JO8-1

Japan International Cooperation Agency (JICA)

Ministry of Transport and Roads of the Kyrgyz Republic

THE PROJECT FOR CAPACITY DEVELOPMENT FOR ROAD DISASTER PREVENTION MANAGEMENT IN THE KYRGYZ REPUBLIC

Final Seminar

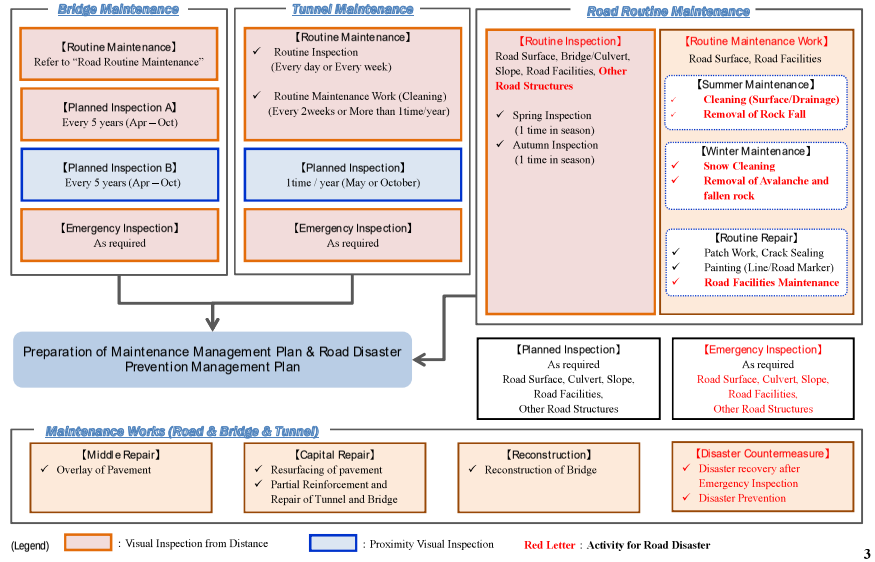
Table of Contents

1. Project Outline

Year		2016												2017												2018												2019				
Month		4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5			
Phase		Phase-1												Phase-2												Phase-3																
		Development of Basic Skills and Knowledge												Trial Implementation												Sustainable Implementation																
Output-1	Responsibilities of MOTR (HQ, RMD, UADs, DEUs) on road disaster prevention become clear	Formulation of Responsibilities of MOTR HQ, RMD, target UADs and DEUs for Road Disaster Prevention												Trial Implementation and Review with JICA Expert Support												Trial Implementation and Review with JICA Expert Support																
Output-2	Capacity of target UADs and DEUs for inspection and analysis of road disaster is enhanced	Development of Basic Skills and Knowledge on Inspection and Analysis for Road Disaster Prevention by Inspection Expert System												Trial Implementation and Review with JICA Expert Support. Basic Skills and Knowledge are Expanded to Target UADs, DEUs by Inspection Expert.												Implementation and Operation by C/P themselves. Basic Skills and Knowledge are Expanded to other UADs, DEUs by Inspection Expert																
Output-3	Capacity of RMD to operationalize Database Management System for road disaster prevention is developed.	Development of Basic Skills and Knowledge on Database Operation												Update of Database with 2nd Inspection												Improvement of Database with 3rd Inspection																
Output-4	Capacity of RMD for Preparing road disaster prevention management plans of the target areas is enhanced.	Development of Nation-wide Management Criteria and Short/Medium-term Road Disaster Prevention Management Plan												Trial Implementation and Review with JICA Expert Support												Implementation and Operation by C/P themselves																
Other Activities	JCC	●			●			●						●			●			●						●			●			●										
	Japan Training																		●												●											
	Meeting / Seminar	● Kick-off Seminar																													● Final Seminar							●				
Report		● Work Plan ● Monitoring				● Monitoring								● Monitoring				● Monitoring								● Monitoring				● Monitoring									● C/R			

2. Project Outputs (Output-1)

2.1 Responsibilities and Activities of MOTR on Road Disaster Prevention



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2. Project Outputs (Output-1)

2.1 Responsibilities and Activities of MOTR on Road Disaster Prevention

Responsibilities and Activities for Disaster Countermeasures (Disaster Prevention)

Activities	DEU	RO-RMD/UAD	RMD
Planning, Implementation and Maintenance of Structural/ Non-Structural Measures	● Proposal on structural/ non-structural measures to RD-RMD/ UAD ● Construction supervision for structural measures ● Maintenance of facilities for structural/ non-structural measures	● Planning of structural/ non-structural measures ● Management of design commission for structural/ non-structural measures ● Management of implementation (e.g. bidding and construction) of structural/ non-structural measures ● Supervision of DEU's maintenance work	● Budgeting of structural/ non-structural measures based on RD-RMD/UAD planning ● Revision of Countermeasures Manual for Road Disaster Prevention (situational) **AMS** ● Management of DB Server for planning, implementation and maintenance of structural/ non-structural measures

2. Project Outputs (Output-1)

2.1 Responsibilities and Activities of MOTR on Road Disaster Prevention

Responsibilities and Activities for Disaster Countermeasures (Disaster Prevention)

Activities	DEU	RO-RMD/UAD	RMD
Preparation of List of Priority Project and Short-Term & Medium-Term Road Disaster Prevention Management Plan	● Provision of urgent project information to RD-RMD/ UAD	● Receiving and evaluation of urgent project information from DEU ● Selection of urgent project information and sending to RMD	● Preparation of list of priority project on the basis of hazard list, periodic/post-disaster I&E and selected urgent project information from RD-RMD/UAD ● Preparation of short-term &medium-term road disaster prevention management plan ● Revision of Preparation Manual for Short-Term and Medium-Term Road Disaster Prevention Management Plans, situational **AMS** ● Management on DB Server for list of priority project

2. Project Outputs (Output-1)

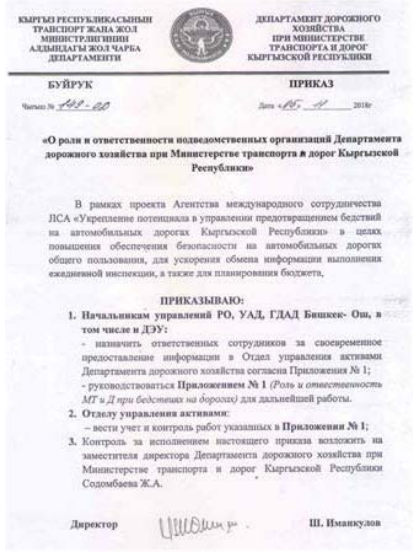
2.1 Responsibilities and Activities of MOTR on Road Disaster Prevention

Responsibilities and Activities for Disaster Countermeasures (Disaster Prevention)

Activities	DEU	RO-RMD/UAD	RMD	Remarks
Database Operation			● Supervision of AMS's DB management **AMS** ● Management on DB Server including Tablets	● Technical cooperation with university
Hazard Map of Road	● Distribution of hazard map to road users	● Preparation of hazard map per DEU in their jurisdiction	● Preparation of common format for hazard map	
Prediction of Disaster	● Preparedness for the disaster informed by RD-RMD/ UAD	● Instruction of preparedness of road cleaning to DEU by analysis of meteorological data from MES	● Development of the methodology of disaster prediction using correlation between meteorological data and road disaster data	● Provision of meteorological data from MES

2. Project Outputs (Output-1)

2.2 Decree on Responsibilities and Activities for Road Disaster Prevention



КЫРГЫЗ РЕСПУБЛИКАСЫНЫН ТРАНСПОРТ ЖАНА ЖОЛ МИНИСТРДИГИНИН АЛДЫНДАГЫ ЖОЛ ЧАРБА ДЕПАРТАМЕНТИ

ДЕПАРТАМЕНТ ДОРОЖНОГО ХОЗЯЙСТВА ПРИ МИНИСТЕРСТВЕ ТРАНСПОРТА И ДОРОГ КЫРГЫЗСКОЙ РЕСПУБЛИКИ

БУЙРУК

ПРИКАЗ

«О роли и ответственности подведомственных организаций Департамента дорожного хозяйства при Министерстве транспорта и дорог Кыргызской Республики»

В рамках проекта Агентства международного сотрудничества ЛСА «Укрепление потенциала в управлении предотвращением бедствий на автомобильных дорогах Кыргызской Республики» в целях повышения обеспечения безопасности на автомобильных дорогах общего пользования, для ускорения обмена информации выполнения ежедневной инспекции, а также для планирования бюджета,

ПРИКАЗЫВАЮ:

1. Начальникам управлений РО, УАД, ГДАД Бишкек- Ош, в том числе и ДЭУ:
- назначить ответственных сотрудников за своевременное предоставление информации в Отдел управления активами Департамента дорожного хозяйства согласна Приложения № 1;
- руководствоваться **Приложением № 1** *(Роль и ответственность МТ и Д при бедствиях на дорогах)* для дальнейшей работы.
2. Отделу управления активами:
– вести учет и контроль работ указанных в **Приложении № 1;**
3. Контроль за исполнением настоящего приказа возложить на заместителя директора Департамента дорожного хозяйства при Министерстве транспорта и дорог Кыргызской Республики Содомбаева Ж.А.

Директор Ш. Иманкулов

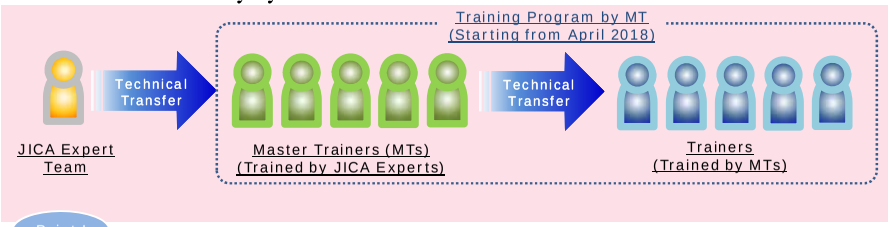
Point !

The roles and activities of relevant units of MOTR for road disaster prevention was issued by the RMD as a Director's Order on November 2018.

2. Project Outputs (Output-1)

2.3 Training Program By Master Trainers

- MOTR prepared and implemented a Training Program on road disaster prevention management
- Master Trainers (MT) trained target UADs and DEUs staff by the Training Program
- The skill and knowledge on the road disaster prevention and database system will be enhanced widely by the trainees.

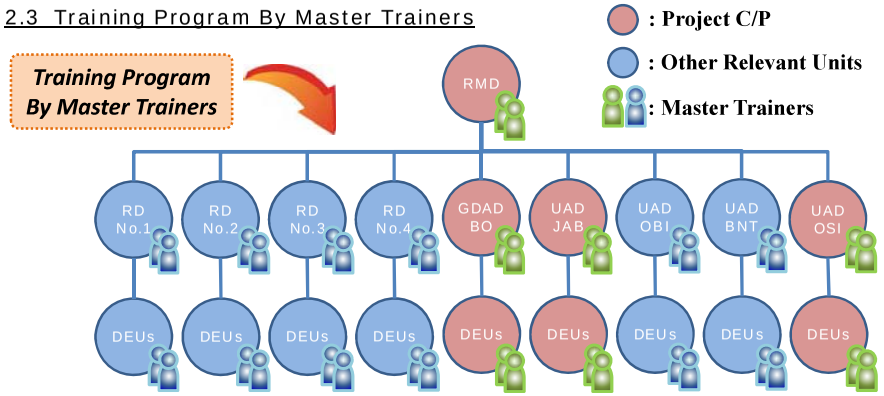


Point !

Through the Training Program by MT, it can be expected that technology transfer will be implemented continuously after the project.

2. Project Outputs (Output-1)

2.3 Training Program By Master Trainers



Point

- Master Trainers from the MOTR, who were trained by JICA Experts educate/train other engineers of the other relevant units. Besides, the training program and trainees are spread nationwide.
- Budget for the Training Program on road disaster prevention management was allocated and executed by the MOTR.

2. Project Outputs (Output-1)

2.3 Training Program By Master Trainers

MOTR Units			Number of Trainees		
			Database System	Slope Disaster (Including River Bank Erosion)	Snow Disaster
Project Target Units	RMD		3	5	2
	RO/UADs	GDAD-BO	1	1	1
		UAD-JAB	1	0	1
		UAD-OSI	1	0	1
	DEUs	DEU-9	1	2	1
		DEU-23	1	0	0
		DEU-26	1	1	2
		DEU-30	1	0	0
		DEU-50	1	2	0
		DEU-959	1	2	1
	Subtotal		12	13	9
Other Units	RD/UADs		44	57	48
	DEUs		4	7	4
	Subtotal		48	64	52
Total			60	77	61

2. Project Outputs (Output-1)

2.3 Training Program By Master Trainers

Implementation Plan of Training Program

Area	Bishkek	Osh
Date	Beginning of October	Beginning of October
Venue	MOTR, Conference Hall	UAD OSI
MT	Master Trainers from RMD	Master Trainers from RMD
Number of Participants	30	30
Training Contents	Bridge and Tunnel Management, Road Disaster Management	Bridge and Tunnel Management, Road Disaster Management
Material	Manuals	Manuals

2. Project Outputs (Output-1)

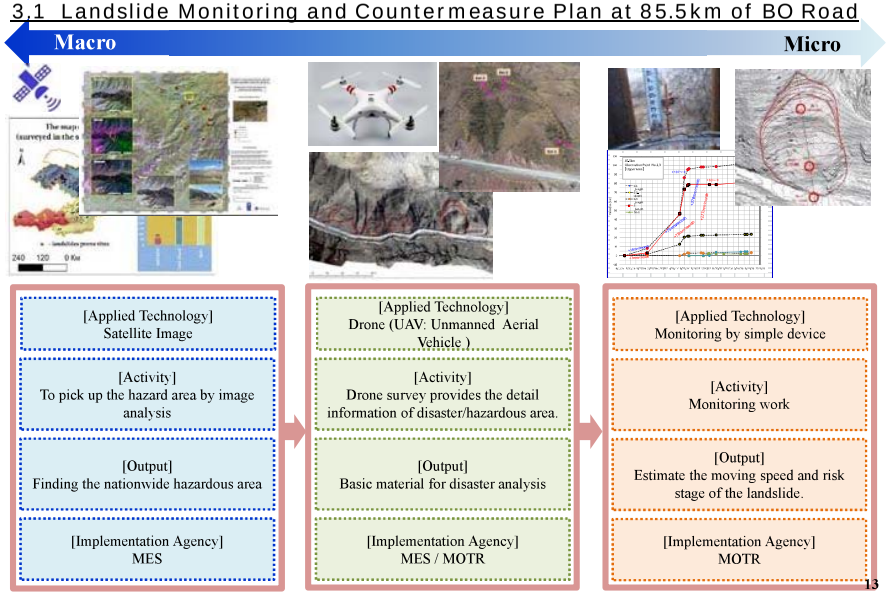
2.4 Inspection Conducting Plan

Inspection Conducting Plan for 2019

Inspection	Duration period	Organization	Inspection Items	Others
Bridge and Tunnel	March ~ April	UADs and RDs	Visual Inspection	Using Tablets Manuals
Road Disasters	March ~ April	UADs and RDs	Slope along the road (Hazardous Area)	Using Tablets Manuals
Road	April / September	UADs and RDs	Road Surface Road Facilities	In cooperation with Ministry of Internal Affairs

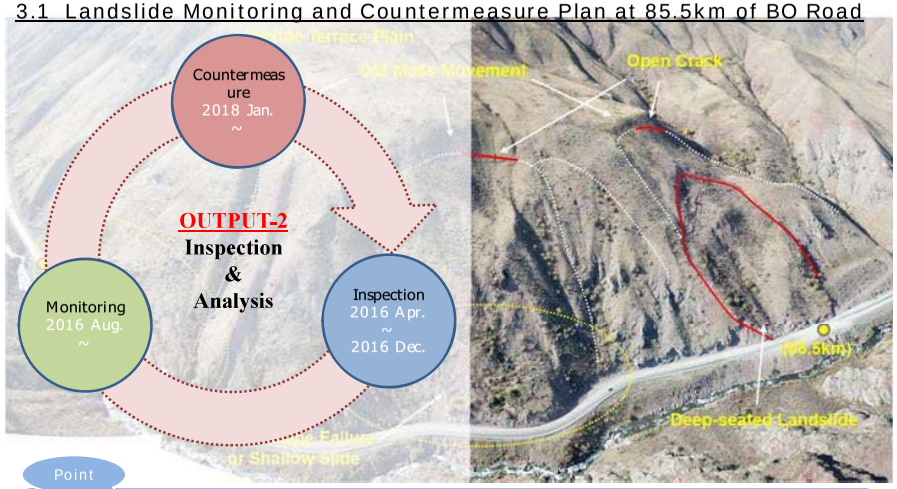
3. Project Outputs (Output-2)

3.1 Landslide Monitoring and Countermeasure Plan at 85.5km of BO Road



3. Project Outputs (Output-2)

3.1 Landslide Monitoring and Countermeasure Plan at 85.5km of BO Road

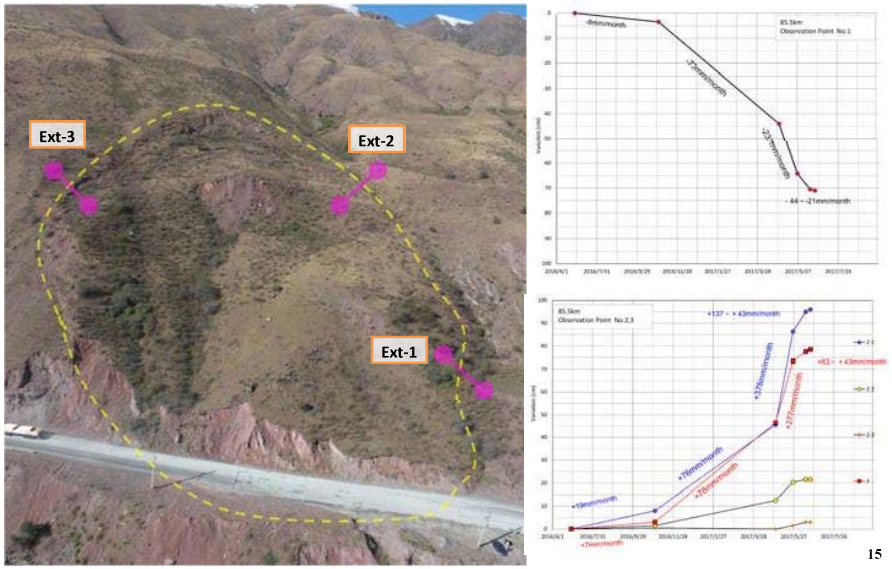


Point

- The capacity of target C/P for inspection, monitoring and countermeasure plan for slope disaster were developed through the study case of landslide at 85.5km on BO road.

