster prevention in the Aso bridge area

- To prevent the collapse of unstable soil from causing secondary disasters, the Kyushu Bureau began sediment disaster prevention works in May 2016.
- To ensure the safety of this work, it was done using construction machinery that can be remotely controlled.

New bypass of National Route 57

- To restore the functions of National Route 57 that was cut off in the Aso Bridge area, the Japanese government decided to construct a new bypass on the north side of the existing road.
- The Kyushu Bureau is executing the work with opening the bypass in 2021 as its goal.

Improvement of the Milk Road

- The Kyushu Bureau, in cooperation with Kumamoto Prefecture, improved the Prefectural Milk Road by December 2016, so it could serve as the detour around National Route 57.

Restoration of the Aso bridge on the Route 325

- Restoration of the Aso bridge on the Route 325 required advanced technology, so the Japanese government decided to implement the disaster restoration project as a direct project.

Replacement work of the Aso bridge

- The Kyushu Bureau is undertaking the work with the aim of replacing the bridge by 2021.
A Minami-Aso village road near the Aso Bridge was also become impassable due to disasters. Following the request of the village mayor, the Japanese government decided to restore it directly on behalf of the village under the Large Disaster Restoration Law.

The Kyushu Bureau undertakes restoration work with the aim of restoring the road in the summer of 2017.

The Kyushu Bureau is undertaking restoration work with the aim of restoring the road in the summer of 2017.

The Kyushu Bureau is undertaking restoration work with the aim of restoring the road in the summer of 2017.

Advanced expertise is required for restoration of these roads and sediment control work, the Kyushu Bureau has established technical committees. Experts on sediment control, bridges, etc. from the NILIM and PWRI also join these committees, and survey at the disaster site to give technical advice on restoration methods etc.

The Kyushu Bureau opened the Kumamoto Earthquake Disaster Countermeasures Promotion Office. Six experts from NILIM also participated as the Promotion Office members.

The Kyushu Bureau opened the Kumamoto Reconstruction Project Office in Minami-Aso Village in Kumamoto Prefecture. NILIM also opened the Kumamoto Earthquake Recovery Division in the same building as the Project Office.

The two organizations will work together to promote the restoration and recovery from the Kumamoto Earthquake.
Thank you very much for your kind attention


Opening Ceremony the Kumamoto Prefectural Route 28 on December 24, 2016

Photo: Kyushu Regional Development Bureau

Emergency Management and Resilience in Transportation

LISSADE, Herby

Department of Transportation, State of California
U.S.A.
State DOT’s Major Responsibilities

- Highways
- Transit
- Freight and Passenger Rail
- Ports and Ferries
- General and Commercial Aviation Facilities
- Bike/Pedestrian
- Motor Carrier/Motor Vehicle Services
- State Patrol


State DOT’s - Guardians of Nation’s Transportation Network

DOT’s own & operate 1.8 million lane miles & 273,200 bridges

5 billion daily vehicle miles (DVMT) traveled on DOT’s roads and bridges, or 65% of total DVMT

$92 billion/year needed just to preserve system without extra security


Goverance

Government, control, or authority

Stafford Act Support to States


Caltrans Emergency Response in Assisting Other Government Agencies

In response to Emergencies/Disasters, through CalOES, Caltrans will assist other agencies and local authorities with the restoration of function and mobility to affected city and county critical infrastructure.

Caltrans will also carry out “Mission Tasking” through CalOES, in areas not related to the transportation system (based on capabilities).

Definition and Context for Resilience
**California Emergency Functions CA – EF’s**

1. Transportation
2. Communications
3. Construction & Engineering
4. Fire and Rescue
5. Management
6. Care and Shelter
7. Resources
8. Public Health & Medical
9. Search & Rescue
10. Hazardous Materials
11. Food & Agriculture
12. Utilities
13. Law Enforcement
14. Long-Term Recovery
15. Public Information
16. Volunteer & Donations Management
17. Cybersecurity

**FEMA Recognized Types of Disasters**

- Chemical Emergencies
- Dam Failure
- Earthquake
- Fire or Wildfire
- Flood
- Hazardous Material
- Heat
- Hurricane
- Landslide
- Nuclear Power Plant Emergency
- Terrorism
- Thunderstorm
- Tornado
- Tsunami
- Volcano
- Wildfire
- Winter Storm

**All Hazards Planning Fundamentals**

- **Prevention:** Capabilities necessary to avoid, prevent, or stop a threatened or actual act of terrorism.
- **Protection:** Capabilities necessary to secure against acts of terrorism and manmade or natural disasters.
- **Mitigation:** Capabilities necessary to reduce loss of life and property by lessening the impact of disasters.
- **Response:** Capabilities necessary to save lives, protect property and the environment, and meet basic human needs after an incident has occurred.
- **Recovery:** Capabilities necessary to assist communities affected by an incident to recover effectively.


**Why is Pre-Event Recovery Planning For Transportation Infrastructure recovery important?**

- Effective and efficient Transportation Systems helps drive a nation’s economy
- Pre-Event planning helps to accelerate the response and recovery of the Transportation System
- Opportunity to build back better
- Adds to the overall Resiliency of the Transportation System

**Basic Principles**

*Recovery Efforts are executed better when:*

- Resources are prepositioned
- Contractors are pre-approved
- Alternate Facilities are identified
Statewide Vulnerability Assessments

Assessing Disaster Risk

- Vulnerability Assessments
- Threat and Hazard Identification and Risk Assessment (THIRA)
- California MULTI-HAZARD MITIGATION PLAN
- Assessing Disaster Risk - Economic Studies
- Plans
- Human Behavior
- Hazard Mapping
- Exercise and Training
- Caltrans Division of Research, Innovation and System Information
- Hazard Assessment and Response Tools
- RRAP & HayWired
- Implementation of New Technology
- Transportation Research Board
- Hait Engineering, Inc.

Sea Level Rise Adaptation Options

2013 STATE OF CALIFORNIA MULTI-HAZARD MITIGATION PLAN

- State Hazard Mitigation Plan
- Emergency Operations Plan
- Continuity of Operations/Continuity of Government
- Pandemic Plan
- All Hazards Infrastructure Protection Plan
- Security Plan
- Recovery Plans
- IT Recovery Plan
Human Behavior & Emergency Management Planning
- How do people actually react & why during emergencies?
- Accept what is, not what we want to believe.
- What we plan, and what people actually do are increasingly different.
- Design systems to support what people actually do.
- Engage Law enforcement in Planning and Response

HAZARD MAPPING

PREPARATION
- The effective use of Hazard Maps decreases the magnitude of disasters
- Hazard Maps provide information on the range of possible damage and disaster prevention activities

CALTRANS MAPS
- Earthquake + Fire Maps
- Flood + Landslide Maps
- Supply Chain Maps
- Traffic Flow Maps

HIGHWAY MAINTENANCE STATIONS & Emergency Supply Chains
- 30 Mile Buffer – Assess for response time along Emergency Lifeline Routes and NHS

Exercises and Training
Training Videos

Fire
Flood
Earthquake

Caltrans Division of Research, Innovation and System Information (DRISI)
Hazard Assessment and Response Tools

- ShakeCast
- FloodCast
- FireCast
- SnowCast
- Avalanche Path Atlas Map

What is ShakeCast?

ShakeCast System Overview

ShakeCast at Caltrans

- Automatic delivery of ShakeMap products to Caltrans.
- Automatic analysis of potential bridge damage state based on Basoz & Mander methodology using ShakeMap peak spectral accelerations.
- Email/Page bridge inspection prioritization lists.

Inspection Prioritization
Earthquake Early Warning System

Sustainable Snow and Ice Removal

Snow Lion in the snow roads open soon

Eight units can be set to break the ice on the ground in real-time profiling

ASSESSING DISASTER RISK - ECONOMIC STUDY
REGIONAL RESILIENCE ASSESSMENT PROGRAM (RRAP)

- Caltrans is working with the U.S. Department of Homeland Security on a Regional Resilience Assessment Program (RRAP) Project
- RRAP focuses on goods movement through high hazard areas from the Port of Long Beach through the Cajon Pass (I-15) to the State of Nevada - 390 kilometers

Implementation of New Technology

Earthquake Early Warning System

Sustainable Snow and Ice Removal

Mechanical Ice-breaking

Icebreaker system

Eight units can be set to break the ice on the ground in real-time profiling

WWW.XSQDF.COM
Blind Zone (no warning)
Earthquake Early Warning
Up to 90 sec warning depending on distance.

Transportation Research Board (TRB)
Promoting Innovation and Progress in Transportation
trb.org

TRB “Professional Society” Functions
- 200 Standing Technical Committees – about 4,000+ people
- Constitute communities of interest
- Identify research needs
- Sponsor sessions, conferences, and meetings – 50+ events in addition to Annual Meeting
- Review and publish papers and reports
- Share information

Identification of R&D Gaps & Needs
1. TRB Committee on Critical Transportation Infrastructure Protection shares research results from all sources & identifies research needs
2. AASHTO Special Committee on Transportation Security & Emergency Management (SCOTSEM) identifies and refers research needs

TRB Brings People Together
- Manage Research
- Deliver Policy Analysis & Advice
- Information Exchange: Meetings, Publications, Website, Dissemination, Outreach
TRB Sponsors

- American Public Transportation Association
- Association of American Railroads
- State Departments of Transportation (All)
- South Coast Air Quality Management District
- U.S. Army Corps of Engineers
- U.S. Air Force Civil Engineering Center
- U.S. Coast Guard
- U.S. DOT: OST, FHWA, FTA, FRA, FMCSA, FAA

TRB Hot Topic: Transformational Technologies

Transformational, or “disruptive” technologies, are those that can be expected to completely displace the status quo, forever changing the way we live and work.

- General examples: internet, personal computer, email, smartphone, GPS, big data
- Transportation: Connected/automated vehicles, shared vehicles, advanced versions of on-demand shared ride and micro-transit services, NextGen, cog in “internet-of-things”

TRB Hot Topic: Resilience

Resilience is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events.

- Natural disasters: blizzards, tornadoes, floods, hurricanes, wildfires, heat waves, earthquakes, and other natural hazards
- Human-induced disasters: acts of terrorism, financial crises, social unrest, cyber attacks

TRB Work in Resilience

Disaster Resilience: A National Imperative (2012)

This report by the National Research Council defines “national resilience,” describes the state of knowledge about resilience to hazards and disasters, and frames the main issues related to increasing resilience in the United States.