3. Project Outputs (Output-2)

3.1 Landslide Monitoring and Countermeasure Plan at 85.5km of BO Road



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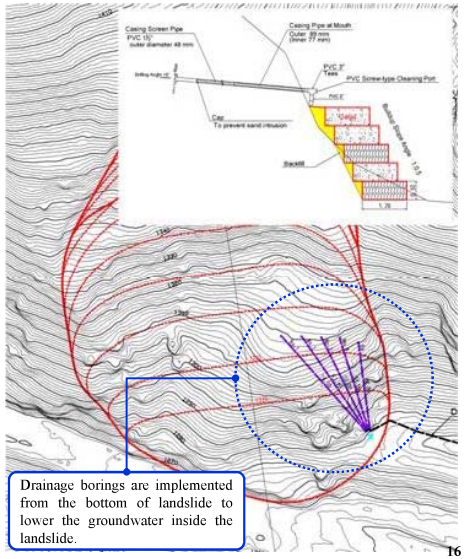
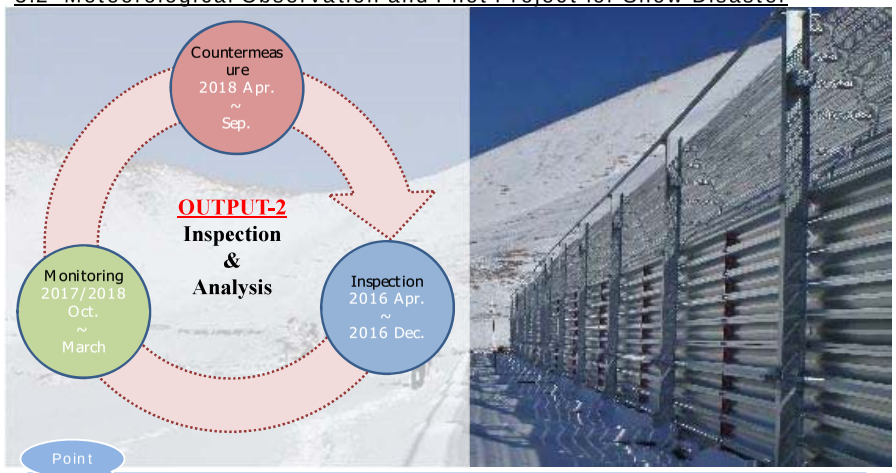
3. Project Outputs (Output-2)

3.1 Landslide Monitoring and Countermeasure Plan at 85.5km of BO Road



3. Project Outputs (Output-2)

3.2 Meteorological Observation and Pilot Project for Snow Disaster



Point

- The capacity of target C/P for inspection, monitoring and countermeasure plan for snow disaster were developed through the study case of snow drifting at Too-Ashuu pass on BO road.

3. Project Outputs (Output-2)

3.2 Meteorological Observation and Pilot Project for Snow Disaster

Meteorological Observation

Construction of Snow Fence

Monitoring Snowdrift Volume

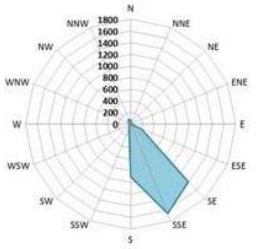
Verification of Applicability of Snow Fence in Kyrgyz

3. Project Outputs (Output-2)

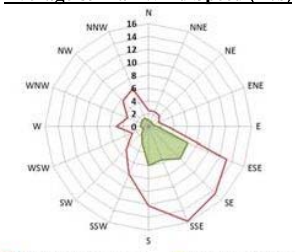
3.2 Meteorological Observation and Pilot Project for Snow Disaster

- Equipment for the meteorological observation was handed over to RMD by the Project.
- The equipment was installed at Too-Ashuu pass and Ala-Bel pass.
- BO-UAD and DEU staff collected the meteorological data such as wind speed, wind direction and snow depth October to May 2017 and 2018.

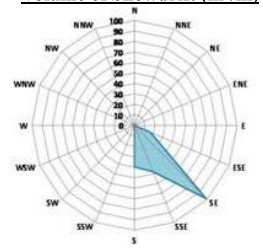
Wind Direction



Average & Max Wind Speed (m/s)



Volume of Snowdrift (m^3/m)



Point

- Data collection using the meteorological observation equipment was understood.
- Based on the data collection, it was possible to evaluate the necessity of the countermeasures against snow disasters.

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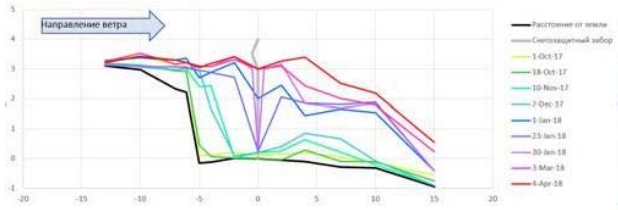
3. Project Outputs (Output-2)

3.2 Meteorological Observation and Pilot Project for Snow Disaster

- Snow Fence (L=50m) was built at Too-Ashuu pass by the Project and MOTR.
- BO-UAD and DEU staff monitored the amount of snowdrift around the snow fence from October to April 2018 and 2019.



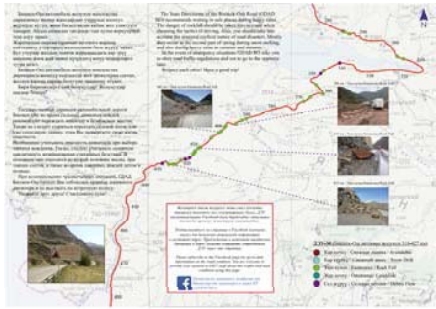
Point

- Through the pilot project, it was determined that the snow fence is effective for the snow drifting in Kyrgyz.
- Based on the data collection, it was possible to evaluate the structure and installation conditions of the snow fence.

3. Project Outputs (Output-2)

3.3 Non-structural Countermeasures (Hazard Map Distribution)

- Under the cooperation of MOTR and JICA project team, a map of hazardous areas along the Bishkek-Osh road (Hazard Map) was prepared on January 2018.
- The number of copies to be printed is about 169 500 copies (for DEUs 9 & 23: 127 000 copies, for DEU 30: 42 500 copies) with financial assistance of UNDP.
- Hazard Map was distributed to the school, the café and the tollgate along BO road by MOTR and MES.



3. Project Outputs (Output-2)

3.4 Non-structural Countermeasures (SNS Service)

- SNS information system using “Facebook” was commenced to establish real time road hazard information intercommunity between MOTR and the public.
- It has delivered the road information on road disaster hazard and traffic regulation etc.

1) Follower Number : 160
2) Posting of Information: 34
3) Information:

- Situation on the roads
- Traffic restrictions
- Artificial avalanche
- Rockfall implementations
- Occurrence of natural disasters on the roads etc.

3. Project Outputs (Output-2)

3.5 Non-structural Countermeasures (Emergency Board)

- Two emergency boards (Sosnovka Tollgate and 80.7km of BO Road) were installed by MOTR in September 2018.
- A emergency board in Kara-Kul city was installed by MOTR in December 2018.

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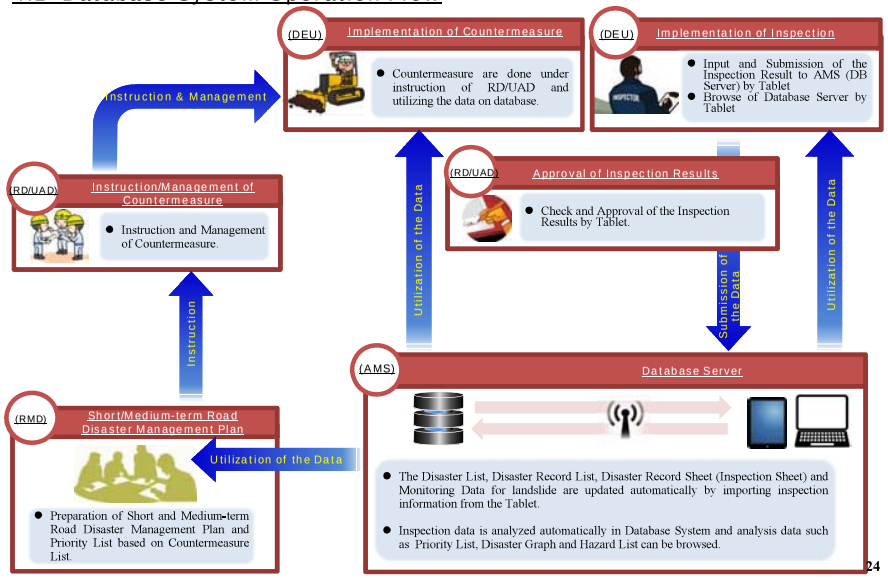
4. Project Outputs (Output-3)

4.1 Database System Operation Flow



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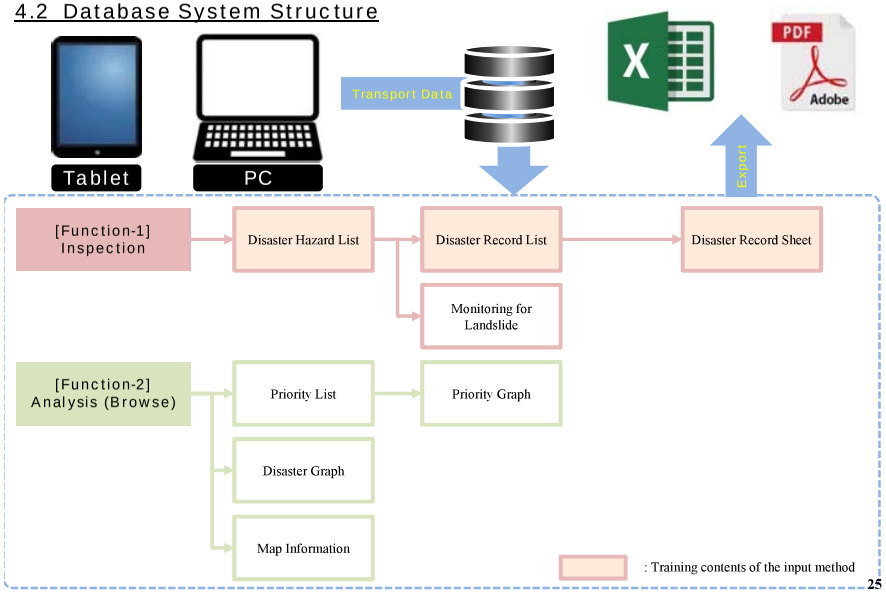
4. Project Outputs (Output-3)

4.2 Database System Structure



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4. Project Outputs (Output-3)

4.2 Road Disaster Data

UAD/RD	Falling Rocks	Slope Collapse	Bedrock Collapse	Debris Flow	Avalanche	Landslide	Snow Drifting	River Bank Erosion	Sub total
GDAD_BO	63	12	40	73	58	37	1	19	303
RD_1	0	0	0	7	0	0	0	6	13
RD_2	0	2	0	3	1	0	1	11	18
RD_3	0	0	0	3	2	0	0	0	5
RD_4	0	0	0	8	2	1	2	8	21
UAD_BNT	1	0	0	12	0	0	4	3	20
UAD_JAB	9	3	0	77	19	12	4	91	215
UAD_OBI	0	0	0	34	1	2	0	0	37
UAD_OSI	7	0	0	40	22	27	5	10	111
TOTAL	80	17	40	257	105	79	17	148	743

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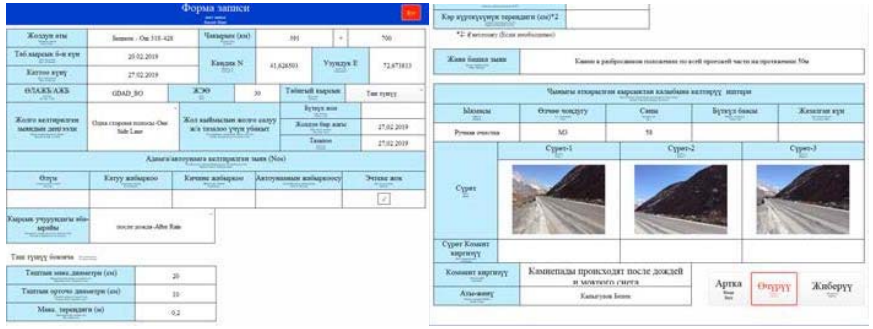
4. Project Outputs (Output-3)

4.2 Road Disaster Data

GDAD BO, DEU -30, Falling Rocks, 20-02-2019



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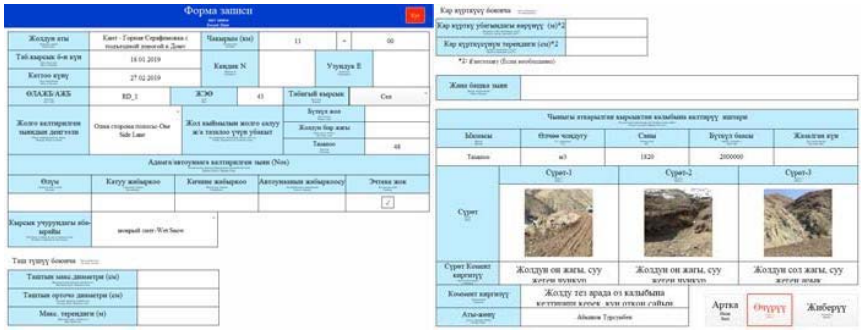
4. Project Outputs (Output-3)

4.2 Road Disaster Data

RD - 1, DEU - 43, Debris Flow, 18-01-2019



5. Project Outputs (Output-4)

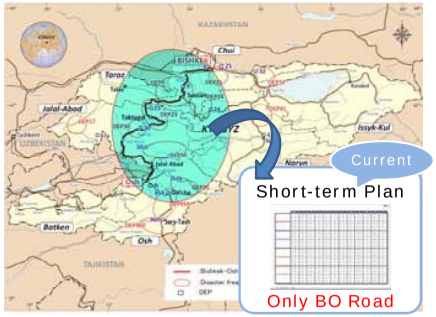
5.1 Preparaton of Shor-term Road Disaster Prevention Management Plan

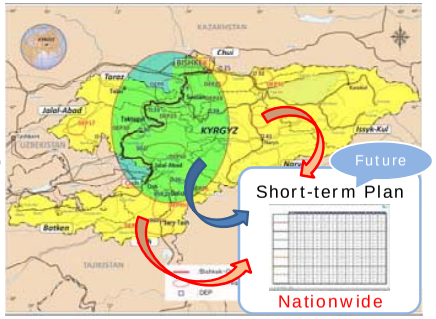
№	Road Name	Kilopost	DEU	Disaster Type	Cost (Millions KGS)	Countermeasure type
Structural Countermeasures						
1	Bishkek - Osh	116.5km	9	Rockfall	37,7	Protection Net
2	Bishkek - Osh	414.7km	30	Rockfall	55,6	Protection Net
3	Bishkek - Osh	424.8km	30	Rockfall	54,6	Protection Net
4	Bishkek - Osh	422km	30	Debris flow	27,2	Concrete Pavement (Causeway), Retaining Wall
5	Bishkek - Osh	423.5km	30	Debris flow	27,2	Concrete Pavement (Causeway), Retaining Wall
6	OSI Road	96km	959	Debris flow	13,6	Concrete Pavement (Causeway), Retaining Wall
7	Bazar-Korgon - Arstanbap	15.6km	50	Riverbank Erosion	6,8	Embankment, Gabion Mattress Revetment
8	Bazar-Korgon - Arstanbap	40.1km	50	Riverbank Erosion	6,8	Embankment, Gabion Mattress Revetment
9	Bazar-Korgon - Arstanbap	40.2km	50	Riverbank Erosion	6,8	Embankment, Gabion Mattress Revetment
10	Bishkek - Osh	123.0km	9	Avalanche	84,8	Protection Wall
11	Bishkek - Osh	245.8km	23	Avalanche	101,8	Protection Wall
12	Bishkek - Osh	126.5-126.7km	9	Snowdrift	19,0	Collector Snow Fence
13	Bishkek - Osh	127.4-127.7km	9	Snowdrift	28,5	Collector Snow Fence
14	Bishkek - Osh	129.1-129.3km	9	Snowdrift	19,0	Collector Snow Fence
	Subtotal				**489,4 (7.1 million USD)**	
Non-Structural Countermeasures						
15	Bishkek - Osh	85.5km	9	Landslide	0,1	Monitoring
16	Bishkek - Osh	86km	9	Landslide	0,1	Monitoring
17	Bishkek - Osh	395km	30	Landslide	0,1	Monitoring
18	OSI Road	60km	959	Landslide	0,1	Monitoring
19	OSI Road	61km	959	Landslide	0,1	Monitoring
20	OSI Road	70km	959	Landslide	0,1	Monitoring
21	Bishkek - Osh	262km	23	Rockfall	1,0	Artificial Rockfall Removal
22	Bishkek - Osh	423.5km	30	Debris flow	0,1	Sign Board Installation
23	OSI Road	96km	959	Debris flow	0,1	Sign Board Installation
24	Bazar-Korgon - Arstanbap	26.4km	50	Debris flow	0,1	Sign Board Installation
25	Myrzake - Karakulja - Alaikuu	42km	26	Debris flow	0,1	Sign Board Installation
26	Bishkek - Osh	81km	9	All kind of Disasters	0,3	Electrical Sign Board Installation
27	All Target Road	-	each DEU	All kind of Disasters	0,7	Monitoring of Meteorological Data
28	All Target Road	-	each DEU	All kind of Disasters	0,7	Debris Removal Management System
29	Bishkek – Osh	85.5	9	Landslide	5	Drainage Drilling
30	Bishkek – Osh	-	9, 23, 30	All kind of Disasters	0,18	Hazard Map Distribution
	Subtotal				**8,88 (0.13 million USD)**	

Grand Total = 498.3 million KGS (7.3 million USD)

5. Project Outputs (Output-4)

- Based on the Short-term Road Disaster Prevention Management Plan, the implementation schedule will be prepared by MOTR.
- Since it takes time to prepare the budget for the structural countermeasures, Non-structural countermeasure will be also planned by the implementation plan.
- The implementation plan will be prepared in consideration of the short-term plan outside the target area.





Thank You for Your Attention

JO8-8

Japan International Cooperation Agency (JICA)

Ministry of Transport and Roads of the Kyrgyz Republic

THE PROJECT FOR CAPACITY DEVELOPMENT FOR ROAD DISASTER PREVENTION MANAGEMENT IN THE KYRGYZ REPUBLIC

Meeting on the Completion Report for Sustainability of the Project

JO9-1

Table of Contents

1. Project Outline

Year		2016												2017												2018												2019				
Month		4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5			
Phase		Phase-1												Phase-2												Phase-3																
		Development of Basic Skills and Knowledge												Trial Implementation												Sustainable Implementation																
Output-1	Responsibilities of MOTR (HQ, RMD, UADs, DEUs) on road disaster prevention become clear	Formulation of Responsibilities of MOTR HQ, RMD, target UADs and DEUs for Road Disaster Prevention												Trial Implementation and Review with JICA Expert Support												Trial Implementation and Review with JICA Expert Support																
Output-2	Capacity of target UADs and DEUs for inspection and analysis of road disaster is enhanced	Development of Basic Skills and Knowledge on Inspection and Analysis for Road Disaster Prevention by Inspection Expert System												Trial Implementation and Review with JICA Expert Support. Basic Skills and Knowledge are Expanded to Target UADs, DEUs by Inspection Expert.												Implementation and Operation by C/P themselves. Basic Skills and Knowledge are Expanded to other UADs, DEUs by Inspection Expert																
Output-3	Capacity of RMD to operationalize Database Management System for road disaster prevention is developed.	Development of Basic Skills and Knowledge on Database Operation												Update of Database with 2nd Inspection												Improvement of Database with 3rd Inspection																
Output-4	Capacity of RMD for Preparing road disaster prevention management plans of the target areas is enhanced.	Development of Nation-wide Management Criteria and Short/Medium-term Road Disaster Prevention Management Plan												Trial Implementation and Review with JICA Expert Support												Implementation and Operation by C/P themselves																
Other Activities	JCC	●					●										●									●					●											
	Japan Training																			●												●											
	Meeting / Seminar		●	Kick-off Seminar																																		Final Seminar		●			
Report			●	Work Plan			●	Monitoring						●	Monitoring				●	Monitoring						●	Monitoring				●	Monitoring						C/R				
			●	Monitoring																																						

**All indicators of the outputs on PDM were achieved.*

MOTR: Ministry of Transport and Roads, Kyrgyz, RMD: Road Maintenance Department, UAD: Main Roads Management Unit, DEU: Local Level Roads Management Unit, JCC: Joint Coordination Committee, C/R: Completion Report

2. Project Evaluation

Development Assistance Committee (DAC) Evaluation Criteria

Criteria		Contents	Results
Relevance		Relevance to the policy of the Kyrgyz Republic; ● Road Sector Development Strategy to 2025 ● National Sustainable Development Strategy for the Kyrgyz Republic for the period of 2013-2017 ● Resolution No.435 of the Government of the Kyrgyz Republic	High
Effectiveness	Output1	● Responsibilities of MOTR on road disaster prevention were clearly determined by RMD Director's Order.	High
	Output2	● In total 170 members of MOTR were trained for inspection and countermeasures based on the manuals prepared by the Project. ● In total 138 members out of 170 members passed the final exam.	
	Output3	● In total 70 members of MOTR were trained for database input and operation based on the manuals prepared by the Project. ● In total 60 members out of 70 members passed the final exam. ● 137 inventory data of disaster hazard section and 913 data of past disaster record were collected and integrated into the database.	
	Output4	● "The Short-term Road Disaster Prevention Management Plan in 2017" for the target area was prepared by the RMD. ● "The Short-term Road Disaster Prevention Management Plan in 2018" for nationwide hazardous areas was prepared by RMD.	

JO9-2

2. Project Evaluation

Development Assistance Committee (DAC) Evaluation Criteria

Criteria	Status	Results
Efficiency	● Project Period: 39 months (April 2016 ~ June 2019) ● Japanese Expert's Input : 81.1 Man Month in total ● Kyrgyz Side Input : Counterparts for the Project, Running expenses necessary for the implementation of the Project	**Fair**
Impact	***Objectively Verifiable Indicator (1) of Overall Goal*** *In reference to the Project experiences and Manuals produced by the Project, Short-Term Road Disaster Prevention Management Plan continues to be prepared by RMD of MOTR every year.* ● Before the Project, the road disaster prevention plan was not formulated by MOTR in the Kyrgyz. After the Project, MOTR worked out the Short-Term Road Disaster Prevention Plan for the target areas in 2017. Besides, nationwide Short-Term Road Disaster Prevention Plan was prepared by MOTR in 2018 in cooperation with JICA Experts. ***Objectively Verifiable Indicator (2) of Overall Goal*** *Road disaster prevention work is implemented based on the Short-Term Road Disaster Prevention Management Plan prepared by RMD of MOTR.* ● Before the Project, MOTR seldom conducted preventive measures against road disasters. After the Project, MOTR budgeted for preventive measures against road disaster. Besides, road disaster prevention were implemented based on the Short-Term Road Disaster Prevention Management Plan.	**High**

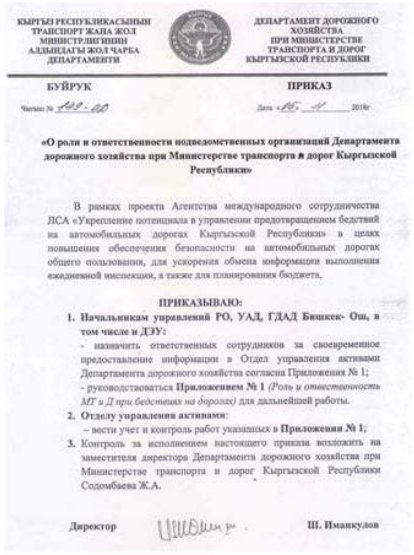
2. Project Evaluation

Development Assistance Committee (DAC) Evaluation Criteria

Criteria	Status	Results
Sustainability	***Institutional Aspect*** ● Responsibilities of MOTR on road disaster prevention management were clearly institutionalized by the RMD Director's Order. ● RMD comprehensively manages disaster data, implementation plan, budget plan, activities and training program for road disaster prevention management to clarify the smooth decision-making process in MOTR. ***Technical Aspect*** ● Master Trainers (MT) train UADs and DEUs staff once a year by the Training Program prepared by the Project to extend the skill and knowledge on road disaster prevention management (Budget for the Training Program was allocated and executed once a year by the MOTR.) ● The database system for bridge and tunnel was improved to the same system as the road disaster database system to enhance the cooperativeness of both database systems ***Financial Aspect*** ● MOTR allocated a budget for preventive measures against road disaster on BO Road such as landslide monitoring, drainage boring, hazard map distribution and emergency board installation in conformity with the Short-Term Road Disaster Prevention Management Plan.	**High**

3. Sustainable Project Output (Output-1)

Decree on Responsibilities and Activities for Road Disaster Prevention



КЫРГЫЗ РЕСПУБЛИКАСЫНЫН ТРАНСПОРТ ЖАНА ЖОЛ МИНИСТРЛИГИНИН АЛДЫНДАГЫ ЖОЛ ЧАРБА ДЕПАРТАМЕНТИ

ДЕПАРТАМЕНТ ДОРОЖНОГО ХОЗЯЙСТВА ПРИ МИНИСТЕРСТВЕ ТРАНСПОРТА И ДОРОГ КЫРГЫЗСКОЙ РЕСПУБЛИКИ

БУЙРУК

ПРИКАЗ

«О роли и ответственности подведомственных организаций Департамента дорожного хозяйства при Министерстве транспорта и дорог Кыргызской Республики»

В рамках проекта Агентства международного сотрудничества ЛСА «Укрепление потенциала в управлении предотвращением бедствий на автомобильных дорогах Кыргызской Республики» в целях повышения обеспечения безопасности на автомобильных дорогах общего пользования, для ускорения обмена информации выполнения ежедневной инспекции, а также для планирования бюджета,

ПРИКАЗЫВАЮ:

1. Начальникам управлений РО, УАД, ГДАД Бишкек- Ош, в том числе и ДЭУ:
   - назначить ответственных сотрудников за своевременное предоставление информации в Отдел управления активами Департамента дорожного хозяйства согласна Приложения № 1;
   - руководствоваться **Приложением № 1** *(Роль и ответственность МТ и Д при бедствиях на дорогах)* для дальнейшей работы.
2. Отделу управления активами:
   – вести учет и контроль работ указанных в **Приложении № 1**;
3. Контроль за исполнением настоящего приказа возложить на заместителя директора Департамента дорожного хозяйства при Министерстве транспорта и дорог Кыргызской Республики Содомбаева Ж.А.

Директор Ш. Иманкулов

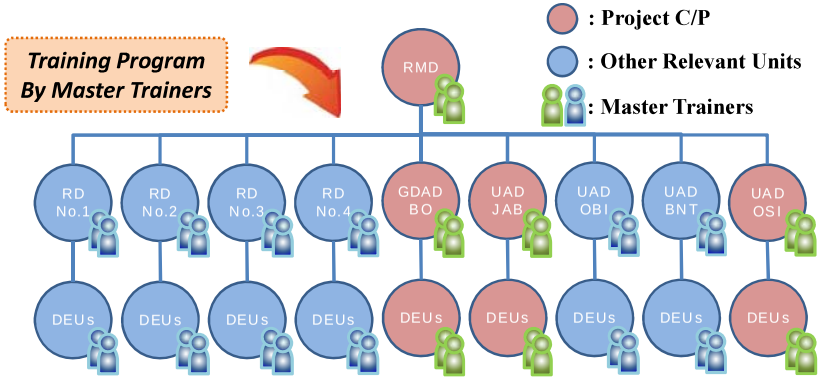
Point !

The roles and activities of relevant units of MOTR for road disaster prevention was issued by the RMD as a Director's Order on November 2018.

3. Sustainable Project Output (Output-1)

Training Program By Master Trainers to sustain Required Responsibilities

- MOTR prepared and implemented a Training Program on road disaster prevention management in the Project.
- Master Trainers (MTs) will train UADs and DEUs staffs once a year through the Training Program to continuously perform the duties (responsibilities) on road disaster prevention issued by RMD Director's Order.



4. Sustainable Project Output (Output-2)

Execution of Non-structural Countermeasures

Hazard Map Distribution	● A map of hazardous areas along the Bishkek-Osh road (Hazard Map) was prepared by MOTR. ● In total 169 500 copies assisted by UNDP were distributed to the school, the café and the tollgate along BO road by MOTR and MES. ● This activity was institutionalized by RMD Director's Order.	
Emergency Board Installation	● Two emergency boards (Sosnovka Tollgate and 80.7km of BO Road) were installed by MOTR in September 2018. ● A emergency board in Kara-Kul city was installed by MOTR in December 2018.	
SNS Service (Facebook)	● SNS information system using "Facebook" was commenced to establish real time road hazard information intercommunity between MOTR and the public. ● Follower number is 160, and posting number is 34. ● This activity was institutionalized by RMD Director's Order.	

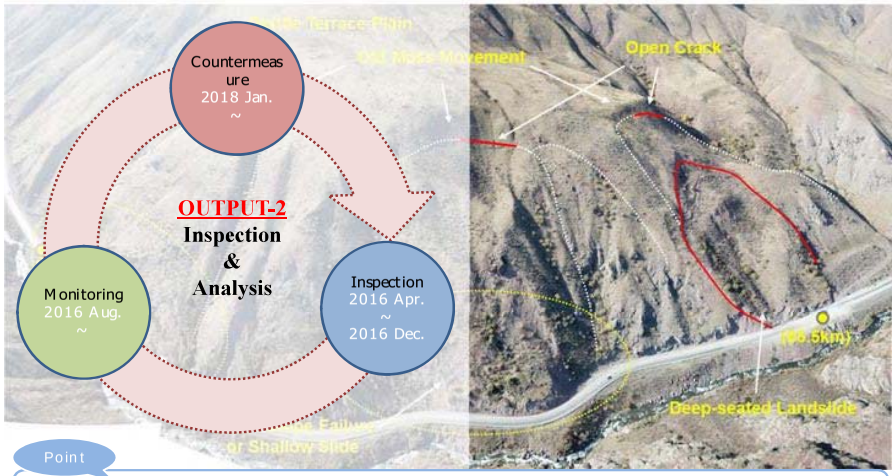
Point !

Above non-structural countermeasures will be continuously executed in other site by MOTR.

UNDP: United Nations Development Programme, SNS: Social Networking Service

4. Sustainable Project Output (Output-2)

Landslide Inspection/Monitoring and Countermeasure Plan



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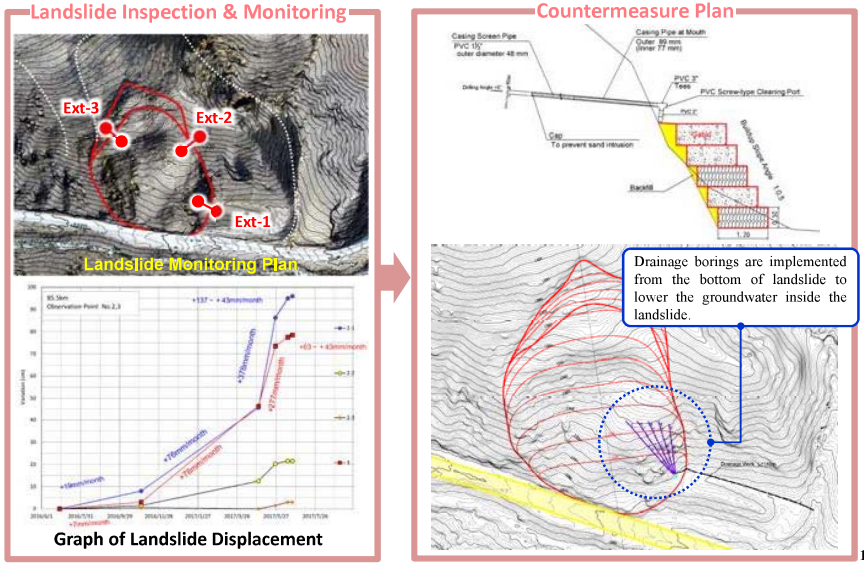
- The capacity of target C/P for inspection, monitoring and countermeasure plan for slope disaster were developed through the study case of landslide at 85.5km on BO road in the Project.
- The monitoring method and the countermeasure for landslide will be continuously executed in other site by MOTR.