Resilience at The National Academies (2015)

TRB Key Products

Research Management

Cooperative Research Programs

- Highway
- Transit
- Airport
- Freight
- Hazardous Materials
- Rail
NCHR Report 753
A Pre-Event Recovery Planning Guide for Transportation
July 2013

Objective: to develop a guide that provides prevent recovery planning principles, processes, tools, and appended resource materials for use by planners and decision makers in prevent planning to support transportation infrastructure recovery.

NCHR Project 20-59(36)
Managing Catastrophic Transportation Emergencies: A Guide for Transportation Executives
2015

NCHR Project 20-59(14B)
Fundamental Capabilities of Effective All-Hazards Infrastructure Protection, Resilience, and Emergency Management for State Departments of Transportation
2015

Check-In, Check-Out, and Demobilization at ICP
December 2015

TRB Projects in Development

Security, Emergency Management and Infrastructure Protection-related

1. Integrating Climate Risk into Airport Management Systems
2. Emergency Management Training for Airport Critical Incidents
3. Airport Emergency Operations Centers Design Guide
4. Forum on Airport Roles in Reducing Communicable Diseases Transmission
5. Improving Freight Transportation Resilience in Response to Supply Chain Disruptions
7. A Connecting Strategies Guidebook for Administration of Concurrent Regional Emergencies
8. Proposed Guidelines for Performance-Based Seismic Bridge Design
10. Applying and Adapting Climate Change Models to Hydraulic Design Procedures
11. Leveraging Big Data to Improve Traffic Incident Management
12. Update of A Pre-Event Recovery Planning Guide for Transportation
13. Research on Enhancing Transportation System Resilience
14. Voice and Data Interoperability for Transportation
15. Command-Level Decision Making
17. Impacts of Conected/Automated Vehicles on State and Local Transportation Agencies
18. A Guide to Ensure Access to the Publications and Data of Federally Funded Transportation-Related Research
20. Deploying Transportation Security Practices in State DOTs
21. Emergency Management in State Transportation Agencies
22. Deploying Transportation Resilience Practices in State DOTs

Institute of Medicine

Healthy, Resilient, and Sustainable Communities After Disasters: Strategies, Opportunities, and Planning for Recovery

DETAILS
504 pages | 6 x 9 | PAPERBACK

AUTHORS
Committee on Post-Disaster Recovery of a Community’s Public Health, Medical, and Social Services, Board on Health Sciences Policy, Institute of Medicine
INTERNATIONAL WORKSHOP ON DISASTER MANAGEMENT FOR ROADS

MORI, Mikihiro
Nippon Koei Co., Ltd.
JAPAN


2. Non-seismic and Seismic Road Geohazard Events occurring at same road location

- Non-seismic road geohazard events
  - Mostly due to storms, and also non-hydrological events such as rockfall.
  - Higher probability and lower economic loss of road damage.

- Seismic road geohazard events
  - Rockfall, soil collapse on road, road foundation collapse, bridge collapse.
  - Lower probability and higher economic loss of road damage.

3. “Integrated analysis of non-seismic and seismic road damage events” increase accountability for the investment of the road geohazard risk reduction

- Most structural measures for road geohazard are valid for both non-seismic and seismic caused events such as groundwater drainage for landslide or road embankment slope stabilization.
- Total risk of potential annual losses and annual average benefits of risk reduction can be summed up as the non-seismic and seismic risks and benefits.

4. Flow of Risk Estimation and Cost-Benefit Analysis of a Road Location

(1) Annual exceedance probabilities (%/year) or occurrence probability in years (year) of different extents of road geohazard events

(2) Economic loss (US$) of different extents of road geohazard events

(3) Potential annual loss (US$/year) = Integral computation of sets of annual exceedance probabilities and economic losses of road geohazard events

(4) Risk reduction target in annual exceedance probability (%/year) or occurrence probability in years

(5) Annual risk reduction benefits (US$/year)

(6) Cost (US$) of risk reduction measures Annual maintenance cost (US$/year)

(7) Cost benefit analysis indicators: Cost-benefit ratio, Net present value (US$), Economic internal rate of return (%)

5. Geohazard Prone Road Locations to be Evaluated

(Road locations with slopes, crossing streams)

A geohazard prone road location is referred to a geographically distinguishable portion of road (normally, less than 1 kilometer)
M: mountainside slope, V: valley side slope, S: Stream Crossing
6. Bridge (river bridge and overpass on road) to be evaluated

Risk evaluation is done by four parts of a bridge

1. End (river side)
2. Abutment (origin side)
3. Abutment (destination side)
4. Superstructure

Example of Rating Checklist of the Occurrence Probability of Road Geohazard Event

<table>
<thead>
<tr>
<th>Check items and their categories for occurrence probability in years of a road geohazard event</th>
<th>Input “1” only for one applicable category</th>
<th>Non-Seismic Hazard Score of occurrence probability in years: % of road damage</th>
<th>Seismic Hazard Score for critical horizontal seismic acceleration (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor item</td>
<td>Category</td>
<td>Factor item</td>
<td>Category</td>
</tr>
<tr>
<td>1. Extension along road of hazardous road location: E</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E ≥ 300 m</td>
<td>0.5</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>300 m &gt; E ≥ 200 m</td>
<td>1</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>200 m &gt; E</td>
<td>3.0</td>
<td>6.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Score of occurrence probability in years for the selected category 1: 3Yp1

Score of occurrence probability in years for the selected category 2: 5Yp2

Score of occurrence probability in years for the selected category 3: 6Yp3

7. Procedure of Evaluation/Estimation

7.1 Annual exceedance probabilities (%) or occurrence probability in years of different extents of road geohazard events

- Rating checklist of occurrence probability in years for a non-seismic event; and critical horizontal seismic acceleration for a seismic event, which is converted to the occurrence probability according to the return period of the seismic magnitude at the evaluation location.
- A rating checklist with check item and their categories can provide the evaluation results of both for non-seismic and seismic road geohazard events. An example of an item is ‘roadslope angle’, and its category is ‘steeper than 40 degree’

- Each category (selection or identification of applicable category) assigns scores of occurrence probability in years or critical horizontal seismic acceleration. The rating is adding all scores selected or identified category.
- Each rating score is initially set by engineering judgment, calibrated by multivariate statistic analysis, searching the most suitable regression model by minimizing residual sum of squares of actual – calculated occurrence probability in years or critical seismic acceleration of road geohazard events. Actual values are returned period of rainfall index or seismic acceleration of the historical road geohazard events, a recurrent period of frequently occurred road geohazard events, and determined by numerical model calculation.

- Due to the difficulty to determine road damage levels and lack of historical events for the rating tool calibration, the rating for road damage levels is only for 1-3 levels as next table.
Rating checklist for road location

<table>
<thead>
<tr>
<th>Rating for Road Damage Levels</th>
<th>Non-seismic events</th>
<th>Seismic events</th>
</tr>
</thead>
<tbody>
<tr>
<td>With Mountainside slope</td>
<td>Roadside only “one-lane closing,” and “two-lane closing.”</td>
<td>Rating is determined only for critical horizontal acceleration of road location damage. Road damage extent is determined by engineering judgment or numerical calculation.</td>
</tr>
<tr>
<td>With Valley side slope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With Stream crossing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A set of Bridge piers (origin side)</td>
<td>Rating is determined only for critical occurrence probability in years of bridge. Bridge damage extent is determined by engineering judgment or numerical calculation.</td>
<td>Rating is determined only for critical horizontal acceleration of bridge. Bridge damage extent is determined by engineering judgment or numerical calculation.</td>
</tr>
<tr>
<td>Bridge abutment (destination side)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superstructure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- If existing measures are on the location, an effect on the occurrence probability in years (Eyp EM) of existing measures is replaced the rating results. Eyp EM is target return period designed or occurrence probability in years. Eyp EM shall be modified to smaller if road or measures structures are damaged. Next table proposes Eyp EM for the effect of slope stability measures by design safety factor.

Proposed Values for the Effect of Slope Stability Measures on the Occurrence Probability in Years for Road Damage Events due to Geohazards

Note: “Slope failure” is a term used to cover slope fall, collapse, or slide.

<table>
<thead>
<tr>
<th>Effect on the occurrence probability in years on a road location (years)</th>
<th>Design safety factor of slope stability (resistance force against slope failure force)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>1.20</td>
</tr>
<tr>
<td>80</td>
<td>1.15</td>
</tr>
<tr>
<td>50</td>
<td>1.12</td>
</tr>
<tr>
<td>30</td>
<td>1.10</td>
</tr>
</tbody>
</table>

7.2 Economic Loss

- Reopening Cost
- Loss of other public property
- Economy loss
- Loss of traffic disturbance
- Human lives loss
- Loss of private property

7.3 Potential Annual Loss

- The risk index of potential annual loss = integral computation of sets of annual exceedance probability and economic loss of road geohazard events.
- To understand the risk index of potential annual loss, a risk curve as shown in the Figure in next slide would be useful.
- The risk curve is derived from the plots of annual exceedance probability of disaster occurrence on the vertical axis and potential economic loss of road geohazard event on the horizontal axis.
7.4 Risk Reduction Target in Annual Exceedance Probability (%/year) or Occurrence Probability in Years

Risk reduction target occurrence probability in years for a road location (unit: years): This is the target occurrence probability in years of no geohazard damage-causing events on a road location when road geohazard risk reduction measures are in place.

Proposed Risk Reduction Target of Occurrence Probability in years for road geohazard damage events

Note: "Slope failure" is a term used to cover slope fall, collapse, or slide.

<table>
<thead>
<tr>
<th>Proposed risk reduction target of occurrence probability in years on a road location (years)</th>
<th>Design safety factor of slope stability (resistance force against slope failure force)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>1.20</td>
</tr>
<tr>
<td>80</td>
<td>1.15</td>
</tr>
<tr>
<td>50</td>
<td>1.12</td>
</tr>
<tr>
<td>30</td>
<td>1.10</td>
</tr>
</tbody>
</table>

7.5 Annual Risk Reduction Benefits

Annual risk reduction benefits are the potential annual economic loss with measures minus potential annual economic loss without measures. The risk curb shows as the area of risk curbs of without/with measures and axis of the chart.

7.6 Cost of Risk Reduction Measures, Annual Maintenance Cost

- Investment cost for road geohazard risk reduction (unit: currency): The planners of road geohazard risk reduction measures (experts in engineering geology and civil engineering) prepare a conceptual design with a rough cost estimation to meet the design target occurrence probability in years.
- Annual maintenance cost for measures installed (unit: currency per year): The planners of the risk reduction measures of road geohazard also estimate the annual maintenance costs, such as the costs to repair or replace structure materials or to remove sediments from flood or debris control dams.