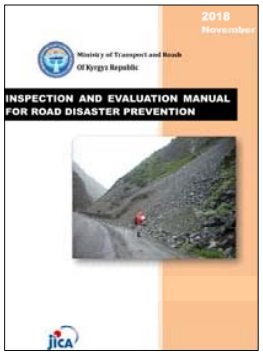
4. Sustainable Project Output (Output-2)

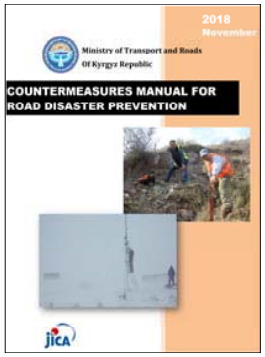
Landslide Inspection/Monitoring and Countermeasure Plan



4. Sustainable Project Output (Output-2)

"Inspection and Evaluation Manual for Road Disaster Prevention" and "Countermeasures Manual for Road Disaster Prevention"



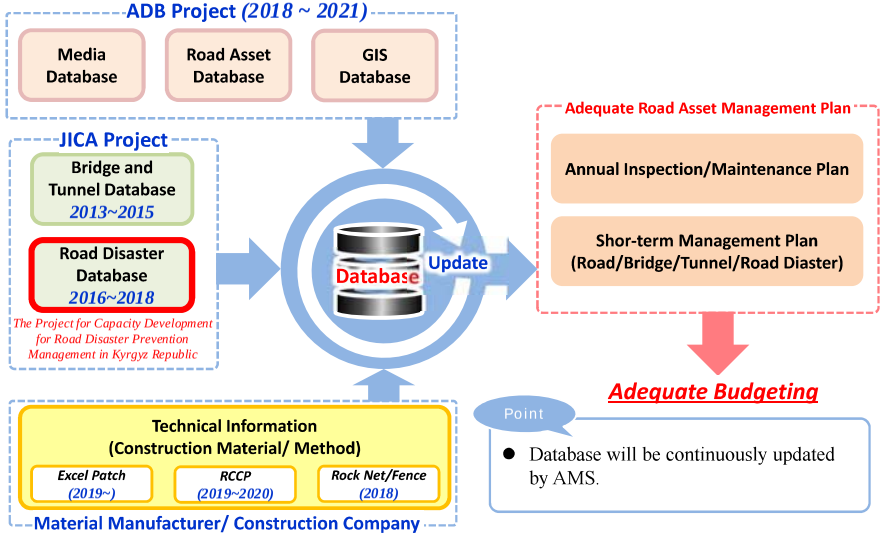


- Manuals were drafted, reviewed and finalized by RMD through the project activities, and Manuals were authorized for use by the RMD Director's Order.
- Manuals will be revised/reviewed by MOTR if necessary.
- Manuals have been utilized in the lecture of KSUCTA since September 2018.

KSUCTA: Kyrgyz State University of Construction, Transport and Architecture

5. Sustainable Project Output (Output-3)

Adequate Road Management Plan utilizing Database System



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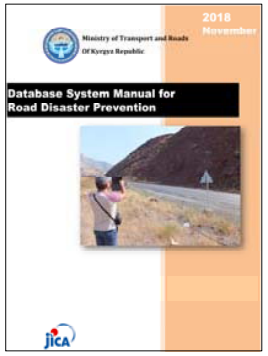
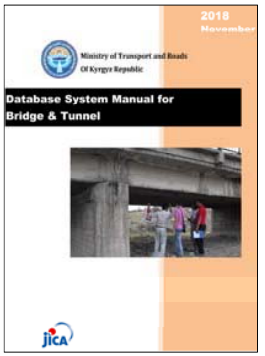
- Database will be continuously updated by AMS.

RCCP: Roller Compacted Cement Concrete Pavement, AMS: Asset Management Section

5. Sustainable Project Output (Output-3)

"Data Input and Database Operation Manual for Road Disaster Prevention"
"Data Input and Database Operation Manual for Bridge & Tunnel Maintenance"





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- Manuals have been utilized in the lecture of KSUCTA since September 2018.

KSUCTA: Kyrgyz State University of Construction, Transport and Architecture

6. Sustainable Project Output (Output-4)

Preparation of Shor-term Road Disaster Prevention Management Plan

The list of the most dangerous automobile roadsections to be prevented from natural disasters (Ministry of Transport and Roads of the Kyrgyz Republic)

No.	Name of automobile road	Kilopost	Type of natural disaster	Engineering measures	Cost in Thousands of USD
2	Bishkek-Naryn-Torugart (Boom Gorge)	110-147	Rockfall	Stonecatching barrier	18,500.00
5	Bishkek-Osh	116	Rockfall	Stonecatching barrier L=210 m	492.11
6	Bishkek-Osh	391.5	Rockfall	Stone catching barrier L=400 m	500.00
8	Bishkek-Osh	398	Rockfall	Stone catching barrier L=250 m	1,000.00
10	Bishkek-Osh	411.9	Rockfall	Stone catching barrier L=700 m	1,200.00
11	Bishkek-Osh	413.5	Rockfall	Stone catching barrier L=400 m	800.00
12	Bishkek-Osh	424.8	Rockfall	Stone catching barrier L=70 m	797.30
13	Bishkek-Osh	425	Rockfall	Stone catching barrier L=70 m	300.00
15	Bazar-Korgon-Arstanbap	15.6	Riverbank Erosion	Installation of gabion mattresses L=50 m	99.33
16	Bazar-Korgon-Arstanbap	40.1-40.2	Riverbank Erosion	Installation of gabion mattresses L=100 m	198.97
19	Bishkek-Osh	198-199	Snow avalanche	Construction of an avalanche barrier	3,000.00
				Subtotal 1	**26,887.71**

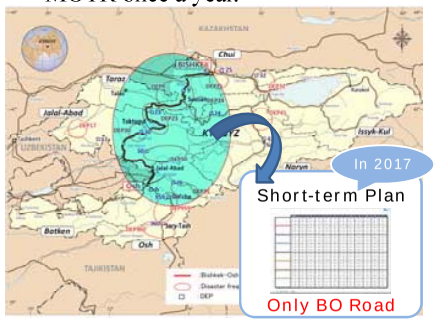
Additional objects prone to natural disasters in the Kyrgyz Republic					
50	Naryn bypass road	1.2-1.4	Rockfalls	Gallery or forced descen	2,920.00
51	Tyup-Kegen	59-74	Snowdrifts	Collector Snow Fence	32,455.00
				Subtotal 2	**35,375.00**

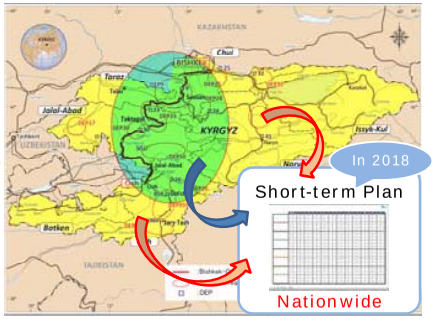
Total	62,262.71

6. Sustainable Project Output (Output-4)

Preparation of Shor-term Road Disaster Prevention Management Plan

- "The Short-term Road Disaster Prevention Management Plan in 2017" for the target area was prepared by the RMD.
- "The Short-term Road Disaster Prevention Management Plan in 2018" for nationwide hazardous areas was prepared by RMD.
- "The Short-term Road Disaster Prevention Management Plan" will be updated by MOTR once a year.





JO64

7. Monitoring Plan

Objectively Verifiable Indicator (1) of Overall Goal

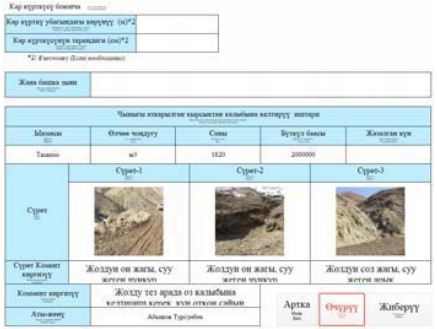
In reference to the Project experiences and Manuals produced by the Project, Short-Term Road Disaster Prevention Management Plan continues to be prepared by RMD of MOTR every year

Target in 3 years (Action to take)	Monitoring Method
● **To update the Road Disaster Record Sheet on the Database continuously**	Disaster Record Sheet in Database
● **To update the Short-term Road Disaster Prevention Management Plan once a year**	Short-term Road Disaster Prevention Management Plan
● **To conduct the joint coordination meetings with MES and related agencies once a year**	Minutes of Meeting Meeting Materials
● **To conduct the training on road disaster prevention once a year by the Training Program**	Training Program Materials Attendance List

7. Monitoring Plan

To update the Road Disaster Record Sheet on the Database continuously

Data Collection on Road Disaster (Hazard List and Disaster Record Sheet)



7. Monitoring Plan

To update the Short-term Road Disaster Prevention Management Plan once a year

The list of the most dangerous automobile roadsections to be prevented from natural disasters (Ministry of Transport and Roads of the Kyrgyz Republic)

No.	Name of automobile road	Kilopost	Type of natural disaster	Engineering measures	Cost in Thousands of USD
2	Bishkek–Naryn–Torugart (Boom Gorge)	110–147	Rockfall	Stonecatching barrier	18,500.00
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12	Bishkek–Osh	424.8	Rockfall	Stone catching barrier L=70 m	797.30
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51	Tyup–Kegen	59–74	Snowdrifts	Collector Snow Fence	32,455.00
				Subtotal 2	**35,375.00**

Total	62,262.71

Short-term Road Disaster Prevention Management Plan will be updated based on:

- **Result of Inspection**
- **Inspection and Evaluation Manual for Road Disaster Prevention**
- **Countermeasure Manual for Road Disaster Prevention**
- **Short-term & Mid-term Road Disaster Prevention Management Plan Manual**

7. Monitoring Plan

To conduct the joint coordination meetings with MES and related agencies once a year

Conduct of joint coordination meetings with MES and related agencies (DI, MIA, KSUCTA, CAIAG, etc.) to share road disaster data, to exchange opinions and to discuss the utilization of road disaster prevention priority list.

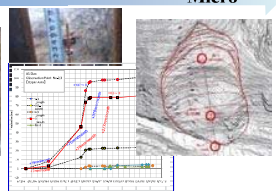
MES: Ministry of Emergency Situations, Kyrgyz, DI: Design Institute, MIA: Ministry of Internal Affairs,
KSUCTA: Kyrgyz State University of Construction, Transport and Architecture, CAIAG: Central Asian Institute for Applied Geosciences

7. Monitoring Plan

To conduct the joint coordination meetings with MES and related agencies once a year

Applied Technology on Landslide Countermeasure

Macro ⟵ ⟶ Micro



[Applied Technology] Satellite Image	[Applied Technology] Drone (UAV: Unmanned Aerial Vehicle)	[Applied Technology] Monitoring by simple device
[Activity] To pick up the hazard area by image analysis	[Activity] Drone survey provides the detail information of disaster/hazardous area.	[Activity] Monitoring work
[Output] Finding the nationwide hazardous area	[Output] Basic material for disaster analysis	[Output] Estimate the moving speed and risk stage of the landslide.
[Implementation Agency] MES	[Implementation Agency] MES / MOTR	[Implementation Agency] MOTR

7. Monitoring Plan

To conduct the training on road disaster prevention once a year by the Training Program

Training Program By Master Trainers

Area	Bishkek	Osh
Date	Beginning of October	Beginning of October
Venue	MOTR, Conference Hall	UAD OSI
MT	Master Trainers from RMD	Master Trainers from RMD
Number of Participants	30	30
Training Contents	Road Disaster Management • Snow Disaster • Slope Disaster • Flood Disaster/Riverbank Erosion • Database Management Bridge and Tunnel Management • Database Management	Road Disaster Management • Snow Disaster • Slope Disaster • Flood Disaster/Riverbank Erosion • Database Management Bridge and Tunnel Management • Database Management
Material	Manuals	Manuals

MOTR: Ministry of Transport and Roads, Kyrgyz, RMD: Road Maintenance Department, UAD: Main Roads Management Unit, OSI: Osh-Sary-Tash-Irkeshtam

7. Monitoring Plan

Objectively Verifiable Indicator (2) of Overall Goal

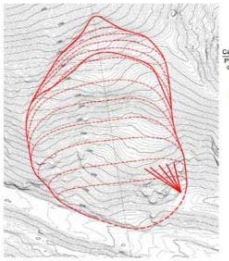
Road disaster prevention work will be implemented based on the Short-Term Road Disaster Prevention Management Plan prepared by RMD of MOTR.

Target in 3 years (Action to take)	Monitoring Method
● **To allocate budget for road disaster prevention works once a year**	Budget Report
● **To conduct road disaster prevention works every year**	Project Report
● **To conduct monitoring of landslide at 85.5 km along BO road quarterly**	Monitoring Report

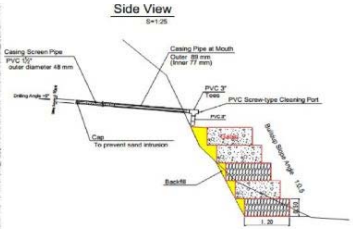
7. Monitoring Plan

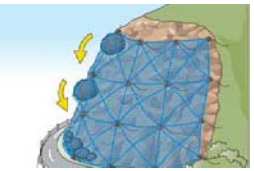
- To allocate budget for road disaster prevention works once a year
- To conduct road disaster prevention works every year

Samples of Road Disaster Prevention Works (Structural Measures)



Against Landslide (Horizontal Drainage Drilling)





Against Rockfall (Protection Net)

Against Riverbank Erosion (Gabion Mattress)

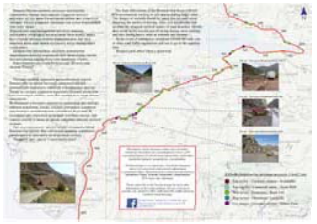
Against Avalanche (Protection Wall)

Against Snowdrift (Snow Fence)

7. Monitoring Plan

- To allocate budget for road disaster prevention works once a year
- To conduct road disaster prevention works every year

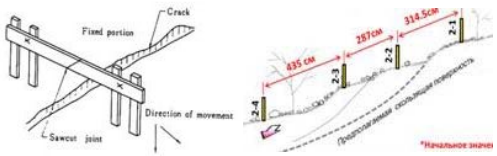
Samples of Road Disaster Prevention Works (Non-Structural Measures)



Hazard Map

Social Networking Service (FACEBOOK)

Electronic Message Board



Monitoring Work

7. Monitoring Plan

To conduct road disaster prevention works every year

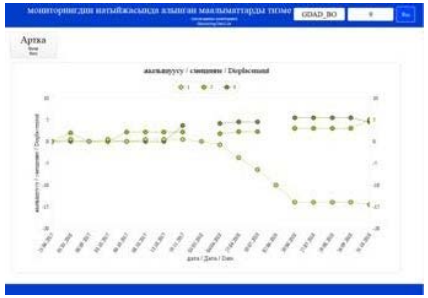
Annual Inspection Plan

Inspection	Duration period	Organization	Inspection Items	Others
Road Disaster Prevention	April / September	UADs, ROs-RMD and DEU	Hazardous Area along the road	Using Tablets Manuals
Bridge and Tunnel	April / September	UADs, ROs-RMD and DEU	Visual Inspection	Using Tablets Manuals
Road	April / September	UADs, ROs-RMD and DEU	Road Surface/ Road Facilities	In cooperation with Ministry of Internal Affairs

7. Monitoring Plan

To conduct monitoring of landslide at 85.5 km along BO road quarterly

Data Collection on Landslide Monitoring



Thank You for Your Attention

RA1-1

Management of Bridges on Expressway in Japan

Daisuke HAJIMA
International Business Department

NEXCO 中日本

Today's Contents

1. Outline of Expressways in Japan

What is Asset Management ?

What is Asset Management ?

Asset management is a systematic process of deploying, operating, maintaining, upgrading, and disposing of assets, such as stocks, bonds, deposits and savings or the real estate, cost-effectively.

What is Road Asset Management ?

To be adopted asset management method for the operation and maintenance of social infrastructure facilities. A way of thinking to place social infrastructure facilities for assets of the nations, and to carry out the operation and maintenance of the assets effectively, premeditatedly and steadily.