7.7 Cost Benefit Analysis Indicators

Inputs items are annual risk reduction benefit, cost of risk reduction investment, annual cost, and discount rate (%)

Output are economic feasibility indexes such as benefit/cost ratio (BCR), net present value (NPV) and economic internal rate of return (EIRR) of risk reduction projects of road geohazard.

8. Conclusions

It is aware of the limitations of this procedure and requirement of further improvement as follows.

The accuracy of evaluation results depends on the quality of data entered for road geohazard event and rainfall, seismic acceleration, which needs further improvement.

The accurate disaster records (occurrence time, magnitude, damage assessment including economic loss estimate), dense distribution of rainfall stations, and automatic recording of the definite period of rainfall amount are essential to improving the accuracy of the assessment results. Numerical geohazard model calculation should be conducted to compensate for a shortage of actual geohazard data.
Strategy and practical use of temporary bridges and supporting structures

GRUBER, Jan

Department of Transportation
Czech Republic
The Age of Mega Disaster and Risk Governance - Thinking Creative for Road and Other Infrastructures

Norio OKADA
Professor Emeritus, Kyoto University, Japan
Senior Fellow, IASS, Potsdam, Germany
Adviser, IDiRRG, Kwansei Gakuin University, Japan
International Workshop on Disaster Management for Roads
Hibiya Rainbow Building, Tokyo, Japan May 31, 2017

Plan of my talk (1)

Prelude: Sendai Framework for Action

0. Self-introduction
1. Seemingly different, two challenging issues which I predicted we would face, right after March 11, 2011 Eastern Japan Earthquake
2. Challenge I (local)
   Geo-spatial integration over time
   Adaptive design for smart governance makes difference
3. Challenge II (global)
   Geo-focused, issue-based integration over time
   Adaptive design for smart governance makes difference

Plan of my talk (2)

4. Major message summarized:
   i) Mega-disasters challenge infrastructure: more creative thinking and communication (two competing process dynamics needed: top-down and bottom-up)
   ii) Integrated disaster management, especially governance

5. Conclusion
   ◆ Further ahead (from reactive to proactive)
   ◆ Anticipating Nankai Trough Earthquake in the Western Pacific Coast of Japan
   ◆ Climate change

Preamble

- To adopt a concise, focused, forward-looking and action-oriented post 2015 framework for disaster risk reduction;
- To complete the assessment and review of the implementation of the Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters;
- To consider the experience gained through the regional and national strategies/institutions and plans for disaster risk reduction and their recommendations, as well as relevant regional agreements for the implementation of the Hyogo Framework for Action;
- To identify modalities of cooperation based on commitments to implement a post 2015 framework for disaster risk reduction;
- To determine modalities for the periodic review of the implementation of a post 2015 framework for disaster risk reduction.

To attain the expected outcome, the following goal must be pursued:

- Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience.
Priorities for action

- **Priority 1:** Understanding disaster risk.
- **Priority 2:** Strengthening disaster risk governance to manage disaster risk. *Geo-spatial integration over time*
- **Priority 3:** Investing in disaster risk reduction for resilience.
- **Priority 4:** Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction.

Means of implementation (continued)

- (a) To reaffirm that developing countries need enhanced provision of coordinated, sustained and adequate international support for disaster risk reduction, in particular for the least developed countries, small island developing States, landlocked developing countries and African countries, as well as middle-income countries facing specific challenges, through bilateral and multilateral channels, including through enhanced technical and financial support and technology transfer on concessional and preferential terms, as mutually agreed, for the development and strengthening of their capacities;
- (b) To enhance access of States, in particular developing countries, to finance, environmentally sound technology, science and inclusive innovation, as well as knowledge and information sharing through existing mechanisms, namely bilateral, regional and multilateral collaborative arrangements, including the United Nations and other relevant bodies;

Follow-up actions

- The Conference invites the General Assembly, at its seventieth session, to consider the possibility of including the review of the global progress in the implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030 as part of its integrated and coordinated follow-up processes to United Nations conferences and summits, aligned with the Economic and Social Council, the High-level Political Forum for Sustainable Development and the quadrennial comprehensive policy review cycles, as appropriate, taking into account the contributions of the Global Platform for Disaster Risk Reduction and the Hyogo Framework for Action Monitor system.

Deficit of this holistic worldview and perspective!

Okada (2017)
Self-introduction: my research pathways

1978

[Diagram]

2017

Rural development / Community vitalization
Infrastructure planning and management
Disaster risk management
Water and environmental management

Methodology and Systems thinking

International organization-based
Local field-based
Adaptive community management
Conflict analysis and game theory
Risk analysis and management
Risk governance

The age of mega disasters

- Mega hazards × Vulnerable Communities × Interconnected societies → Local to regional to global impacts → short of structural change or into structural change
- Here and there sequential mega and other disasters (e.g. in Japan)
- Un-thinkables, Un-imaginables? Yet-unidentified gaps/holes in the conventional, existing social systems
  → governance deficits
- Sometimes social innovations and emergence of new self-organization and leadership

1. Seemingly different, two challenging issues which I predicted we would face, right after March 11, 2011 Eastern Japan Earthquake

- Evidence-based adaptive knowledge-action development approach
- Two different angles
- Both addressing needs for “adaptive management for smart governance”
- Common platform for communication and collaborative action development

Pagoda Model (by Okada) as a scope of multi-layer space and nature changing over time
Systemic risks and their risk governance
O. Renn (2017 etc) x N. Okada (2016)

- Interconnected world
- Networks of networks, Systems of systems
- Science of Complexity
- Emergence
- Cascading (Domino) effects
- Slowly developing risks => Catastrophe
- Structural change and transformation
- Breakthrough-making leading to innovation
- Breakdown of society and/or economy and survival failure
- Challenge for infrastructure: Super (-geo)-spatial risk governance over long period of time

Global Infrastructure as a “Network of Networks”

My local challenges (three decades)
Where is Chizu-cho, Tottori Prefecture?

Three decade-long local community initiatives (“machizukuri”) in Chizu, Tottori, Japan
- Decade I (1985-1995) warming-up phase
- Decade II (1995-2005) “zero-to-one movement” version1 (village community unit level)
- Decade IV (2015- ) more self-developing process, open community, new challenges by new and old residents
The role of Local Champion
- Atsushi Teratani, (63), the Postmaster of Nagi Post Office, also in Chizu, is one of the main founders of vitalization of the area.
- He and the residents are still in the process of activities, including the zero-ichi Community Vitalization Movement, aiming to build a lively community.

1. Local Communicator (Between local area and outside area)
2. Local Leader
3. Local Knowledge (Guiding for Outside Partner)

What is 0-to-1 Community Vitalization Movement? (Zero-ichi Movement)
- Rediscover something valuable but almost diminishing “0” (zero) and recreate it to “1” (one).
- Residents themselves should design ten-year processes of actualizing it together.
- Make smart changes implemented.
- Compete each other among communities.
- Every selected community gets each year 200,000 yen per year till 5th year. 100,000 yen thereafter.

■ 3 Pillars of 0-to-1 Movement
1. Exchanging Information
2. Local Autonomy
3. Local Management

Report of Zero-ichi Movement in Chizu-cho (Every March)

Zero-ichi Movement Activity of Hayase Village using Yonmenkaigi Workshop, 1997-2006

The Yonmenkaigi system (YSM), originally designed and used for collaborative action development for small groups in community-citizen vitalization initiatives (Machizukuri) in a mountainous area of Chizu Town, Tottori, Japan

The Yonmenkaigi System Method (YSM)

The Zero-to-one Version 2: Activities in Yamasato Area & Participatory Workshops
Implementation of YSM-based action plans
(Open Ceremony of Yamasato Area, Chizu in 13, July, 2008)

At the time of a disaster, Yamasato valley community has an action plan: Fukuhara bus stop to be an evacuation area, and they made curry rice as emergency food.

Semi-open in/out gate

Spiral local road access x expressway

What and how to build back better devastated Eastern Japan Region?
Vision

without Job?
without Training
Community

Good leadership
Local champion

Good facilitation
External support

Local government’s support

Adaptive design for small governance

Interregional highway routing from a longer-term perspective but local section finetuning might work effectively for a limited period of time latitude?

Spatial/Stagewise Rearrangement (Puzzle/game)

Resettlement By when?

Relocation promotion subsidy scheme

Time transition

Land use D
Land use E
Land use B
Land use C

Prohibitive for living? By when?

Neighborhood community 2

Neighborhood community 1

Industry and shops
Taro, Miyako City, Iwate
A tsunami devastated town
research outlet developed by Prof. Masaaki Taro, Iwate University

Mr. Shigeatsu Hatakeyama’s initiative
Supported by Louis Vuitton

NGO “Moriwa Koibioto”:
“The forest is longing for the sea”.

Recovery of Coastal Fauna after the 2011 Tsunami in Japan as Determined by Bimonthly Underwater Visual Censuses Conducted over Five Years
- Reiji Masuda,
- Makoto Hatakeyama,
- Katsuhide Yokoyama,
- Masaru Tanaka
- Published: December 12, 2016
- https://doi.org/10.1371/journal.pone.0168261
Geo-spatial integration over time
Adaptive design for smart governance makes difference

Where scientists find their roles?
- Theories and models
- Art of facilitation and communication
- Systematic documentation and archives
- Process design of adaptive management
- Workshop methods

Plan-Do-Action-Plan Process
Small but Complete by Adaptive Management

3. Challenge II (global)
Geo-focused, Issue-based integration over time
Adaptive design for smart governance makes difference

Systemic risk governance of mega disasters
- Mega hazards \times Interconnected societies \rightarrow Local-to-regional-to-global impacts \rightarrow Short of structural change or into structural change
- Here and there sequential mega and other disasters (eg. in Japan)
- Unthinkables, Unimaginables? Yet unidentified gaps/holes in the conventional, existing social systems \rightarrow governance deficits
- Sometimes social innovations and emergence of new self-organization and leadership

Risk Governance of Infrastructure needs more creative and imaginative
- "Critical infrastructure"
- Physical objects vs. Situation-dependent, Perception-dependent subjects/issues?
- Infrastructure potentially turns "critical mode", and more "cascading" to become "globally-critical mode" under systemic disaster risks
- Depends on how we perceive, how we scope the problem complex and what/how we wish to govern
- Systemic disaster risks make mega-disaster globally impacting disasters
Evidence-based adaptive knowledge-action development approach

Impact on Production in North America

<table>
<thead>
<tr>
<th>Month</th>
<th>Estimate</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td></td>
<td></td>
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<tr>
<td>Jun</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jul</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Initial loss estimate: 500,000 units
- Total lost production volume: 242,200 units
- Improvement: 257,800 units

*Courtesy: Toyota Motor Manufacturing Canada

Eastern Japan Earthquake (March 11, 2011):
Top Five Factors Affecting the Restart of Production at Toyota in Canada*

- The extensive, widespread damage.
- The damage to second-, third-, fourth- and fifth-tier suppliers.
- Semiconductor plants located in the Tohoku Region were impacted.
- Damage to industrial complexes in Japan.
- Effects of nuclear plant crisis.