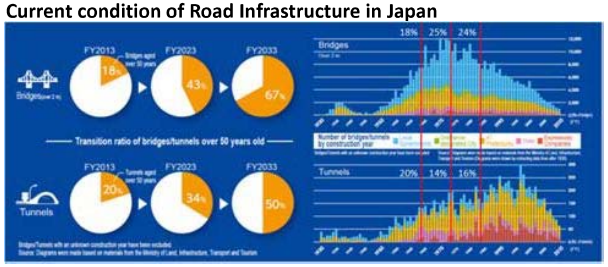
Expected effects for Road Asset Management

・Minimization of maintenance cost and Grasp of the necessary maintenance cost
・Optimization and Equalization of the future investment budget for road sector

1. Outline of Expressways in Japan

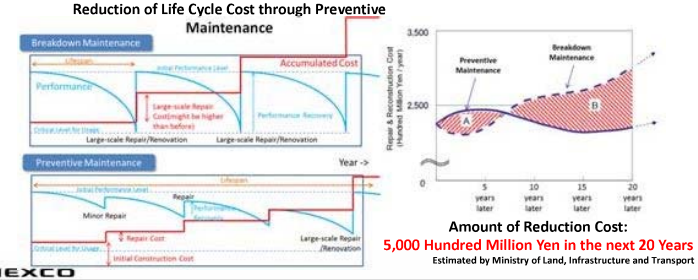
Condition of Road Infrastructure in Japan

Current condition of Road Infrastructure in Japan



Action for Road Infrastructure in Japan

Reduction of Life Cycle Cost through Preventive Maintenance



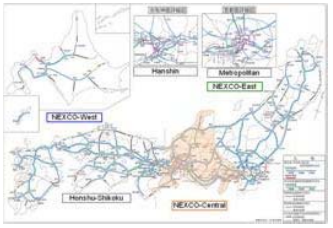
Amount of Reduction Cost:
5,000 Hundred Million Yen in the next 20 Years
Estimated by Ministry of Land, Infrastructure and Transport

1. Outline of Expressways in Japan

More than 50 years of experience in expressway operation in Japan

1956	Japan Highway Public Corporation (JH) established	
1963	Japan's 1st expressway opened	i)
1969	All 347 kilometers of the Tomei Expressway opened	
～	The total length of JH's expressways exceeded 7,000 kilometers by 2006	
2005	JH split into three companies under privatization NEXCO-Central established	ii)
2012	162 kilometers of the Shin Tomei Expressway (Shizuoka) opened	
2016	55 kilometers of the Shin Tomei Expressway (Aichi) opened	iii)

i) Opening of the 1st expressway



ii) NEXCO-Central established

iii) Opening of Shin Tomei Expressway

1. Outline of Expressways in Japan

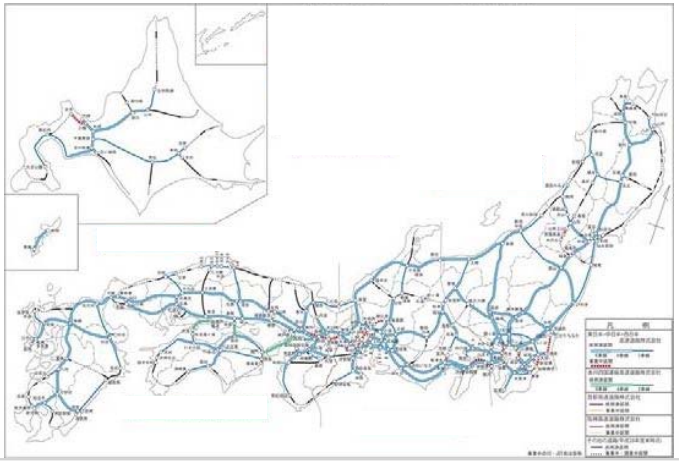
Master Plan of Japan's Expressway Development

◆ The Fourth Comprehensive National Development Plan (1987)

- A plan to establish the expressway network that can be accessed in **less than 1 hour from every region** in Japan

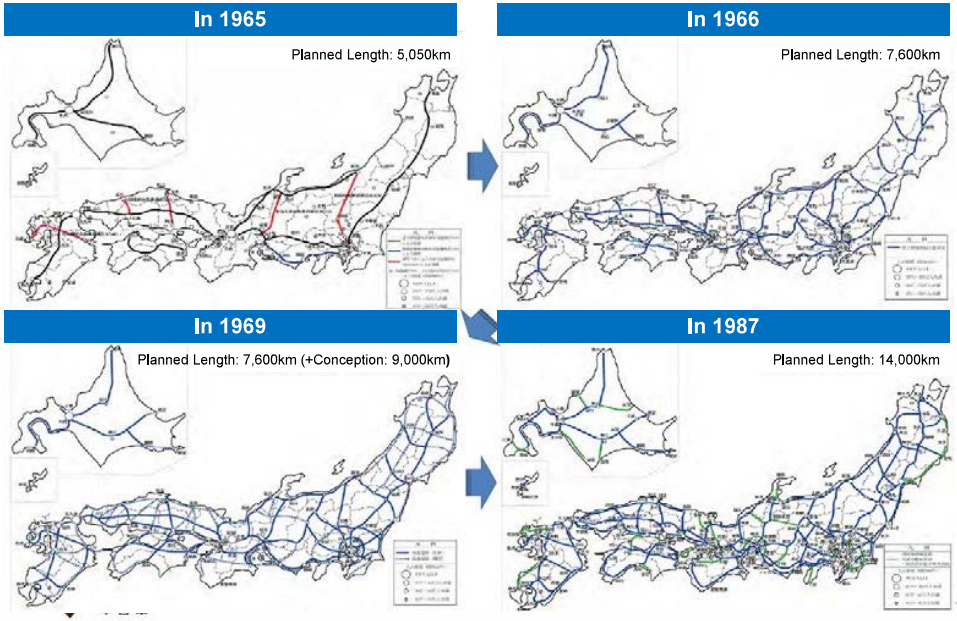
Arterial high-standard highway
Planned Length: 14,000km

- **National expressway**
  Planned Length: 11,520km
- **National limited Highway**
  Planned Length: 2,480km



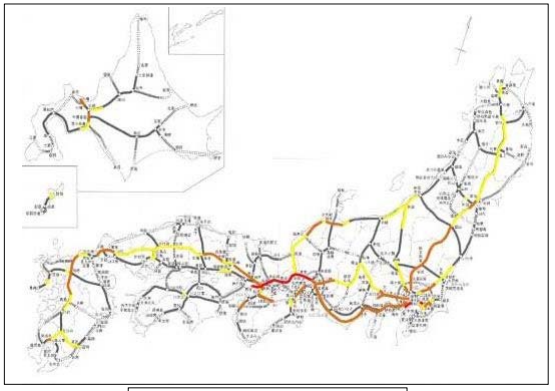
1. Outline of Expressways in Japan

Transition of Master Plan of Japan's Expressway Development

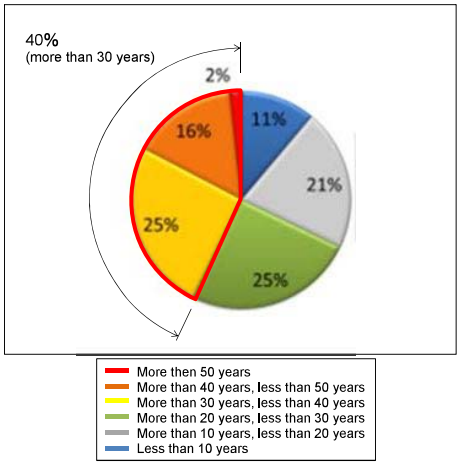


2. Current Situation of Expressways in Japan

- Among 9,000km expressways under the operation, some 40% (3,700km) are more than 30 years old. Also, the bridges can be observed the same situation.
- Therefore, the increase of the damage due to aging may be concerned in the future.



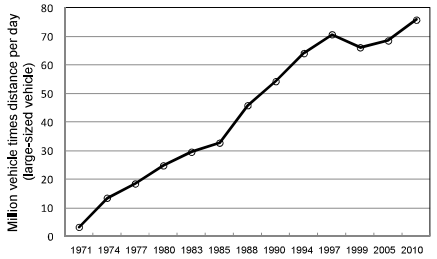
Expressway (more than 30 years old)
(as of the end of FY 2013)



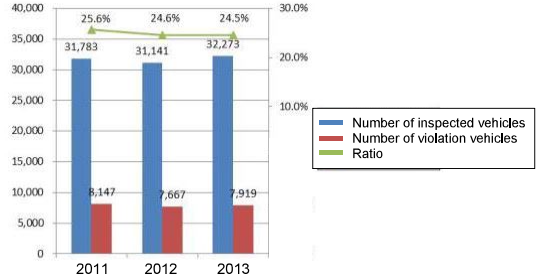
Ratio of Bridges by elapsed years
(as of the end of FY 2013)

2. Current Situation of Expressways in Japan

- The number of large-sized vehicles has increased year by year, and also, the gross weight of large-sized vehicle increased by the deregulation of the vehicular dimension.



Time-shift of vehicle times distance of large-sized vehicle

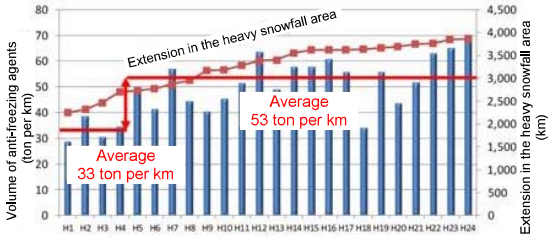


Ratio of violation vehicle

Increase of large-sized vehicles

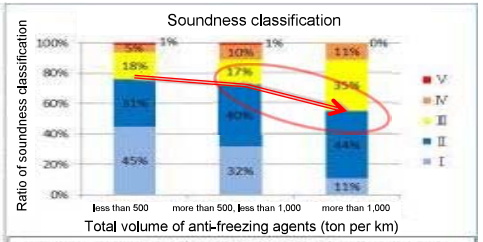
2. Current Situation of Expressways in Japan

- Expressways in tough environment by using of anti-freezing agents against the heavy snowfall and extreme rainfall due to natural disasters from global warming.



Volume-shift of the use of anti-freezing agents

Influence due to extreme rainfall



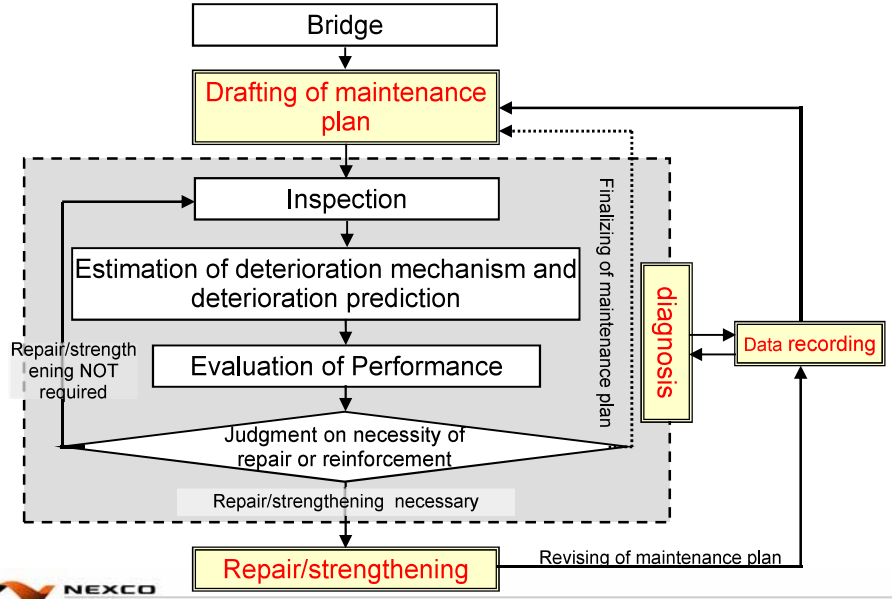
Serious damage has been observed in the area that more than 1,000 ton per km of anti-freezing agents has been used.

Expressways along coastal area

1. Outline of Expressways in Japan
2. Current Situation of Expressways in Japan
3. Bridge Management
4. Deterioration
   - 4-1. Steel Structure
   - 4-2. Concrete Structure
5. Expressway Renewal Project
6. Bridge Condition in Kyrgyz

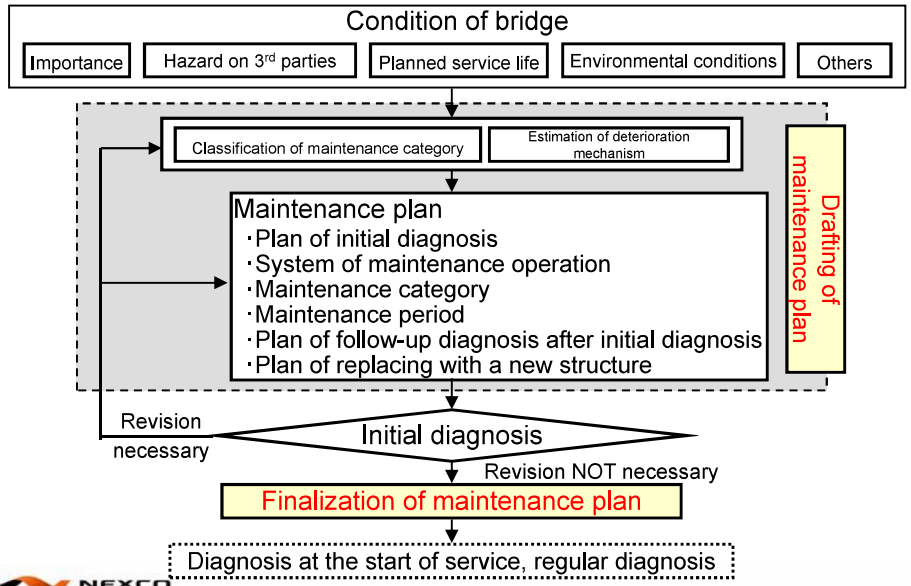
3. Bridge Management

3.1 Maintenance Procedure



3. Bridge Management

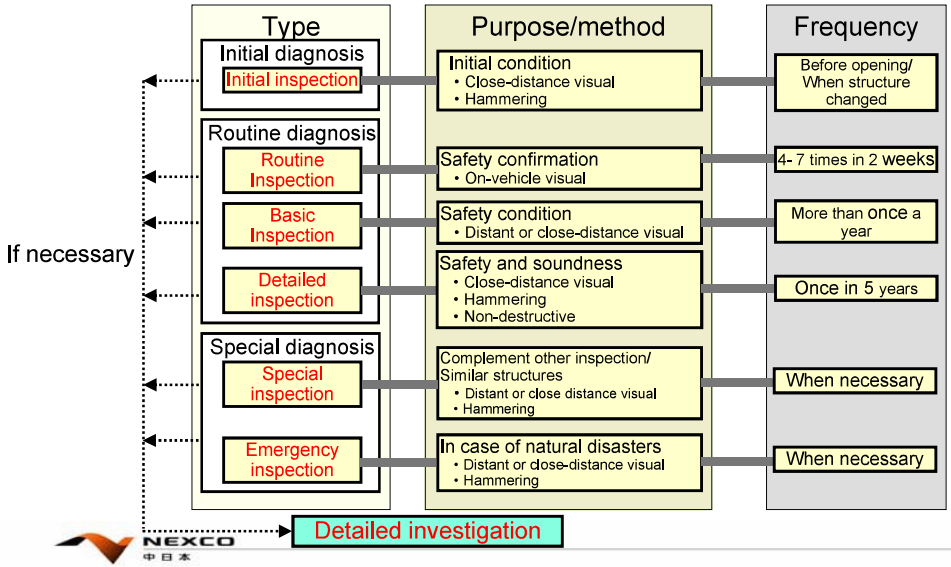
3.2 Procedure of Maintenance Planning



3. Bridge Management

3.3 Types of Inspections

● Inspections are conducted according to purposes



3. Bridge Management

3.4 Prediction of Deterioration Mechanism

Investigation of Design Drawings and Specifications
- Designed load, Designed effect
- Deterioration mechanism and environmental effect estimated during design
- Section shape, materials

Investigation of Construction Records
- Used materials
- Quality management records
- Method and results of inspection

Environmental Conditions of Existing Structures
- Meteorological Conditions (data)
- Operational Conditions (traffic volume, amount of applied anti-freeze agent)

Investigation of Maintenance Records
- Evaluation of inspection results
- Results of repair/strengthening

Estimation of Deterioration Mechanism

3. Bridge Management

3.5 Performance Evaluation & Judgement from Inspection results

Inspection → Evaluation of each degradation area → Evaluation of each structural member → Countermeasure

Examples of evaluation of degradation

Classification		Description of condition
Functional degradation	AA	Has severe damage/degradation. Requires immediate repair to recover its functionality.
	A	Has damage/degradation and functional deterioration. Require repair but no immediately.
	A1	Has damage/degradation and a high degree of functional deterioration.
	A2	Has damage/degradation but no functional deterioration.
	B	No sign of functional deterioration albeit damage/degradation. Requires continuous monitoring of damage/degradation.
	C	Requires further survey in order to evaluate its functionality
	OK	No or only slight sign of damage/degradation
Hazard to 3rd parties	E	Has risk of causing damage to 3rd parties, or affecting the safe traffic condition. Required immediate attention.

3. Bridge Management

3.5 Performance Evaluation & Judgement from Inspection results

Inspection → Evaluation of each degradation area → Evaluation of each structural member → Countermeasure

Examples of evaluation on each structural member

Degradation level	Severity of initial defect, damage or deterioration	Performance of structure and its structural member	Deterioration stage
Ⅰ	No problematic degradation	No performance loss	Incubation stage
Ⅱ	Slight degradation	No durability loss	Development stage
Ⅲ	Some degradation	Attention required for possible durability loss	Initial acceleration stage
Ⅳ	Notable degradation	Some durability loss and risk of it worsening beyond the allowable limit	Final acceleration stage
Ⅴ	Severe degradation	Severe durability loss and has serious safety issues	Deterioration stage

3. Bridge Management

3.5 Performance Evaluation & Judgement from Inspection results

Inspection → Evaluation of each degradation area → Evaluation of each structural member → Countermeasure

Examples of relevant countermeasures for each degradation grade

Grade	Severity of initial defect, damage or deterioration	Performance of structure, region and parts	Preventive maintenance	Enhance inspection	Repair	Strengthening	Restoration of Serviceability	Service restriction	Removal	Type of Measure
Ⅰ	No problematic degradation	No performance loss	○							None
Ⅱ	Slight degradation	No durability loss	◎							Prevention
Ⅲ	Some degradation	Attention required for possible durability loss	◎	○	◎					Repair
Ⅳ	Notable degradation	Some durability loss and rick of it worsening beyond the allowable limit		◎	◎	◎	◎			Strengthening
Ⅴ	Severe degradation	Severe durability loss and has some safety issues		◎	○	◎	◎	◎	◎	Major repair (replacement)

◎: Standard measures ○: Possible measures
(can be implemented preventively)

3.6 Issues of Bridge Management

Determination of designed service life
- Clarification of service life of bridges as infrastructures
- Clarification of service life of each member of bridge structures

※Formulation of a plan for countermeasures (repair/strengthening)

Selection of inspection methods based on scientific grounds
- Determination of inspection plan/method with deterioration factors in consideration
- Determination of inspection frequency by each deterioration factor with deterioration speed in consideration
- Evaluation of inspection results corresponding to required performance of structures

※Implementation of efficient and economical inspection and diagnosis

Immediate implementation of countermeasures corresponding to cause and degree of deterioration
- Immediate implementation of countermeasures corresponding to deterioration speed
- Establish the system to deal with all deterioration matters

※Implementation of efficient and economical countermeasures

⇒ Designed service life of bridge ensured

4-1. Steel Structure

4-1.1 Deterioration Mechanism, Factor, State of Deterioration and Indicator

Mechanism	Causal Factor	Description of the State	Indicator
Corrosion	Ultraviolet rays, Chloride ion, Acidic Substance, Oxygen, Rainwater (dews)	Ultraviolet rays cause chalking where the coating is decomposed into powdery state and loses its shiny finish. Macro-cell corrosion is developing under the coating first by water penetration and oxygen, then the coating is perforated (corrosion spots), and lastly those corrosion spots spread further due to micro-cell corrosion. As they develop into larger corrosions, the size of steel members will be thinned out, which is escalated further by chloride.	Discoloring & peeling Area of corrosion Thinning of steel Reduced steel size
Fatigue	Repeated cycle, Stress concentration	As it repetitively undergoes stress below the yielding point, crack develops in weld ends (particularity around boxing weld joints) and the root of fillet welds, where stress is concentrated.	Crack

4-1. Steel Structure

4-1.2 Appropriate Measures for Improvement of Bridge Durability

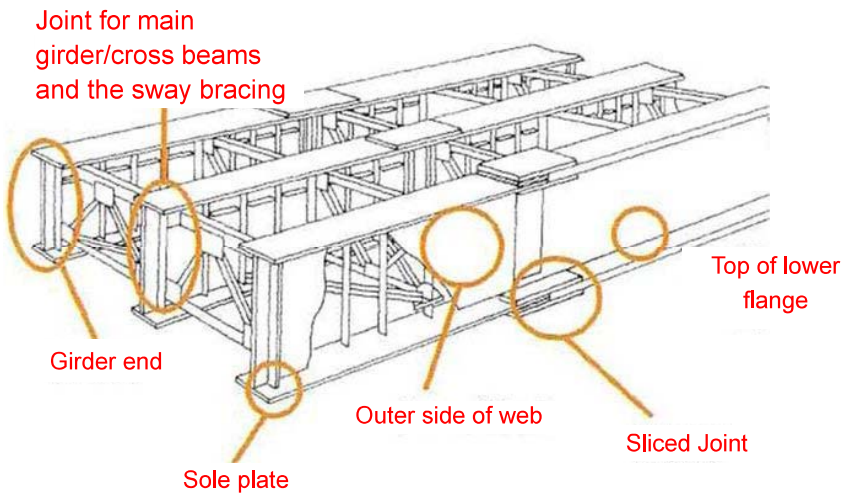
Corrosion
- Steel members suffer from progressive corrosion damages if appropriate rust-proof treatment is not conducted.
- When the rust-proof treatment for steel members is specified in the paint specifications, the design of steel structures is made based on the premise that regular repainting (repairing) is surely implemented.