*Courtesy: Toyota Motor Manufacturing Canada

What We Did During the Downturn*

*Courtesy: Toyota Motor Manufacturing Canada

Kenesas Electronics Corporation, Tohoku, Japan
(reporting by Kimura, Nikkei Electronics)

April 10, 2011

March 21, 2011

2500 volunteers/day from other areas and companies to repair the damages

http://www.nikkeibp.co.jp/article/reb/20110613/27378/
Collaborative survival rules tentatively developed

- Rival companies joined rescue and recovery
- And revised when next and next mega disasters occurred
- If we can promote this more strategically
- Adaptive design to ferment communicative space over time
- For smart governance
- New rules and collective behaviors implemented

Risk Governance of Infrastructure needs more creative and imaginative

- "Critical infrastructure"
- Physical objects vs. Situation-dependent, Perception-dependent subjects/issues?
- Infrastructure potentially turns "critical mode", and more "cascading" to become "globally-critical mode" under systemic disaster risks
- Depends on how we perceive, how we scope the problem complex and what/how we wish to govern
- Systemic disaster risks make mega-disaster globally impacting disasters

Collision scenarios:

- Ship Collisions
- Naps
- Oil leaks (e.g. BP (Hinterland-Critical Infrastructure))
- Piracy
- Terrorism (Raymond, 2006)
- Cyber Attack (Security issues)

Significant volcanic ash events

- Eyjafjallajökull, Iceland, 2010. The eruption’s ash plume drifted eastward, reaching as far as the United Kingdom and parts of Western Europe. Air travel over western and northern Europe was disrupted for six days because of the amount of ash injected into the atmosphere and the forecast that the ash would reach some areas of very high air traffic volume. The contingency plans and procedures for airspace control during this event were not adequately defined or understood, resulting in significant disruption to European and North Atlantic air traffic.
Recommendation 4/1 —
• In the context of ground-based lidar capabilities for volcanic ash detection in support of the International Airports Volcano Watch (IAVW), ICAO be invited to encourage the World Meteorological Organization (WMO) to continue its efforts to include volcanic ash in its programme of the Global Atmosphere Watch (GAW), recognizing that the GAW provides a strong framework for improving the use of lidar techniques and networks for the detection and characterization of volcanic ash in the atmosphere.

Adaptive design for smart governance
• Geo-focused, Issue-based integration over time
• Meeting together and repeat
• A seed of a rule/practice is adaptively brought forth.
• Make it a tentative(seed) rule/practice, and ferment it over time.
• Small to start, repeat step by step, with incremental knowledge, development, and networking.
• Adaptive design for smart governance
• The modest rule to start with is to meet again with small homework
• Research initiatives joined/endorsed by multiple stakeholders.

4. Major message summarized
i) Mega-disaster challenges infrastructure: more creative thinking and communication (top-down and bottom-up)

ii) Integrated disaster management, especially governance

http://www.idrim.org/

iii) Risk governance: Perspective, Methodology and Process Design of Communication Platform

IRGC Risk Governance Framework
• Originally proposed by Ortwin Renn, professor of sociology, University of Karlsruhe, Germany
• Refined, reexamined and evolved by IRGC S&T members and other reviewers
• Now published as the first of the series of IRGC Whitepapers.
• Implementation trials made for many different projects

We miss this!
Thank you for your kind attention!
Disaster Management Technologies
in Hanshin Expressway

ADACHI, Yukio

Hanshin Expressway
JAPAN
Strategy and practical use of temporary bridges and supporting structures

Presented by:
Jan Gruber
Ministry of Transport of the Czech Republic
Security Department,
Crisis Management Division

Contents

- Transport infrastructure
- Resilience
- Basic technological procedures for bridge renewal
- Emergency reserves for Recovery
- Training, research and development
- Other resources
- Atypical use of railway temporary constructions
- Practical experience of using temporary bridges
- Conclusions

Transport infrastructure

Road and motorway network of the Czech Republic

Transport infrastructure

Road Transport Infrastructure

<table>
<thead>
<tr>
<th>Bridges</th>
<th>Underpasses</th>
<th>Railway Crossings</th>
<th>Tunnels</th>
</tr>
</thead>
<tbody>
<tr>
<td>number</td>
<td>number</td>
<td>number</td>
<td>number</td>
</tr>
<tr>
<td>Motorways</td>
<td>843</td>
<td>530</td>
<td>0</td>
</tr>
<tr>
<td>1st class roads</td>
<td>3548</td>
<td>1181</td>
<td>225</td>
</tr>
<tr>
<td>2nd class roads</td>
<td>4467</td>
<td>536</td>
<td>685</td>
</tr>
<tr>
<td>3rd class roads</td>
<td>8852</td>
<td>842</td>
<td>1678</td>
</tr>
<tr>
<td>Total</td>
<td>16500</td>
<td>3089</td>
<td>2583</td>
</tr>
</tbody>
</table>

The statistic shows the percentual ratio of single-pole bridges with maximal span 18,0 m is 92,3%.

Based on this research - two economical version of footbridge with maximal span 18 m and 36 m were set up.
Natural Disaster - Floods

Support tools for planning

Risk model and equation:
\[ R = \frac{1}{1 + e^{-\beta (F - T)}} \]

Output – 1 value (risk R)

Cartographic materials, web applications, and software applications with risk assessment.

Software applications CritInfo is based on risk analysis procedures processed into a methodological framework for risk assessment of transport infrastructure.

National Traffic Information Center

Team of operators works on 24/7 basis

The center receives traffic information and traffic data from highways and expressways, evaluates traffic situations, and verifies generated traffic information. It receives traffic information about current traffic situation from many subjects including the police, firefighter departments, rescue teams, and traffic correspondents.

INTEGRATED TRAFFIC INFORMATION SYSTEM FOR CZ

Regulatory measures in road transport

A part of a system of economic measures for crisis situations:
- provide services in accordance with the emergency plan
- special legislation (Act No. 13/1997 Coll., On roads)
In order to maintain the mobility of transport infrastructure and to ensure the functionality and transport service, bridges are particularly critical.

The Ministry of Transport directs its efforts to ensure the repair of damaged or destroyed bridges in crisis situations by replacing them with temporary bridge constructions.

Sources of these materials are available to business entities or stored in standby stocks of the State Material Reserves Administration.

Emergency reserves

- materials and products to ensure the needs of the population and for operations of emergency services
- generated in the case when materials and products are not available

Renewal of the road infrastructure

Management of the Provisional Bridges under Crisis Situations

Leader: Ministry of Transport

Partners: Ministry of Defence
University of Defence Brno
Administration of State Material Reserves
Road and Motorway Directorate
Technical Schools
Private Businesses

Users: Bridge Owners (Stricken Regions, Municipalities, Infrastructure Managers)

Road Infrastructure Recovery

<table>
<thead>
<tr>
<th>Floods Situations</th>
<th>Type of bridge</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MS</td>
<td>TMS</td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td>Length</td>
</tr>
<tr>
<td>July 1997</td>
<td>14</td>
<td>384</td>
</tr>
<tr>
<td>July 1998</td>
<td>4</td>
<td>99</td>
</tr>
<tr>
<td>August 2002</td>
<td>39</td>
<td>798</td>
</tr>
<tr>
<td>March 2006</td>
<td>2</td>
<td>48</td>
</tr>
<tr>
<td>June 2009</td>
<td>15</td>
<td>294</td>
</tr>
<tr>
<td>August 2010</td>
<td>19</td>
<td>393</td>
</tr>
<tr>
<td>June 2013</td>
<td>5</td>
<td>96</td>
</tr>
<tr>
<td>TOTAL</td>
<td>98</td>
<td>2,112</td>
</tr>
</tbody>
</table>

Basic technological procedures for bridge renewal
Use of temporary bridges in crisis situations

Types and degrees of damage to bridge objects:
- Light damage to bridge structure without impact on load capacity
- Damage to the load bearing structure of the bridge with bearing capacity
- Destruction of the bridge object
- Damage or destruction of the access road

Summary of measures to restore transport infrastructure

A summary of measures to restore transport infrastructure includes:
- Planning,
- Construction and technical measures,
- Provision of resources and their preparation,
- Preparation of activation of forces and resources,
- Own recovery, which is divided into:
  - site survey
  - designing
  - construction work.

Implementation of building temporary bridge

Construction preparation
- Ensuring building permits, Depositing of debris, Landscaping, Disconnection of utility networks, Ensuring site space, Securing auxiliary building materials - road panels, aggregates, construction timber

Construction realization:
- Moving of building materials and technology; Focus and positioning of the runway, positioning of the bridge and pillars; Positioning of the crane; Construction of the runway, Construction of the individual parts of the bridge; Ejection of the bridge; Stacking of the bridge and construction of ramps on the bridge; Facilities (eg barriers, pedestrian walkways, traffic signs); handover of the bridge to the traffic controller

Operation and maintenance:
- Performing regular inspections and prescribed Technical Conditions maintenance

Technical Conditions MoT

The regulations and documentation for roads

Survey and geodetic focus

The main task of the reconnaissance team is to survey and perform the geodetic focus of the area where bridge construction is planned. The team is primarily composed of geodetters and experts in the TMS and MS bridging facilities.

The terrain representation in the 3D model

Support for the implementation of reconstruction/recovery of transport infrastructure

System hospodáření s mosty (BMS)

Information system BMS Vars for management of bridges

Information system for management of bridges BMS (http://bms.vars.cz/) is used for conducting main inspections on local bridges by investigations as well as providing necessary information in the framework of calculation of requirements. Possibility of comparison of the state and development of the disturbance of the original structures. Support for the implementation of reconstruction/recovery of transport infrastructure.