Fatigue
- Checking whether a rational fatigue deign was conducted in the early design stage
- The wheel load of an actually traveling vehicle is greater than that assumed in the Specification for Highway Bridges.
- Fatigue analysis and measures require a high level of expertise.

4. Deterioration

4-1. Steel Structure

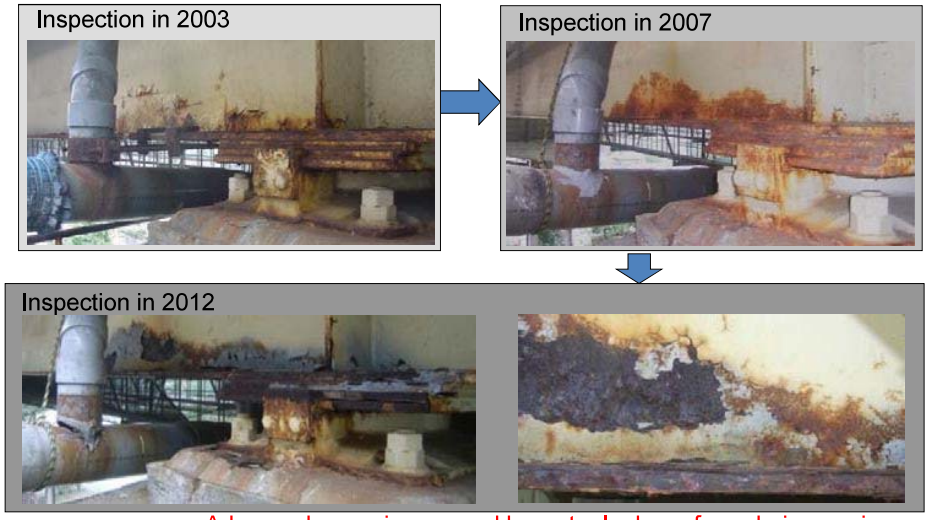
4-1.3 Corrosion of Steel Structure



4. Deterioration

4-1. Steel Structure

4-1.3 Corrosion of Steel Structure (Progress of Corrosion in Steel Structure)

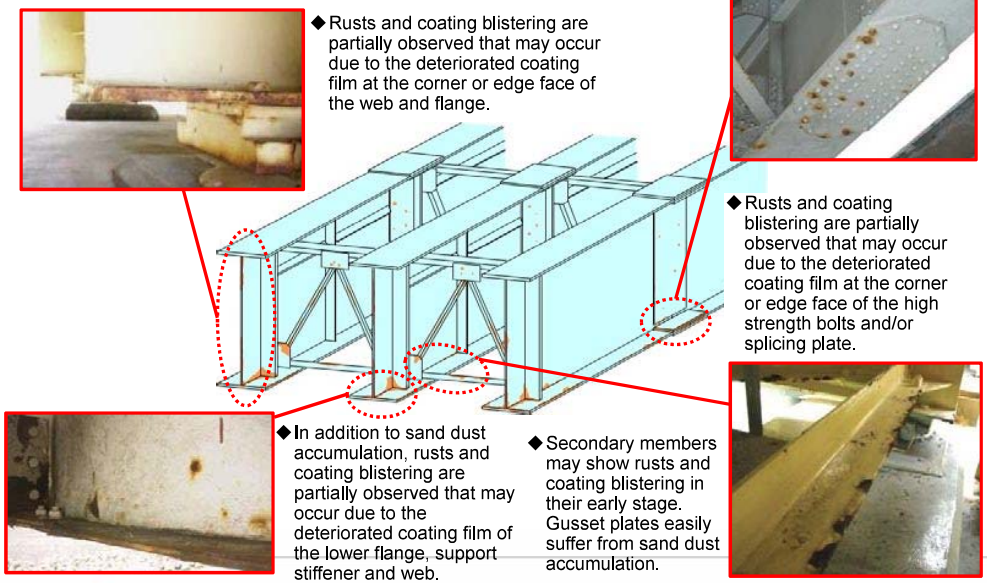


Advanced corrosion caused by water leakage from drainage pipe

4. Deterioration

4-1. Steel Structure

4-1.3 Corrosion of Steel Structure (Grade II)



◆Rusts and coating blistering are partially observed that may occur due to the deteriorated coating film at the corner or edge face of the web and flange.

◆Rusts and coating blistering are partially observed that may occur due to the deteriorated coating film at the corner or edge face of the high strength bolts and/or splicing plate.

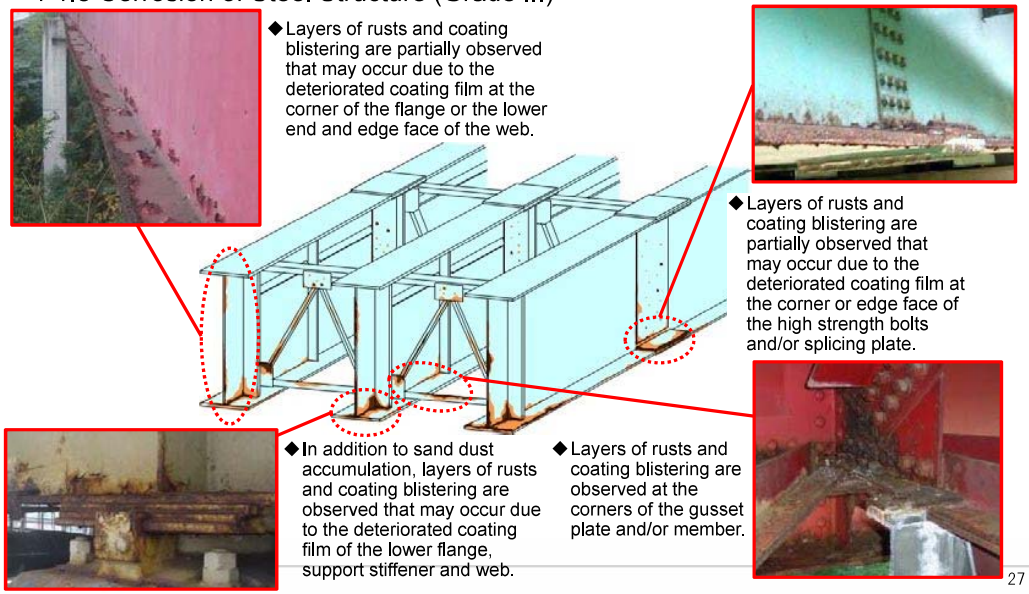
◆In addition to sand dust accumulation, rusts and coating blistering are partially observed that may occur due to the deteriorated coating film of the lower flange, support stiffener and web.

◆Secondary members may show rusts and coating blistering in their early stage. Gusset plates easily suffer from sand dust accumulation.

4. Deterioration

4-1. Steel Structure

4-1.3 Corrosion of Steel Structure (Grade III)



◆Layers of rusts and coating blistering are partially observed that may occur due to the deteriorated coating film at the corner of the flange or the lower end and edge face of the web.

◆Layers of rusts and coating blistering are partially observed that may occur due to the deteriorated coating film at the corner or edge face of the high strength bolts and/or splicing plate.

◆In addition to sand dust accumulation, layers of rusts and coating blistering are observed that may occur due to the deteriorated coating film of the lower flange, support stiffener and web.

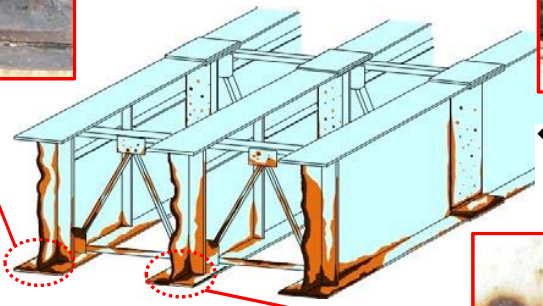
◆Layers of rusts and coating blistering are observed at the corners of the gusset plate and/or member.

4. Deterioration

4-1. Steel Structure

4-1.3 Corrosion of Steel Structure (Grade IV)

◆Cross-sectional defects remarkably take place at the lower end of the web of the girder edge.



◆The lower flange corrodes and also the plate thickness are reduced, resulting in remarkable cross-sectional defects.

◆Layers of rusts remarkably take place on the lower flange at the girder edge and the plate thickness are reduced, resulting in remarkable cross-sectional defects.

4. Deterioration

4-1. Steel Structure

4-1.4 Fatigue of Steel Structure

Cause

Repeated stresses of a steel member by external forces (such as traffic load, wind load, etc.)

Phenomena

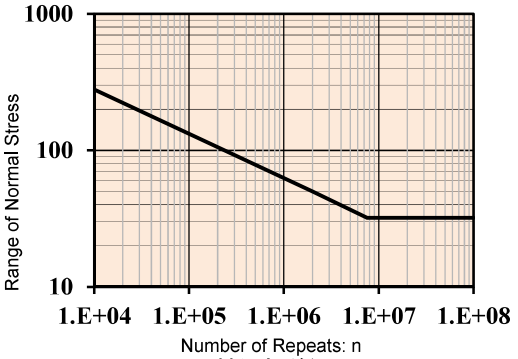
Cracking starts from a stress concentration part. In some location where cracks have occurred, the progress of the crack may lead to the occurrence of brittle fracture, having significant impacts on the safety of bridges.

Despite a small load, if the load repeatedly acts on a steel member millions of times, cracking will occur in the member.

Location of Fatigue

- Structural stress concentration part
- Stress concentration parts that occurred due to the weld shape and weld defects

*Fatigue Design Curve for Boxing Parts in the Fillet Welding Joint (Grade G) in accordance with the Specification for Highway Bridges

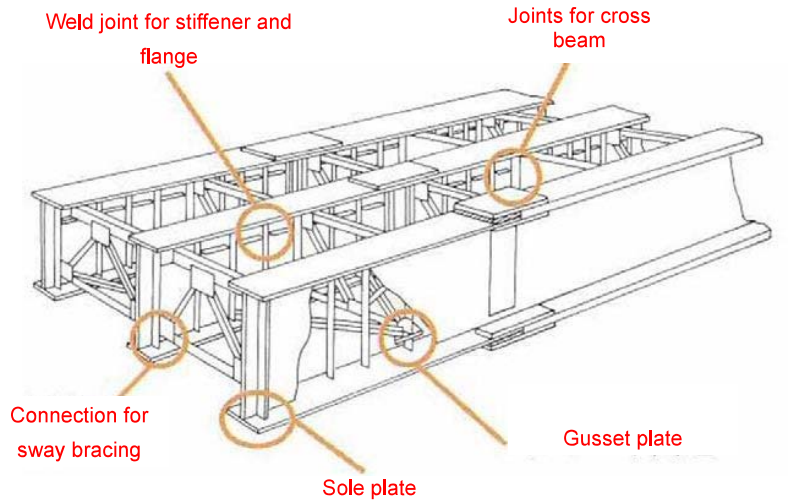


Example of the Fatigue Design Curve of a Joint in which Right Stresses are Applied*

4. Deterioration

4-1. Steel Structure

4-1.4 Fatigue of Steel Structure (Typical Area of Fatigue Cracks)

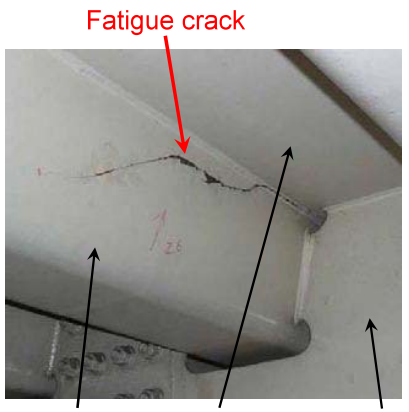


4. Deterioration

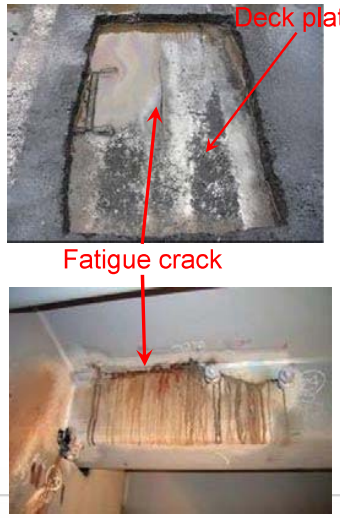
4-1. Steel Structure

4-1.4 Fatigue of Steel Structure (Steel Deck)

- Repeated traffic load ⇒ Cracks in steel deck



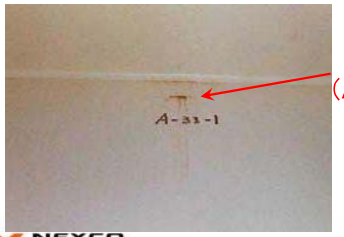
Fatigue crack develops further



4. Deterioration

4-1. Steel Structure

4-1.4 Fatigue of Steel Structure (Connection for sway bracing)



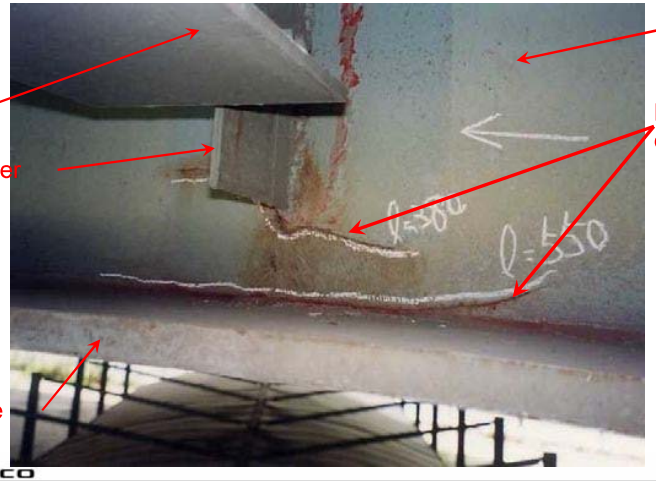
Fatigue crack
(Advance to the back of web)

4. Deterioration

4-1. Steel Structure

4-1.4 Fatigue of Steel Structure (Joint between web and cross beam)

- Crack in the welded joint between cross beam and vertical stiffener

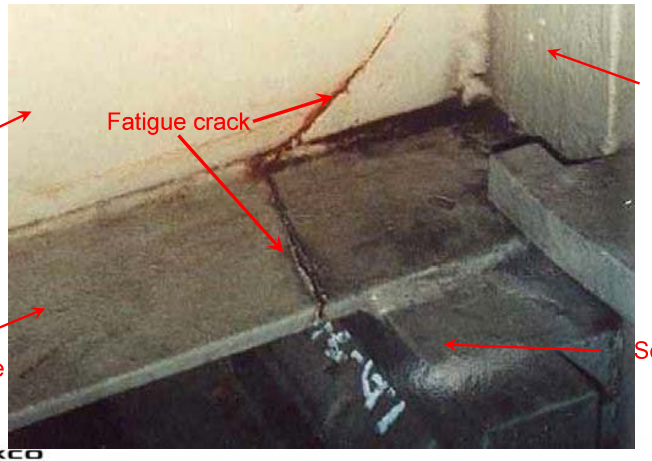


4. Deterioration

4-1. Steel Structure

4-1.4 Fatigue of Steel Structure (Sole plate)

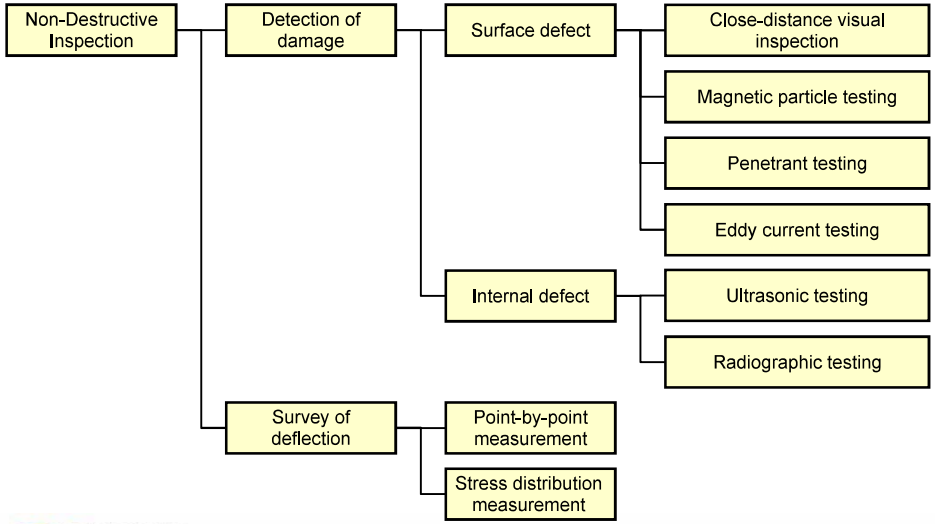
- Stress from the restraint on girder ⇒ Crack in the welded joint (loss of bearing function)



4. Deterioration

4-1. Steel Structure

4-1.5 Non-Destructive Inspection Methods for Steel Members



4-1. Steel Structure

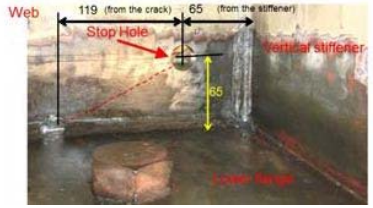
4-1.5 Non-Destructive Inspection for Cracks

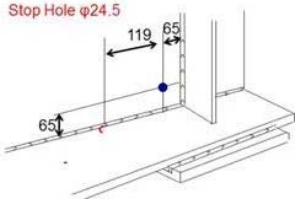
Test	Advantages	Disadvantages
MT : Magnetic Particle Testing JIS G 0565	1. Able to obtain highly accurate data about shapes and size of cracks 2. Able to measure the length of even the smallest scale of crack	1. Cannot detect cracks underneath 2. Needs to remove coating to detect cracks 3. Results might be inaccurate when inspecting severely uneven surfaces (corrugated bead, undercut)
PT : Penetrant Testing JIS Z 2343	1. Suitable for detecting surface crack 2. Convenient method, which does not require a lot of devices or any power supply	1. Cannot detect cracks underneath 2. Needs to remove coating to detect cracks 3. Difficult to detect minor cracks as penetrant cannot seep into them 4. Results might be inaccurate when inspecting severely uneven surfaces (corrugated bead, undercut)
ET : Eddy Current Testing JIS G 0568	1. Suitable for detecting surface cracks 2. Can be conducted from over the coating film 3. Can be conducted quickly	1. Cannot detect cracks underneath 2. Cannot measure the exact sizes of cracks accurately 3. Accuracy of the test depends on the experience and skills of the inspector
UT: Ultrasonic Testing JIS Z 3060	1. Can detect defects inside welded connection	1. Results may be inaccurate in some cases depending on the location and the size of crack 2. Accuracy of the test depends on the experience and skills of the inspector

4-1. Steel Structure

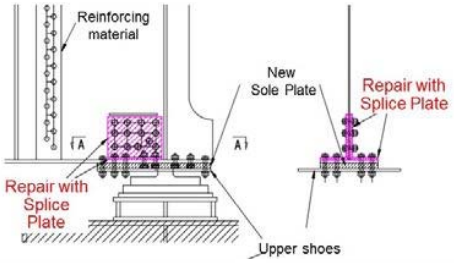
4-1.6 Repair/Reinforcing Methods against Fatigue Cracks

■ Stop Hole





■ Repair for Type SP Cracks Using Splice Plate



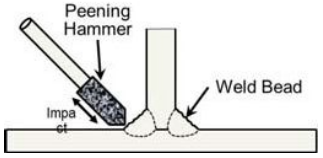
4-1. Steel Structure

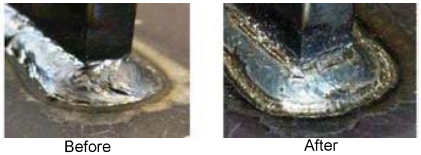
4-1.6 Repair/Reinforcing Methods against Fatigue Cracks

■ Improvement of the Fatigue Strength of Weld Joints

(1) High Frequency Peening

This technique is applied to weld toes as a preventive measure to enhance the fatigue strength. In the technique, an impact force by ultrasonic vibration is given to a welded part, which micronizes and densifies the structure of the metal surface and also shifts the weld residual stress from tensile to compressive, thereby improving the fatigue strength of the metal. Application of this technique makes the shape of the weld toe to become round, relaxing the stress concentration of the metal.

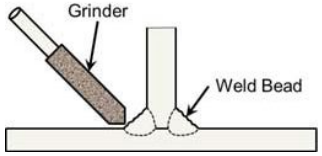




Before After

(2) Grinder Finish

This technique should be applied to a properly-welded part that is not cracked. The technique can serves not only as preventive measures to improve the fatigue strength but also as permanent measures to remove minor fatigue cracks that occurs at a welded part.
With this technique, it is possible to remove cracks and to create a smooth finish, reducing the stress concentration and further, improving the fatigue strength of the welded joints



4-2. Concrete Structure

4-2.1 Deterioration Mechanism, Factor, State of Deterioration and Indicator

Mechanism	Causal Factor	Description of Deterioration	Indicator
Carbonation	Carbon dioxide	Cement hydrate reacts with carbon dioxide to cause carbon reaction in cement hydrate, which lowers the pH of concrete. This also leads to corrosion of steel members, creating cracks and peeling in concrete surface. Due to these damages, the steel members will thin down.	Carbonation depth, Amount of corroded part in steel members
Chloride attack	Chloride ion	Chloride ions in concrete cause corrosion of steel members, leading to cracks and peeling in concrete surfaces and thinning down of steel members	Development of cracks
Alkali-silica reaction (ASR)	Alkali-reactive aggregate	Aggregate containing ASR-causing minerals reacts with alkaline solution, showing an enormous expansion. This causes cracks in concrete.	Level of expansion (cracks)
Frost attack	Repeated cycles of freezing and thawing	Water content in concrete freezes and thaws repeatedly, which escalates deterioration of concrete with the development of scaling and cracks.	Freezing depth, amount of corroded part in steel members

4-2. Concrete Structure

4-2.1 Deterioration Mechanism, Factor, State of Deterioration and Indicator

Mechanism	Causal Factor	Description of Deterioration	Indicator
Chemical attack	Acidic substances, sulfate ions	Concrete is decomposed by acidic substances and sulfate ions, or deteriorated by expansion pressure generated when chemical compounds are formed.	Penetration depth of deterioration-causing factor, Carbonation depth, Amount of corroded part in steel members
Fatigue	Repeated loading	Repeated loading applied by vehicles leads to cracks, corrosion of steel members and subsidence of bridge deck.	Crack density Deflection
Wear	Friction	Frictions caused by the flow of water or the cars driven past, concrete gradually wears off over time.	Amount of worn off part, or speed of wear

4-2. Concrete Structure

4-2.2 Appropriate Measures for Improvement of Bridge Durability

Neutralization

- All concrete cannot avoid suffering from the neutralization.
- For a concrete structure with a small compressive strength and with a small reinforcement covering depth (such as, for example, RC superstructures or RC floor slabs), the progress of neutralization is rapid, increasing the possibility of corrosion of reinforcement.
- Although taking immediate countermeasures (such as surface protection method, etc.) can eliminate the influence of the neutralization, the cases in which appropriate measures have been actually taken is very rare.

Alkali Silica Reaction (ASR)

- Whether reactive aggregate is present or absent is important
- As the ASR progresses, both the load carrying capacity and durability of the concrete structure will be decreased.
- Immediate countermeasures are needed.

Fatigue (Floor Slab)

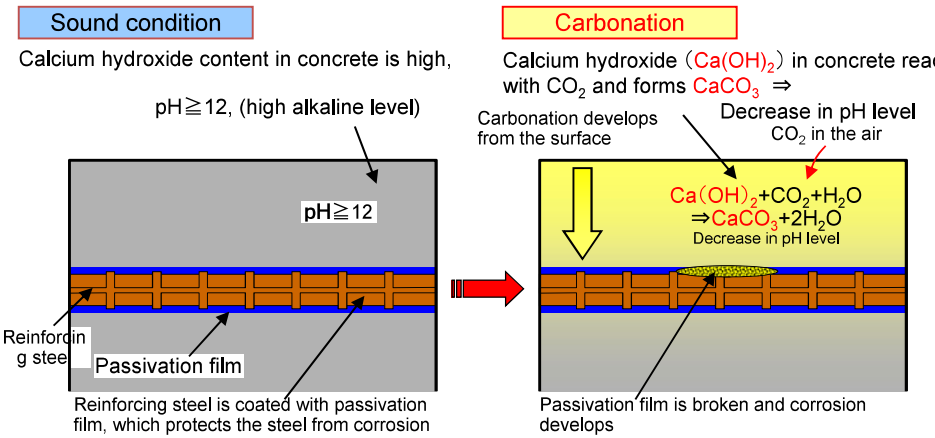
- The wheel load of an actually traveling vehicle is greater than that assumed in the design stage.
- A bridge that has a thin floorboard thickness may suffer from deterioration.
- A bridge with no waterproofing may suffer from accelerated deterioration.
- A bridge that has received salt damage may suffer accelerated deterioration
- Fatigue of the floor slab may have a significantly-adverse impact on the travelling safety of vehicles.

4-2. Concrete Structure

4-2.3 Main Causes of Deterioration

■ Carbonation

lowered pH by carbonation of concrete ⇒ corrosion of reinforcing steel



$Ca(OH)_2+CO_2+H_2O \Rightarrow CaCO_3+2H_2O$

4. Deterioration

4-2. Concrete Structure

4-2.3 Main Causes of Deterioration

■ Alkali Silica Reaction

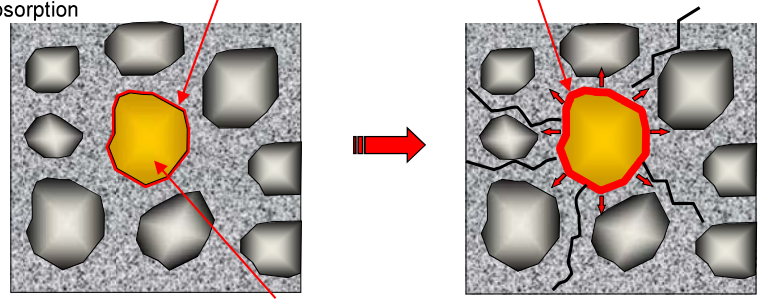
Alkali-reactive aggregate absorbs water and expands ⇒ cracks in concrete

Incubation Stage

Aggregate reacts with alkaline contained in cement ,and forms gel, which expands upon water absorption

Acceleration Stage

Gel has absorbed water (moisture) and expand, which could cause cracking in concrete



※Alkali Silica Reaction is usually abbreviated as ASR.

4. Deterioration

4-2. Concrete Structure

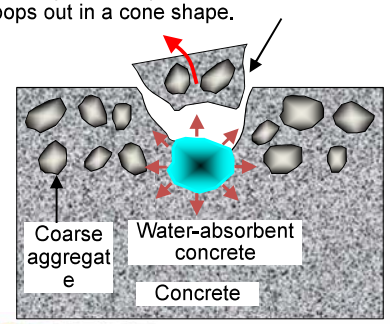
4-2.3 Main Causes of Deterioration

■ Frost Attack

Aggregate and Mortar Freeze ⇒ Deterioration of Concrete Surface

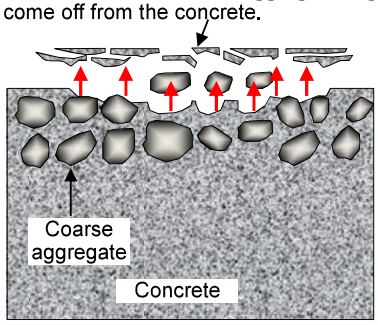
Pop-out

If water-absorbent aggregate is in the surface layer, expansion pressure is generated when the aggregate freezes. Due to this pressure, part of the surface concrete pops out in a cone shape.



Scaling

Due to the repeated cycles of freezing and thawing, mortar in the surface layer is delaminated in this strips. If the delamination continues further, coarse aggregate might come off from the concrete.



4. Deterioration

4-2. Concrete Structure

4-2.3 Main Causes of Deterioration

■ Mechanism of Fatigue Deterioration

(1) Early Stage of Service Life

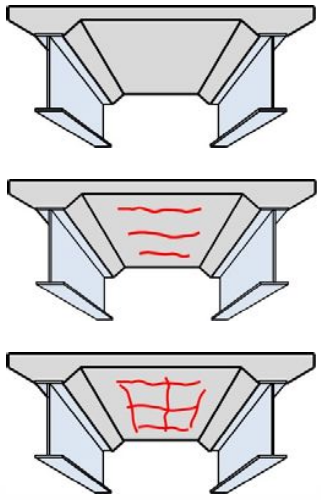
The condition shows no sign of any harmful crack in the early stage of service life.

(2) Occurrence of Unidirectional Cracks

The condition shows occurrence of unidirectional cracks on the floor slab that may be resulted from the effect of drying shrinkage. Because the shrinkage of a floor slab is usually confined by steel girders, cracking easily takes place in the direction perpendicular to the bridge axis.

(3) Occurrence of Latticed Cracks

The condition shows alternating occurrence of horizontal cracks and vertical ones, resulting in increased formation of latticed cracks. The effect of live loads gradually moves the progress of horizontal/vertical crack formation forward, which resulted in a gradual decrease in both shear rigidity and torsional shear rigidity.



4. Deterioration

4-2. Concrete Structure

4-2.3 Main Causes of Deterioration

■ Mechanism of Fatigue Deterioration

(4) Cracks Penetrate through to the Top Surface

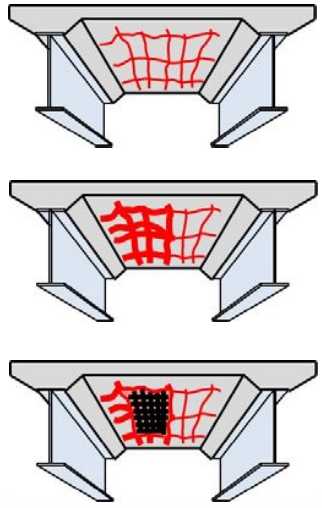
As bi-directional cracks progress, the formation of new cracks occurs, which enables the cracking pattern to have a tortoise-shell like appearance. In addition, repeated traffic loads help bending cracks to penetrate through to the top surface of the floor slab.

(5) Shear Resistance of the Crack Fracture Surface Has been Decreased

An abrasion phenomenon takes place on the crack fracture surface and then the shear resistance decreases. If water is present on the surface, this phenomenon will be remarkably observed. Rainwater infiltrating through the penetrated cracks allows not only efflorescence to begin to precipitate on the bottom surface of the floor slab but also rust leachate to accumulate on the bottom surface.

(6) Latticed Cracks Further Progress

The increase in crack density cannot be stopped until the size of the tortoiseshell like crack reaches 20-30 centimeters square. After the increase in crack density has stopped, the punching shear strength significantly decreases and the wheel load that is larger than the shear strength results in the fall of concrete chunks from the bottom surface of the slab.



4. Deterioration

4-2. Concrete Structure

4-2.4 Mechanism in Deterioration of PC Steel Materials

Mechanism of Deterioration	Factors of Deterioration	Phenomenon of Deterioration	Example of the Indices of Deterioration
Corrosion	Chloride ion, acidic substances, oxygen, rainwater (dew condensation), etc.	After rust-proof functions have been impaired, PC steel materials gradually gets corroded due to rainwater penetration and oxygen effects and reaches rapture.	Soundness of anti-rusting function, Breaking of PC steel materials
Fatigue	Repetitive load Wind/Vibration	After either repetitive loads from vehicles or repetitive stresses from wind or traffic vibration have continued to be applied, PC steel materials reaches rapture.	Tensile force Breaking of PC steel materials

4. Deterioration

4-2. Concrete Structure

4-2.5 Appropriate Measures for Improvement of Bridge Durability

Corrosion

- PC steel members suffer from progressive corrosion damages if appropriate rust-proof treatment is not conducted.
- In some locations of an existing structure, poor grout filling is found due to not only the material separation of PC grout but also the low void ratio of the sheath.
- For inner cable structures, inspections are extremely difficult to conduct.
- There may occur a delayed fracture.

Fatigue

- Inner cable structures seldom result in fatigue-induced deterioration
- Outer cable structures and/or diagonal members of a cable-stayed bridge may be deteriorated due to fatigue.