The elements to be removed

Simple scheme of the bridge location with instructions for construction and site preparation
Designing Shortened project documentation:
- Technical report (text part of the project documentation),
- Bridge layout and bridge situation (bridge crossing bridge 1:25, longitudinal section bridge 1:50 or 1:100 – by length of bridge),
- Scheme of assembly and dismantling of temporary bridge construction,
- Extract part of bridge temporary bridge kit including assembly tools.

Support for designers

PROJEKTOVÁNÍ A STAVBA PROVIZORNÍCH MOSTŮ ZE SOUPRAV
Design and construction of temporary bridges MS and TMS

More detailed information on the website. The websites are published and regularly updated site with fairly extensive additional information to aid in the design process.

Emergency reserves for Recovery

Warehouses of emergency reserves

Provisional Bridges in the Emergency Reserves

- Heavy bridge set – TMS
- Bridge Set – MS
- Pontoon bridge set – PMS
- Bridge Piers – PIZMO

<table>
<thead>
<tr>
<th>BRIDGE TYPE</th>
<th>BRIDGE NUMBERS</th>
<th>TOTAL BRIDGE LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMS</td>
<td>30</td>
<td>4581 m</td>
</tr>
<tr>
<td>MS</td>
<td>52</td>
<td>1056 m</td>
</tr>
<tr>
<td>PMS</td>
<td>11</td>
<td>802 m</td>
</tr>
</tbody>
</table>

Heavy bridge set - TMS

- These are steel framework structures, assembled from individually pre-manufactured components
- Depending on the load, they are built as one-storey, one-wall or two-storey constructions with two walls and reinforced
### Bridge Set - MS

- The structure is composed of full bridges parts of length 3 m.
- The bridge is approved for civilian traffic.
- MS is characterized by rapid and simple construction and low-carrying capacity.

### Pontoon bridge set - PMS

- It is a standardized folding bridge structure on floating supports
- The material of the set may be used to assemble bridges of floating supports with load-bearing capacity from 20 to 170 tons

### Bridge Piers - PIZMO

- It is a steel framework dismountable structure, which may be easily adapted to the load, and height and load-bearing capacity of the ground foundation
- Serves as a support for both railway and road bridges

### Training, research and development

**Ministerstvo dopravy**

Training, research and development

### Training and Education

Security Department organizes professional courses to prepare participants to be able in crisis situations in transport to ensure the implementation of measures, particularly in the case of the destruction of bridges.

Course participants:
- Private construction companies,
- Consulting companies for planning,
- Employees emergency departments of municipalities, regions and companies with a focus on road transport,
- Organizations and companies that protect temporary bridge structures and ensure their removal for the purposes of restoring bridges,
- Students civilian and military universities and colleges aimed at building bridges (such as the practice of theoretical training provided by the second subsystem).
Prefab bridge road MMS 2005

MMS 2005 is designed as a single-lane bridge.

This material was developed for use in the civilian sector designed in accordance with the DIN and other applicable regulations in the resort Ministry of Transport based on the findings from the 2002 floods.

Temporary bridges for pedestrian and bicycle traffic range of 3-18 m (the small bridge)

Through the transition piece can be connected together MMS in 2005 with the construction of MS.

Temporary bridges for pedestrian and bicycle traffic range of 3-36 m (the big bridge)

Modular footbridge with variable span from 3,0 m up to 36,0 was also designed as steel panel truss construction with modulus 3,0 m with headroom 2,50 m.

Other resources

Bridge mounted rear MMT

A fast-to-install road bridge with two lanes and two-sided walkways.

The set with two intermediate pillars allows to bridge the length of up to 135 m.

With a load capacity of 40 tons, the maximum span of one bridge field of 40 m can be achieved.

Plate bridge provision

For quick casting, small construction height, for reinforcing bridge structures for securing oversized transport.
Bridges mobile AM-50

Two types of mobile bridge constructions: Rail or full bridge

Bridge with a full bridge used in the AM-50 bridge car

Bridges mobile MT-55A

Rail bridge, the transport of which is ensured by the MT 55A bridge tank

Atypical use of railway temporary constructions

Sets of beams IP

Different sizes and lengths:

- IP 60 – 12, 14, 16
- IP 75 – 14, 16, 18, 20
- IP 100 – 16, 20, 22, 24, 26

For road bridges, the beams can be longitudinally joined

Atypical use of railway temporary constructions

Supporting railway bridges

During their reconstruction

Supporting road bridges

"Transport"
Atypical use of railway temporary constructions

Supporting statically disturbed buildings

Vertical and horizontal shifting of structures

Use of the PIŽMO structure for the lifting of a permanent bridge construction
The stroke of three parts of the arch of a permanent bridge construction up to 20 m high, with the maximum weight of individual parts 680 - 720 t using 5 auxiliary pillars PIŽMO

Floating support and installation of technological equipment

Auxiliary supports for the construction of permanent bridges or pipelines

Sliding track from the ZM-16 belts
Practical experience of using temporary bridges

We have in the reserves only of the former military structures that need to be equipped with provisional technical modifications to meet the requirements for civilian operation in times of peace - after crisis.

Mistakes in the design and placement of traffic signs: Incorrectly placed TS (TS combination on one pillar, TS position, etc.)

Need practical verification of the functionality of the bridge temporaries before commissioning.

Insufficient maintenance and control of bridges during long-term use.
The need for timely response to further potential floods and the provision of a bridge against the negative effects of natural threats.

No overview of their use and cycles

Installation of chips that are placed on important components and give information on how many times the element was used, where it was used and how many times it was cyclically loaded.

Conclusions

- Verification of the strategy after 20 years (1997-2016)
- Stock optimization
- International response - Humanitarian aid - Air transport requirements
- Education and training
- Modernization of inventories - technical and safety parameters
- Information on how many times were used individual parts of bridges
- Effective and fast retrieval of transport services and transport functions
- Increasing the resilience of the transport sector
Prediction and Enhancement of Resistance of RC Bridge during Service

ZHANG, Jianren
Changsha University of Science and Technology
CHINA
Disaster Management Technologies in Hanshin Expressway

Yukio ADACHI*, Masato OKAYAMA*, Nobuhiro ARIMA** and Takayuki ARAKAWA**

Contents

1. Highway network in Japan and Hanshin expressway
2. Lessons learned from previous earthquakes in Japan
3. Disaster Information Management using GIS Technology
4. Recent study for earthquake disaster mitigation
5. Conclusion

Highway network in Japan and Hanshin expressway

Current Highway system in Japan

Highway Network in Japan

Service length: 10,068km
(As of April 30, 2016)
Lessons learned from previous earthquakes in Japan

Structural feature of Hanshin expressway

Lessons learned from previous earthquakes

Seismic improvement to bridges and viaducts

Lessons learned from previous earthquakes

2011 East Japan earthquake
Lessons learned from previous earthquakes

Road network considering disaster resilience

Cost-benefit analysis considering disaster relief

2016 Kumamoto earthquake

Demand for more reliable structures and network

Disaster Management in Emergency

Event

Road closure

Technical Information Gathering, Sharing and Management

Immediate Repair (Road clear)

Detailed Inspection

Restoration

Road reopen

Disaster Information management system using GIS technology

Disaster management system

The Lessons of 1995 Kobe earthquake

The measures for information sharing was too bad.

Development of Disaster Information Management System

1999~2011

Disaster management system using GIS

Day-to-Day Work

Disaster Information Management System

GIS

Day-to-Day Work
Disaster management system using GIS

- Data sharing
- Network in the office
- Main Server
- Desktop PC at home
- Mobile phones
- The Internet

Disaster management system using GIS

- Share the map and data on the GIS
- Quick display of structural original drawings
- Easy updating to all users.

Disaster management system using GIS

- General electronic map (1/10,000)
- General aerial photograph map
- Plan drawings of viaducts
- Drawing of traffic markings
- Drawing of viaduct structures
- Layer to edit and display disaster information management
- Layer addable free
- Layer for Anti-Disaster
- Layer for users
- Layer for connection with our maintenance information system

Disaster management system using GIS

- Formation for disaster management works
- Posting information to bulletin board
- Application for Mobile phones
- Prediction of damage
- Maintenance information systems
- Highway running movie
- Day-to-Day Work

Disaster management system using GIS

- Change the mode
- Disaster management mode
- Normal mode
- Alert of emergency
- Formation for disaster management work

Disaster management system using GIS

- Bulletin board
Disaster management system using GIS

Application for Mobile phones

Mobile phone

Disaster management system using GIS

Prediction of damage

Decision of priority route for inspection

Input
Own Seismometers

Information of
• seismic waves
• location

Input
Japan Meteorological Agency

• seismic intensity
• Location

Disaster management system using GIS

Link to driver’s_view.mpg

Disaster management system using GIS

Link to maintenance information system

Disaster management system using GIS

Link to vehicle counter system
Recent study for earthquake disaster mitigation

- Upgrade disaster mitigation strategy toward keeping road function anytime in post event phase
- Demand of network-wide seismic behavior analysis
- Seismic wave simulation
- Structural analysis
- Network simulation in the earthquake event

Recent study for earthquake disaster mitigation

- Start network-wide simulation using super-computer resource available in Kobe
- Use finite element models in original design
- Super computer “KEI”
- FEM model for cable stayed bridge
- Super-multi span model for continuous bridges

Recent study for earthquake disaster mitigation

- Ground modeling
  - STEP1: Rock ground behavior
  - STEP2: Soil ground behavior
  - STEP3: Structure behavior

Recent study for earthquake disaster mitigation

- Structure modeling
  - Nakajima PA
  - Hekko JCT
Recent study for earthquake disaster mitigation
- Structure modeling

Recent study for earthquake disaster mitigation
- Fault rupture and structure behavior simulation

Recent study for earthquake disaster mitigation
- Predicting the post event situation of viaduct road through combination study of earthquake simulation and driving simulation.

Conclusion
- Disaster Management Technologies in Hanshin Expressway is presented here by introducing soft management measures.
- In addition to soft management measures, hard management measures especially for tsunami disaster is also going.
- Continuing seismic retrofit program is also going to raise up the performance level from “not-collapse” to “keep road function”.

Thank you!
and
Be prepared!
A Methodology for Emergency Response Decision Makings
with the Consideration of Unexpected Contingencies

ONISHI, Masamitsu
Kyoto University
JAPAN
Prediction and Enhancement of Resistance of RC Bridge during Service

Prof. Jianren Zhang

Changsha University of Science and Technology, China
More attention to safety assessment of service bridges

- At present, performance degradation issues of material components -structure of bridges has become increasingly prominent under adverse environmental and load effect.

- Federal highway administration (FHWA) has implemented "Long-term bridge performance (LTBP)" research project from 2008 to 2018, and will collect bridges data of the key nodes of the road network to improve the understanding of performance deterioration of the bridge, and develop predictive models of deterioration.

- China’s Ministry of Transport is preparing to carry out a 25-year "Long-term bridge performance plan" to improve service level and safety operations of bridges from 2014 to 2019.

Material property testing

- Chloride diffusion test
  - Built artificial climate chamber (Invention No. 201710215274.4)
  - Accelerated reinforcement corrosion test and concrete diffusion test under conditioned circumstances
  - Established the dynamical diffusion coefficient model
  - Diffusion coefficient increases with increasing diffusion depth
  - The consideration of spatial variability enhanced the corrosion initiation probability about 13% to 18.5%

Material property testing

- Mechanics test on corroded bars
  - Axially corroded bars
  - Axially corrugated bars in tension

- Concrete bars from existing bridge

Tension test on 900 corroded bars

Strength reduction has approximately a linear relationship with corrosion loss:

\[ f_{c} = f_{c0} - k \cdot \text{Corrosion Loss} \]

Sample of deteriorated concrete

Mechanics test on deteriorated concrete

Constitutive law of deteriorated concrete

- Strong nonlinearity exhibits at the initial loading test
- Reduction of the ultimate strength and elastic modulus
- Increase of the strain corresponding to peak stress
Experimental Research for Resistance Deterioration

Material property testing
Tension test of bonded specimens

- Applied load to 10 bonded specimens with deformed and plain bars.
- Bond between plain bars and concrete is more sensitive to corrosion.

Accelerated corrosion test
RC beam/column test

- Corrosion effects on beams significantly increase the ultimate deflection.
- Corrosion of longitudinal and induced bars affect significantly the ultimate shear strength.

Test on existing bridge members
Beam test

- Section damage, concrete deterioration, and bars corrosion affect significantly the ultimate strength.

Test on existing bridge members
Arch test

- Establishment of the principle of element division, boundary condition, and the method to consider material property degradation, concrete cracking, and local damage during model building.

Numerical calculations
Ultimate strength of deteriorated RC bridge

- Developed a numerical calculation technique for the service performance of deteriorated bridges and members.

Structural Resistance Degradation Prediction and Updating

### Probabilistic resistance model

**Corrosion loss**

- Aggressive environment changes corrosion type in concrete bridge
- General corrosion and pitting corrosion may occur simultaneously or separately in practical engineering, which increases the model uncertainty
- The likelihood of different corrosion types is important for corrosion loss prediction

\[
D(t) = D_0 = 0.023(t - T)/1000 \quad \quad \rho(t) = 0.0116\left(t - T_0\right)\frac{1}{1000}R
\]

Considering the probability of general corrosion and pitting corrosion model, the corrosion loss can be written as

\[
\rho_{corr}(t) = \rho_{g}(t)\rho_{p}(t)\rho_{g}(t)\rho_{p}(t)
\]

---

### Load testing-Bayesian network

- Load testing is an efficient method for bridge assessment, but this method can not directly reflect structural strength
- Traditional Bayesian method can update model and parameters using observed data
- There is a crucial need to develop a updating method involving intermediate or smaller module calculations, e.g. using deflection data to predict structural strength
- Bayesian network is a type of statistical model and is one of the most useful methods for uncertainty expression and information fusion

---

### Bayesian network updating method

- Load testing directly represents structural stiffness
- Structural strength and stiffness, corrosion initial time, corrosion loss and other influencing factors can be regarded as the nodes in a network
- Bridge strength prediction method integrating the Bayesian network and load testing is proposed, and a Markov Chain Monte Carlo method is developed to implement the calculation process
- All the nodes can be updated given an observation for one node

---

### Corrosion parameters updating

- The posterior mean of the corrosion initiation time increases from 4.62 years to 7.4 years
- The 95% confidence bounds and the variability are decreased
Structural Resistance Degradation Prediction and Updating

- A stable posterior mean strength prediction is obtained by the updating method.
- The standard deviation decreases 34%, 49%, and 53% with increasing updating times.

The Theory and Method of Resistance Enhancement

The experimental research of resistance enhancement

- The experimental research of 60 RC beams was carried out, the beams included strengthened beams after being corroded and corroded beams after being strengthened.
- The influence of parameters such as concrete strength, plate thickness and outer thickness on resistance deterioration of corroded beams was analyzed.

Probabilistic timing for reasonable resistance enhancement

- Probabilistic method for resistance enhancement was developed.
- Developing the resistance enhancement device.

Indirect cost model for resistance enhancement

- Optimized indirect cost models for toll loss, fuel cost, etc. due to bridge resistance enhancement actions.
- The influence of type of vehicle and drivers was considered.

Multi-objective decision method for resistance enhancement

- Multi-objective optimum decision method for resistance improvement was developed.
- An integral enhancement system of bridge performance-cost-enhancement action.
The Theory and Method of Resistance Enhancement

The resistance enhancement of real bridge

strengthening of real bridge

analysis of real bridge

analysis of condition index

analysis of annual enhancement cost

Achievement Application

Popularization and application

Achievements application

- More than 50 papers were published at Journal of Structural Engineering, Structural Safety, Computers & Structures, Journal of Bridge Engineering, etc.
- Achievements have been widely applied for safety assessment and maintenance of more than 700 service bridges in Hunan province, and has reduced the removal of bridge of more than 100 old bridges

Shuanghe bridge in Changsha

Yuzhuang bridge in Guangxi

Zhangjiawan bridge in Yongyuan

Main achievements

- "Concrete bridge service performance and residual life assessment method and its application ", listed to get reward of second prize of the 2015 National Prize for Progress in Science and Technology
- "Evaluation of durability of concrete bridges theory and its applications", listed to get reward of first prize of the 2010 Hunan Prize for Progress in Science and Technology
- "Time-dependent reliability analysis of existing reinforced concrete bridges and Study on Bearing Capacity evaluation", listed to get reward of second prize of the 2004 Hunan Prize for Progress in Science and Technology
- "Structural reliability theory and its application in highway engineering", listed to get reward of second prize of the 1999 Hunan Prize for Progress in Science and Technology

Acknowledgements

Supported by the following Grants

<table>
<thead>
<tr>
<th>Project</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Natural Science Foundation of China</td>
<td>Influence of repair actions on the effect of (time-dependent) reliability of RC beam bridge (51178080)</td>
</tr>
<tr>
<td>National Natural Science Foundation of China</td>
<td>Degradation model of shear performance of existing RC bridge component and its reliability (50978031)</td>
</tr>
<tr>
<td>National Natural Science Foundation of China</td>
<td>Time-dependent reliability of existing reinforced concrete bridges (50778032)</td>
</tr>
<tr>
<td>National Natural Science Foundation of China</td>
<td>Dynamic reliability of long-span concrete cable-stayed bridge during construction (9077001)</td>
</tr>
<tr>
<td>Key basic research project of Ministry of Transportation</td>
<td>Mechanism and reliability assessment of bridge cable damage under common bridge category (50478003)</td>
</tr>
<tr>
<td>Key basic research project of Ministry of Transportation</td>
<td>wind, rain monitoring and simulation of Changsha bridge (201111820140)</td>
</tr>
<tr>
<td>Key basic research project of Ministry of Transportation</td>
<td>Residual life prediction method of concrete bridge(20031140019)</td>
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<tr>
<td>Basic application research projects of Ministry of Transportation</td>
<td>Reliability model of service deterioration of existing concrete bridge components (2004110334)</td>
</tr>
<tr>
<td>Basic application research projects of Hunan province</td>
<td>Evaluation of durability for concrete bridge (64842006)</td>
</tr>
</tbody>
</table>

Conclusion

Research group of safety and durability assessment of bridge at Changsha University of Science and Technology has worked on structural deterioration of bridges. Assessment of time-dependent reliability and optimization of resistance Enhancement, and carried out a large number of experiments and theoretical analysis in the field.
We hope that we can work with bridge mates from all over the world to protect the safety of deteriorating bridges together!
Thank you for your attention!
ICHARM's Practices of Flood Hazard and Risk Assessment

GUSYEV, Maksym

ICHARM, Public Works Research Institute, MLIT, JAPAN UKRANE
A Methodology for Emergency Response Decision-Makings with the Consideration of Unexpected Contingencies

Masamitsu Onishi
Disaster Prevention Research Institute, Kyoto University &
Katsumi Seki, Katsumi Wakigawa, Kiyoshi Kobayashi

Introduction

Joint Statement by the Presidents of JSCE, JGS and CPIJ after the Great East Japan Earthquake

This earthquake disaster is said to be unprecedented and beyond expectation. However, when we use the term 'beyond expectation', it must not mean an excuse as professionals. For such a catastrophic disaster, we should reaffirm the importance of soft policy as well as hard policy (e.g. building facilities), holding awe for nature as our ancestors did.

Why an expectation is needed?

- Disaster countermeasures as public decision-making
- Accountability required for public decision-making
- Modern rationalism based on causality relationship

Requirements for Expectation

- Analysis by professionals on disasters' physical phenomena
- Acceptability by society based on experience
- Expectation as a social consensus

Selection of Countermeasure Based on Prospect

<table>
<thead>
<tr>
<th>Scenario of disaster</th>
<th>Cause</th>
<th>Prospect</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Prevent, 1 billion JPY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Prevent, 2 billion JPY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Prevent, 2.5 billion JPY</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Expectation as a social consensus
想定の壁
A Wall of Expectation

防災から減災へ
From Disaster Prevention to Disaster Reduction

・想定内の災害シナリオに対しては、完全に防御できる。
Disaster scenario with in the expectation can be prevented.

・安全神話
A myth of safety

・想定外リスクの可能性は排除できない。
Risk of beyond expectation cannot be excluded.

・完全には防御できないことを前提にどうすべきか？→
On the premise that we cannot protect from disaster perfectly, how should we do?
→Disaster Reduction

減災計画論に向けて
Toward the Disaster Reduction Approach

選択された対策（基本対策）は、想定外のいかなるシナリオまで対応できるのか？
What disaster scenarios of outside the expectation can be dealt with by a selected basic countermeasure?

対応できないシナリオに対しては、どのような対策案があり得るのか？
What alternatives are available to deal with scenarios which the basic scenario cannot cope with?

災害対策の能力評価
Capability Assessment of Basic Countermeasure

重層的防御
Multi-layered Countermeasures

Identification of Extention by Retrodiction and Generalization
Deductive analysis by simulation
Split the danger zone in the first estimation into 60 meshes
Set the danger zone in the second estimation around the one in the first estimation

おわりに

Conclusion

・想定は基本対策のための社会的コンセンサス（=第1次想定）
Expectation is a social consensus for selecting a basic countermeasure (=the first-order expectation)

・第2次想定まで含めた第1次想定を超える基本対策で対応できない災害シナリオ（想定外リスク事象）に対応する非常時対策の検討
By extending to the second-order expectation, identifying disaster scenarios that a basic countermeasure cannot cope with (i.e., the risk of unexpected) and consideration of emergency countermeasures.

・重層的対応システムの必要性
Necessity of multi-layered countermeasure system
Development of the Web-based Disaster Management Manual

UNO, Takumi

Hanshin Expressway
JAPAN
ICHARM’s Practices of Flood Hazard and Risk Assessment

International Workshop on Disaster Management for Roads

M. Gusyev, Y. Tokunaga and K. Miyake

International Centre for Water Hazard and Risk Management (ICHARM) under auspices of UNESCO, Public Works Research Institute (PWRI)

31st May 2017
Tokyo

Outline

1) Flood disasters overview
2) Flood assessment methodology
3) ICHARM’s background and approach
4) Examples of ICHARM’s flood assessment

Flood disasters overview

Floods are devastating disasters causing major economic damages and losses of lives:

- Australia: Dec 2010-Jan 2011 flood in Brisbane;
- Thailand: Sep-Dec 2011 flood with about $40 billion in economic damage due to 5 typhoons from June to October (ICHARM/PWRI, 2016);
- Pakistan: July 2010 and August 2013 floods;
- Russia and China: August 2013 flood in the Amur River basin flooding major cities (SHI, 2017);
- Myanmar: July – September 2015 flood;


ICHARM as a regional knowledge hub

In 2006, ICHARM was established as UNESCO Category 2 Center.

In 2007, ICHARM acted as Lead Organization for priority theme “Water-related Disaster Management” in the 1st Asia-Pacific Water (APWS) Summit and Regional Knowledge Hubs established.

ICHARM’s activities and challenges

ICHARM’s Challenge: Localism
Delivering best available knowledge to local practices

ICHARM’s Challenge: Localism
Delivering best available knowledge to local practices

Flood hazard and risk mapping in US and EU

- Community based
- Past Event: display past flood event (e.g. remote sensing)
- Simulation model based
  2D hydraulic model for diffusive-type inundation
  1D hydraulic model (e.g. HEC-RAS) + 2D inundation model


ICHARM’s Practices of Flood Hazard and Risk Assessment

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31st May 2017
Tokyo
Flood hazard and risk assessment

**Risk = Hazard x Vulnerability**
- Local data are usually unavailable.
- Models are constructed with globally available datasets such as satellite-based topography and rainfall and inundation simulations are compared with satellite images of flood extent.
- Flood river discharge and inundation depth are calibrated with local data collected during field surveys to include road planning and design of road facilities, embankment, etc.
- Vulnerability (or fragility) curves are developed using collected damage data of past floods.

**Examples of ICHARM’s flood assessment**

- **Common features:**
  - Dam infrastructure is main source of water supply
  - Agriculture is a main economic activity during dry/wet seasons
  - Exposed to severe floods in the past
  - Chao Phraya River basin, Thailand
  - Indus River basin, Pakistan
  - Pampanga River basin, the Philippines
  - 2010 Pakistan flood hazard simulation:
    - 2010 flood damages of about 40 billion USD
    - Infrastructure damages of 1.1 billion USD with about 25,000 km of roads and 1,600 railroads
    - Preparation of hazard map using satellite data
    - Cover flooded area in Lower Indus
    - Developed Indus-IFAS with collaborating Pakistani Government

**Flood Risk Assessment in Pampanga Basin**

- **INPUT DATA:**
  - Rainfall data (ground gauges, forecasted)
- **OUTPUT DATA:**
  - Rainfall distribution maps
  - Hydrographs at specified locations
  - Inundation extents in mid-low Indus
Thank you very much for your attention!

Mt. Tsukuba and

ICHARM
Development of the Web-based Disaster Management Manual

May 31st, 2017
Tokyo, JAPAN
TCE.3, PIARC

Shinjuro KOMATA
Nippon Koei Co., Ltd. JAPAN

Contents
1. What's Risk Management Manual?
4. Functions of Components (Toolbox, Archives, and Links)
5. Inventory Sheets in Toolbox

1. What's Risk Management Manual?

1) Objective (1)

RM - Manual:
The knowledge database designed to introduce and share the risk management techniques, and their practices among PIARC countries:

2) System of Web-based RM-Manual

Designed by Web-application: Drupal, mySQL Database

/ version : Easy PHP 5.3.5.0
/ Web server: Apache 2.2.17
/ language: PHP 5.3.5
/ database: MySQL 5.1.54
/ content management system: Drupal 7

1) Objective (2)

- Introduction of RM techniques to the road sector systematically
- Popularization of the road RM technology in developing countries
- Utilization of RM-Manual as a common property of PIARC

/ Using a Web-application provides an easy, centralized always accessible, and uncomplicated method

for PIARC TC members to contribute risk management techniques and examples to the database

1) Point and click directly:
/To show components in the RM-Manual database such as Toolbox with Inventory sheets and Archives by point and click directly.

2) Search function:
/To search subjects both in the RM-manual and in other external Websites to link to a searchable risk management database such as technical standards, technical papers, etc.

3) Building continually:
/To continue building a vibrant Website for road communities.


Fig.1 Start screen of Risk Management Manual:

4. Functions of Components 1) Toolbox(1)

Fig.2 Screen of Toolbox:

1) Toolbox(2): Faceted Search

Fig.3 Screen of Faceted Search:

Relation RM Process/Toolbox

Establish The Context

Risk Assessment

Identify the Risks

Analyze the Risks

Evaluate the Risks

Treat the Risks

Communicate And Consult

RM-Toolbox

Monitor And Review
4. Functions of Components

2) Archives

Fig. 4 Screen of Archives:

A menu involves previous TC activity reports, useful documentations of TC members for road risk management, and so on.


3) Links

Fig. 5 Screen of Links:

A menu linked with other web sites relating to RM such as RM-manuals and RM-publications for roads.

5. Inventory Sheets in Toolbox

5. Inventory sheets in Toolbox

5. Inventory Sheets in Toolbox

5. Inventory sheets in Toolbox

5. Inventory sheets in Toolbox

5. Inventory sheets in Toolbox

5. Inventory sheets in Toolbox

5. Inventory sheets in Toolbox

5. Inventory sheets in Toolbox

Inventory sheets include 126 contents/elements

Natural disaster Inventory Sheets

Natural events:
Earthquake, Storm surge/tsunami, Volcano, Flood/Heavy rain, Windstorm, Snow/Freeze, Landslide/Rock fall/Debris flow, and Others

Man-made disaster Inventory Sheets

Probability of Road accidents:
(Example: Traffic accident, dangerous goods transport, overloading vehicles, Tunnel fire etc)

Other events:
(Example: Closure of road due to explosion in the factories near road, fire, effect of nuclear accident, terrorism, war etc)
Example of Risk Inventory Sheet

Fig. 13 Tunnel inspection using a laser scanner.

Example of Risk Inventory Sheet

Fig. 14 Evacuation guidance to mitigate tsunami disaster.

Example of Risk Inventory Sheet

Fig. 15 Tsunami signal planning.

Example of Risk Inventory Sheet

Fig. 16 Bridge beam protective structures.

Example of Risk Inventory Sheet

Fig. 17 Information Provision.

Usage Example: In case of slope failure

Establish The Context

1. Define the basic parameters.
2. Consideration must be given to the objectives, stakeholder expectations.

- Site Location
- Natural Event
- Risk Criteria

Search keywords: Disaster slope failure, inspection
Identify the Risk

Data/Information Collection
- Disaster history, Weather Information
- Inspection

Source Identification
- Measurement management system, etc...

Identify the Risk

Visual inspection, etc...

Source Identification
- No.1 R15 Site A
- No.2 R15 Site B
- Described Rock fall, Landslide
- Status Emerging, Live

Evaluate the Risks

<table>
<thead>
<tr>
<th>No.</th>
<th>Risk Score</th>
<th>Risk Category</th>
<th>Risk Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.1</td>
<td>500</td>
<td>Extreme</td>
<td>1</td>
</tr>
<tr>
<td>No.2</td>
<td>10</td>
<td>High</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No.1</th>
<th>Risk Score</th>
<th>Risk Category</th>
<th>Risk Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-10</td>
<td>Low</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>200</td>
<td>Very High</td>
<td></td>
</tr>
</tbody>
</table>

Analysis Risks

Rating the Likelihood
- Threat
  - No.1 Rating 5
  - No.2 Rating 1
- Opportunity
  - Rating 1
  - Rating 4

Rating the Consequence
- Threat
  - No.1 Rating 100
  - No.2 Rating -10
- Opportunity
  - Rating 10
  - Rating -70

Treat the Risks

1. The selection of a treatment type
2. The identification of treatment actions

Evaluation Sheet 3, 15, 31, 32

Inventory Sheet 68, 108


1) Goal:
   - PIARC association’s web-based knowledge database
   - Release to PIARC web-site by the end of current cycle, 2019

2) TCE.3 member’s contribution useful contents to the RM- Manual continually:
   - RM information, topics, and articles
   - Inventory sheet, / RM manual,
   - Case studies on techniques for managing risks of natural/man-made hazards including adaptation to the climate change effects.

Summary

1. What's Risk Management Manual?
4. Functions of Components (Toolbox, Archives, and Links)
5. Inventory Sheets in Toolbox
6. Conclusion
Thank you!
‘Future Ready’ impacts and what they mean to our Highway Networks

ELLIOTT, James

ELLIOTT ASSET MANAGEMENT
U.K.
We’re all comfortable with the words – or are we?

20% increase in peak rainfall by 2050, 30% by 2085 compared to today.

Sea levels are rising at around 3mm a year. Over a century this means that sea levels will be around 1m higher than the early 2000’s.

Unprecedented weather and network risks.

It’s all about PEOPLE:
- Demographics
- Mobility
- Lifestyle
- Loneliness
- Future Generations

Generally people like London. North Londoners are happier and less anxious.

Men have many more close friends.

1 in 4 don’t see family members each week.

After housing, air quality most important.

Lack of confidence in the future or a better life in 5 years’ time!

Unprecedent weather and network risks.

Hardly any Londoners borrow from each other.

An anonymous city!
4 KEY NETWORK CHANGE AREAS

- **Society**
  - Healthy
  - More lonely
- **Climate**
  - Sea levels
  - 1m by the end of the century
- **Resources**
  - Renewable energy
  - Water availability
- **Technology**
  - Self-driving vehicles
  - Sensing
- **Biodiversity**
  - A need for flexibility
- **Modular build**
  - Toward

**CONCLUSION – WHAT SHOULD WE BE DOING**

- Understand the future: not just for us but for future generations
- Understand the impacts arising from Society, Technology, Resources and Climate
- Have a clear and consistent view about what our future world will look like. Engagement is critical
- With this understanding our challenge is to design our networks to both current code and our future world

**WHAT ELSE SHOULD WE BE DOING**

- Everyone should have a ‘Future Ready’ change programme
- Use your data and if it isn’t good enough commission more data but share it to predict the impacts
- Make Future Ready a key focus for highway infrastructure
- In particular understand ‘people’ changes and impacts to our networks

**ARE YOU READY FOR FUTURE READY?**

- James@elliottassetmanagement.com

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“I’ve read the last page of the bible. It’s all going to turn out alright”

“The future is purchased by the present”

“The future destiny of the child is always the work of the mother”
Closing Remarks

SEKIMOTO, Hiroshi
Executive director, Hanshin expressway

TAMURA, Keiichi
Chairman, TC E.3 PIARC
Adjunct Professor, Kyoto University,
3. SEMINAR DISCUSSIONS

Opening Session 10:00-10:30

Session1 10:30-11:45

Efforts for Recovery of Roads from the 2016 Kumamoto Earthquake
Kazuhide Kiyasu, Japan

Q1
In my country (Czech Republic) we usually use temporary bridges to detour to avoid damaged bridges across the river. Do you use temporary bridges in Japan?

A1
In Japan we also use temporary bridges in some cases, but in Kumamoto case we decided to use the alternative road because the damaged area was quite wide. As for Aso-Bridge, it was not appropriate to use temporary bridges because of the bridge length and we decided to fully

Emergency Management and Resilience in Transportation
Herby Lissade, USA

Q1
In the case of disaster, it is necessary to recover the function of highway network quickly. At the same time we need to pay attention to bid rigging in procurement. Bid rigging would help procurement process to be shortened but it would not be the reason why bid rigging is justified in the disaster situation.

In Cartrans do you have any counter-measure to make public procurement quick and fair?

A1
We’ve just checked how to make an emergency contract. We prepare $1.2 billion for an emergency contract for recovery works. We calculate the appropriate price with 20 – 30 % markup and confirm contractors in advance.

Federal Government also supervise the procurement process in order to prevent bid rigging. We can compare the price of the emergency contracts with that of past ordinary contracts.

Q2
Is it possible to share the assessment results using your evaluation tools?

A2
The tools which is produced by TRB are published for free via the website.
Q1
The delay of recovery also causes the economic loss. In your method how do you consider the duration time for recovery works?

A1
I refer to research results by PWRI on days required for recovery works depending on the scale of slope damage. In my method economic loss per day is calculated based on traffic volume and detour and standby losses. Then I can calculate total economic loss by multiplying daily economic loss derived from my method by the duration of road closure.

Keynote Presentation 13:20-14:05
The Age of Mega Disaster and Risk Governance – Thinking Creative for Road and Other Infrastructures
Norio Okada, Japan

Session 2 14:05-15:20
Strategy of the Use of Temporary Bridges in Crisis Situations
Jan Gruber, Czech Republic

Q&A NO

Disaster Management Using GIS Technology
Yukio Adachi, Japan et. al.

Q&A No

Prediction and Enhancement of resistance of RC Bridge during Service
Jianren Zhang, China

Q&A No

Session 3 15:40-17:20
A Methodology for Emergency Response Decision-Makings with the Consideration of the
Expected Contingencies
Masamitsu Onishi, Japan et. al.

Q1
How do you expect and define the valuation of disaster.
A1
We need academic evidence for disaster expectation because it is really difficult to define it. Therefore risk communication between experts and public is important.

ICHARM’s Practices of Flood Hazard and Risk Assessment
Maksym Gusyev, Ukraine et. al.

Q1
Is this method expensive?
A1
This is not expensive but it depends on the resolution of data.

Web-based Disaster Management Manual
Takumi Uno, Japan et. al.

Q&A No

Closing Session 17:20-17:30
## 4. Workshop Summary Sheet

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PIARC Technical Committee</td>
<td>PIARC TC E.3 Disaster Management</td>
</tr>
<tr>
<td>2</td>
<td>Host country</td>
<td>Japan</td>
</tr>
<tr>
<td>3</td>
<td>Seminar title</td>
<td>International Workshop for Disaster Management for Roads</td>
</tr>
<tr>
<td>4</td>
<td>Seminar venue</td>
<td>Iidabashi Rainbow Building, Tokyo, Japan</td>
</tr>
<tr>
<td>5</td>
<td>Seminar dates</td>
<td>May 31, June 1-3, 2017</td>
</tr>
<tr>
<td>6</td>
<td>Number of speakers from lower middle income and low income countries</td>
<td>1 (UKR)</td>
</tr>
<tr>
<td>7</td>
<td>Number of speakers from upper middle income countries</td>
<td>1 (CHN)</td>
</tr>
<tr>
<td>8</td>
<td>Number of speakers from high income countries</td>
<td>9 (CZE-1, JPN-6, UK-1, USA-1)</td>
</tr>
<tr>
<td>9</td>
<td>Number of participants (exclusive speakers) from lower middle income and low income countries</td>
<td>1 (LAO)</td>
</tr>
<tr>
<td>10</td>
<td>Number of participants (exclusive speakers) from upper middle income countries</td>
<td>1 (MEX-1)</td>
</tr>
<tr>
<td>11</td>
<td>Number of participants (exclusive speakers) from high income countries</td>
<td>107 (CZE-1, KOR-1, JPN-105)</td>
</tr>
<tr>
<td>12</td>
<td>Total participants (sum of Q6-Q11)</td>
<td>120</td>
</tr>
<tr>
<td>13</td>
<td>Total participants from host country</td>
<td>111</td>
</tr>
<tr>
<td>14</td>
<td>Number of lower middle income and low income countries represented</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>Number of upper middle income countries represented</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>Number of high income countries represented.</td>
<td>5</td>
</tr>
<tr>
<td>17</td>
<td>Was a PIARC Technical Committee meeting held the same week?</td>
<td>YES (2.0 day meeting)</td>
</tr>
<tr>
<td>18</td>
<td>Was the seminar held in connection with another non-PIARC event? If yes, which event and organization?</td>
<td>JRA, REAAA &amp; Hanshin expressway</td>
</tr>
<tr>
<td>19</td>
<td>Duration of the seminar, incl. field visit. Was a field visit organized?</td>
<td>YES (Tokyo Aqua Line and Kumamoto earthquake disaster area)</td>
</tr>
<tr>
<td>20</td>
<td>Registration fees – (Currency)</td>
<td>€ 0</td>
</tr>
</tbody>
</table>
5. Evaluation Summary of the International Workshop
For TCE.3 Tokyo (JAPAN) 31th May 2017

1. General Information
General information is tabulated below.

<table>
<thead>
<tr>
<th>Relevant organizations</th>
<th>PIARC TC E.3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>JRA, REAAA, Hanshin expressway</td>
</tr>
<tr>
<td>Number of participants</td>
<td>120</td>
</tr>
<tr>
<td>Number of countries involved</td>
<td>9</td>
</tr>
<tr>
<td>Number of answers for questionnaire</td>
<td>48</td>
</tr>
<tr>
<td>Theme of workshop</td>
<td>International Workshop for Disaster Management for Roads</td>
</tr>
<tr>
<td>Technical visits</td>
<td>Tokyo Aqua Line</td>
</tr>
<tr>
<td></td>
<td>Kumamoto earthquake disaster area</td>
</tr>
</tbody>
</table>

2. Synthesis of answers
Average satisfactory rating of each answer is shown below.

<table>
<thead>
<tr>
<th>Item</th>
<th>Strongly agree (5 pts)</th>
<th>Agree (4 pts)</th>
<th>Neutral (3 pts)</th>
<th>Disagree (2 pts)</th>
<th>Strongly disagree (1 pt)</th>
<th>Average score</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) The seminar provided useful information/knowledge.</td>
<td>9</td>
<td>32</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>4.0</td>
</tr>
<tr>
<td>b) The content of the seminar was current and relevant.</td>
<td>9</td>
<td>27</td>
<td>11</td>
<td>1</td>
<td>0</td>
<td>3.9</td>
</tr>
<tr>
<td>c) The methodology of the seminar was productive.</td>
<td>9</td>
<td>31</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>4.0</td>
</tr>
<tr>
<td>d) The seminar responded to my expectations.</td>
<td>9</td>
<td>20</td>
<td>17</td>
<td>2</td>
<td>0</td>
<td>3.8</td>
</tr>
<tr>
<td>e) The content of the seminar met its terms of reference.</td>
<td>11</td>
<td>28</td>
<td>8</td>
<td>1</td>
<td>0</td>
<td>3.9</td>
</tr>
<tr>
<td>f) The quality of the presentations was high.</td>
<td>8</td>
<td>26</td>
<td>13</td>
<td>1</td>
<td>0</td>
<td>3.9</td>
</tr>
<tr>
<td>g) The quality of the discussions was high.</td>
<td>3</td>
<td>7</td>
<td>20</td>
<td>18</td>
<td>0</td>
<td>2.9</td>
</tr>
<tr>
<td>h) Time for discussions was adequate.</td>
<td>5</td>
<td>10</td>
<td>23</td>
<td>9</td>
<td>1</td>
<td>3.2</td>
</tr>
</tbody>
</table>

3. Comments and opinions to be noticed
- The workshop covers wide variety topics.
- Information sharing of foreign and current case studies.
- Do it annually.
- The presentaiton that covers PIARC activites is expected.
- We expect handouts for clear understanding of the presentations.
- Presented materials should have been downloaded from website in advance.
- Few question and no interactive discussion.
a) The workshop provided useful information/knowledge.
b) The content of the workshop was current and relevant.
c) The methodology of the workshop was productive.
d) The workshop responded to my expectations.
e) The content of the workshop met its terms of reference.
f) The quality of the presentations was high.
g) The quality of the discussions was high.
h) Time for discussions was adequate.