4. Deterioration

4-2. Concrete Structure

4-2.6 Deterioration of PC steel materials

Corrosion/Rupture of PC Steel Materials and Reinforcing Bars due to Poor Grout Filling and Water Penetration

4. Deterioration

4-2. Concrete Structure

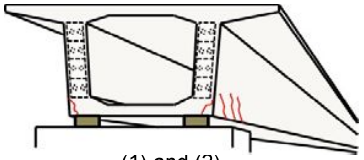
4-2.6 Deterioration of PC steel materials

Corrosion/Rupture of PC Steel Materials and Reinforcing Bars due to Poor Arrangement of PC Steel Materials (Insufficient Covering Thickness)

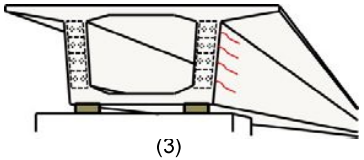
4-2. Concrete Structure

4-2.7 Points to be Noted during Inspection (End Supporting Point)

Condition of the Cracks	Primary Cause
(1) Vertical cracks occurring at bearing points of the bottom and side surface of the girder	Excessive local stress concentration at the bearing point, loss of bearing's functions, earthquake
(2) Diagonal cracks occurring in the web plate around the bearing points	Excessive shear force, short of shear reinforcement steel materials
(3) Cracks occurring along PC steel material	Water penetration from the anchoring part into the inside of the sheath, expansion resulting from alkali aggregate reaction, etc.
(4) Cracks occurring in the areas (filled with secondary concrete of the PC steel anchoring part	Cracks induced by the drying shrinkage of concrete filling materials



(1) and (2)



(3)

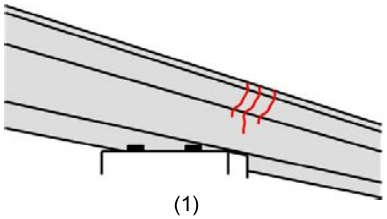
(4)

4-2. Concrete Structure

4-2.7 Points to be Noted during Inspection (Intermediate Support Point/ Center of the Span)

Intermediate Support Point

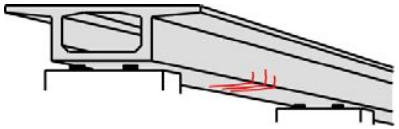
Condition of the Cracks	Primary Cause
(1) Vertical cracks occurring in the upper area of the main girder, at the intermediate support point of the continuous girder	Short of reinforcement steel materials or prestress that correspond to the negative bending moment generated on the upper flange at the intermediate support point
(2) Cracks, occurring at the intermediate support point, of the cross beam	Influences of temperature stress or drying shrinkage



(1)

Center of the Span

Condition of the Cracks	Primary Cause
(3) Cracks occurring on the bottom surface of the lower floor slab and developing perpendicular to the bridge axis, and vertical cracks occurring on the web plate	Short of reinforcement steel materials or prestress that correspond to the positive bending moment generated around the center of the span



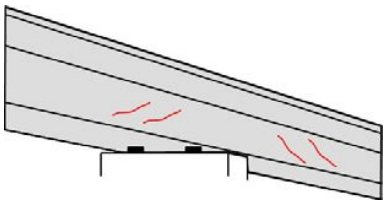
(3)

4-2. Concrete Structure

4-2.7 Points to be Noted during Inspection (Quarter Point of the Span/Construction Joint Part)

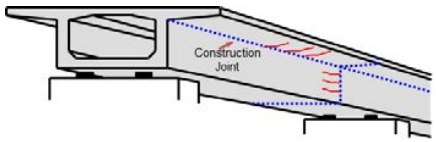
Quarter Point of the Span

Condition of the Cracks	Primary Cause
Diagonal cracks occurring on the web plate	Short of the thickness of members, or short of reinforcement steel materials or prestress



Construction Joint Part

Condition of the Cracks	Primary Cause
Cracks occurring at the construction joint part of the girder or at the construction joint of the floor slab	Improper treatment of the construction joints, temperature stress/drying shrinkage

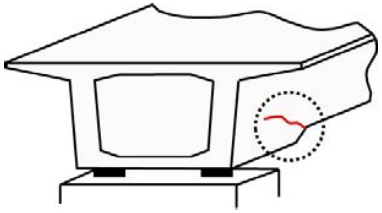


4-2. Concrete Structure

4-2.7 Points to be Noted during Inspection (Sectional Change Part / PC Steel Anchoring Part)

Sectional Change Part

Condition of the Cracks	Primary Cause
Cracks occurring at the sectional change part	Stress concentration associated with abrupt sectional changes



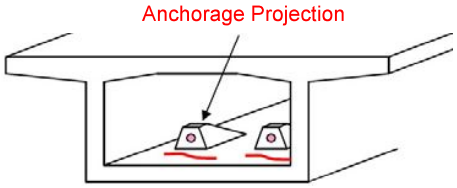
Anchoring Part

Condition of the Cracks	Primary Cause
Cracks occurring around the anchoring part and/or the deflection part	The cracks occurred as a result of stress concentration of the anchoring part and of the deflection part

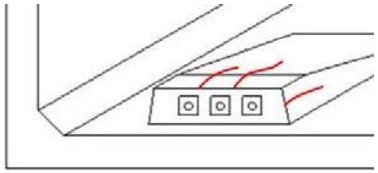
Cracks Occurring at the Anchoring Part for Outer Cables of the Cross Beam

4-2. Concrete Structure

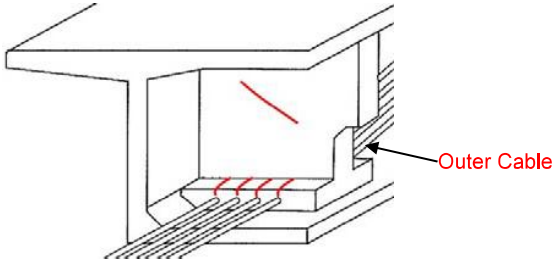
4-2.7 Points to be Noted during Inspection (PC Steel Anchoring Part)



Crack arising around the Anchorage Projection



Crack arising on the Anchorage Projection Used for Several Steel Strands

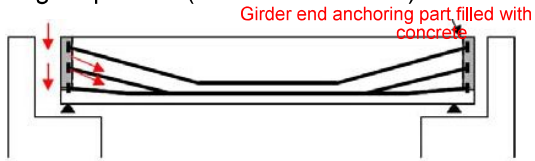


Crack arising on the Deflection Part for Outer Cables

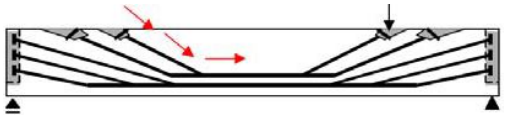
4-2. Concrete Structure

4-2.7 Points to be Noted during Inspection (Water Penetration)

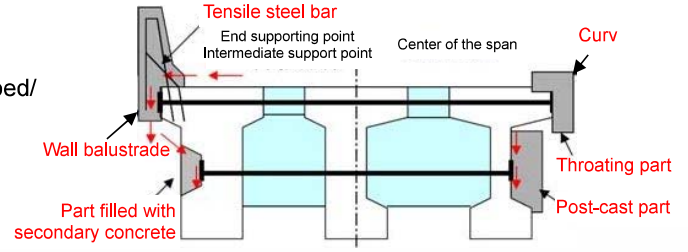
(1) Girder End Part



(2) Upper Edge Anchoring Part



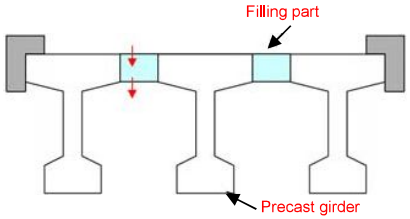
(3) Curv, Wall Balustrade and Transversely-clamped/ Post-cast Part



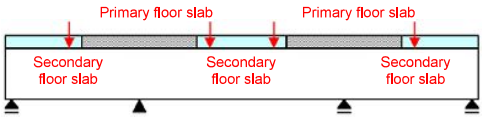
4-2. Concrete Structure

4-2.7 Points to be Noted during Inspection (Water Penetration)

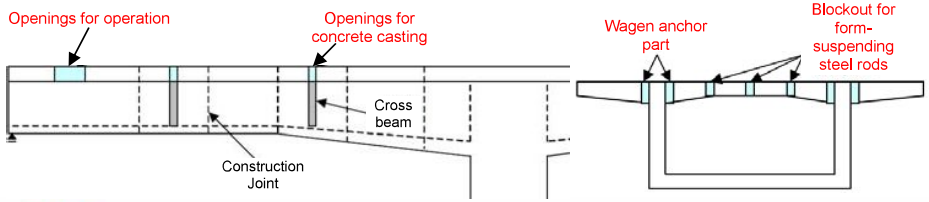
(4) Filling Part of the Precast Girder



(5) Joint parts between Primary and Secondary Floor Slabs of the Continuous Composite Girder



(6) Openings of Box Girder Bridge (for constructional operations)



4-2. Concrete Structure

4-2.8 Non-Destructive Inspection Methods (Concrete Strength & Crack Depth)

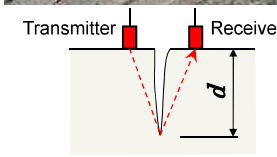
■ Concrete Strength

The rebound of a hammer (Schmidt Hammer) against concrete surface is measured. However, the results of Schmidt Hammer testing may sometimes include significant errors.

■ Crack Depth

Ultrasonic testing is generally conducted . This type of inspection has the following characteristics:

- Ultrasonic wave is transmitted from a transmitter placed on the surface. The depth of a crack can be calculated from the time it takes to reach a receiver.
- When a reinforcing bar is running over a crack, ultrasonic wave travels through the bar; this might lead to a rick of the crack depth being underestimated.
- To conduct this test, the elastic wave velocity of the specimen (concrete) needs to be determined beforehand



$$d = V_0 \times \frac{t}{2}$$

d = Depth of crack (mm)

V_0 = Elastic wave velocity of concrete(km/s)

t = Ultrasonic propagation time (μs)

4-2. Concrete Structure

4-2.8 Non-Destructive Inspection Methods (Degradation near Concrete Surface)

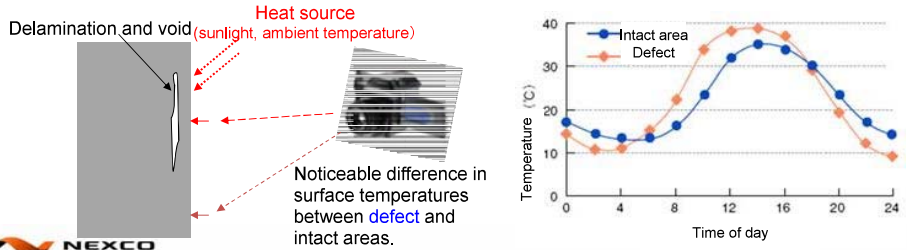
Infrared Thermography Testing can detect the surface to subsurface (i.e. up to the depth of rebar) degradations such as surface delamination and air voids in concrete.

Mechanism

(1) Infrared ray is radiated from any object. The amount of the infrared radiation is in proportion to the temperature of each object.
(2) The temperature of an object can be determined by measuring the infrared energy emitted from it.
(3) Any defect can be detected through thermography; when there is a structure defect in concrete, the temperature will deviate from the surrounding area.

Characteristics

(1) Non-contact, remote inspection method
(2) Some restrictions apply; inspection can be carried out under a certain weather condition



4-2. Concrete Structure

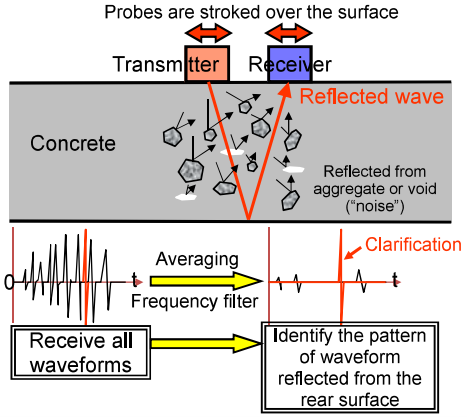
4-2.8 Non-Destructive Inspection Methods (Broadband Ultrasonic Testing)

Internal degradation (e.g. surface peeling, void) can be inspected with ultrasonic testing or electromagnetic testing. One of the most accurate methods is the broadband ultrasonic testing, which is a method improved from the conventional ultrasonic testing.

Mechanism

When an inspector strokes an ultrasonic probe over the surface of target structure, its ultrasonic wave gets absorbed into the concrete. The reflected wave is examined to find out the concrete's internal conditions.

By averaging and filtering the results, more accurate results can be obtained, which are not affected by other waveforms such as aggregate and air void.

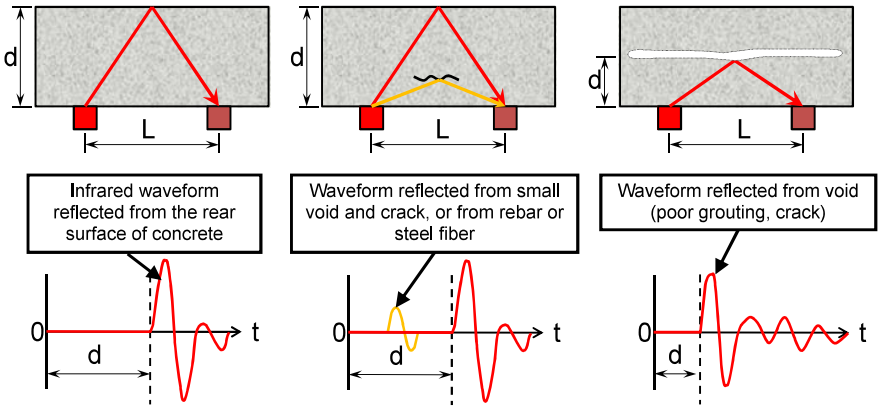


4-2. Concrete Structure

4-2.8 Non-Destructive Inspection Methods (Broadband Ultrasonic Testing)

Broadband ultrasonic probing

(a) Sound condition (b) Small void or crack (c) Defect (noticeable void)



4-2. Concrete Structure

4-2.8 Non-Destructive Inspection Methods (Rebar Locations & Concrete Covering)

Locations of reinforcing steel or the depths of concrete covering can generally be determined by the following two methods:

1. **Electromagnetic Induction**

When a probe is stroked over the target concrete structure, the magnetic flux generated from a coil in the probe changes depending on how close a reinforcing steel is located from the probe. Using this mechanism, the location and the depth of reinforcing steel (distance from the surface to the steel) can be determined. However, only the steel located relatively close to the surface can be detected.

2. **Electromagnetic Wave**

When electromagnetic wave is emanated over concrete surface, some part of electromagnetic wave permeates into the concrete, and this electromagnetic wave is reflected from any object that differs from concrete in terms of electric property (e.g. steel or air void).

Using this mechanism, the location of reinforcing steel can be calculated from the time it takes to receive the reflected wave back by the probe. For this calculation, the speed of electromagnetic wave (relative permittivity) will need to be determined beforehand.

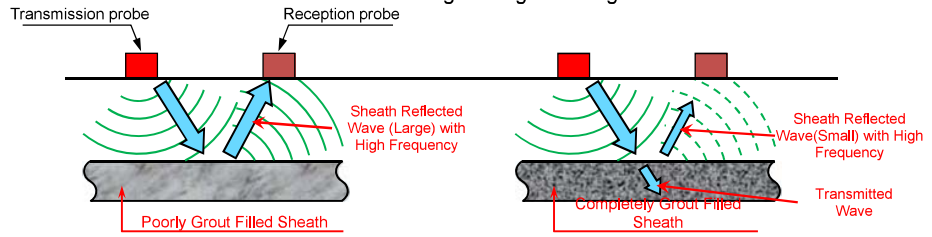
4-2. Concrete Structure

4-2.8 Non-Destructive Inspection Methods (Investigation of Grout Fill Conditions)

Principle of the Probing Technique

An ultrasonic wave, as its characteristics, reflects on the interface between two different substances. If there is a void on the interface, the wave will totally reflect at the void and a large reflected wave will generate. In contrast, if the interface is dense, the reflectance becomes low and, therefore, the reflected wave becomes small.

Since the reflected wave coming from a sheath is predominated by high frequency band waves, in the case of a poorly-grout filled sheath, a high frequency band will be received but, in the case of a completely-grout filled sheath, a high frequency band wave received will become small. In the investigation of grout fill conditions, a pair of probes are put in place and a reception probe of them receives the reflected wave coming from the sheath. The difference in characteristic value between two different sheaths is used to determine the degree of grout filling.



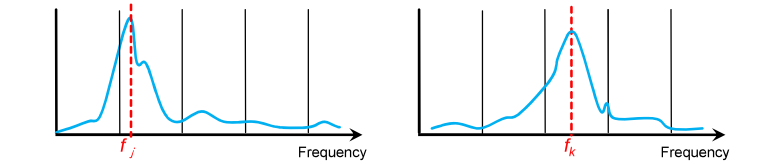
4-2. Concrete Structure

4-2.8 Non-Destructive Inspection Methods (Investigation of Grout Fill Conditions)

Principle of the Probing Technique

A “complete grout filling” case and a “poor grout filling” case, as apparent in the figure below, give different spectrum patterns from each other. In the poor grout filling case, the peak signal tends to be within a high frequency band. This peak pattern difference is used in determining the degree of grout filling.

Because the threshold (frequency) used in determining the degree of grout filling may vary depending on the strength and cover thickness of concrete and/or the sheath’s diameter, a borehole survey for calibrating the investigation results needs to be conducted so that the accuracy of the investigation can be improved.



Predominant Spectrum for a Completely Grout Filled Sheath

Predominant Spectrum for a Poorly Grout Filled Sheath

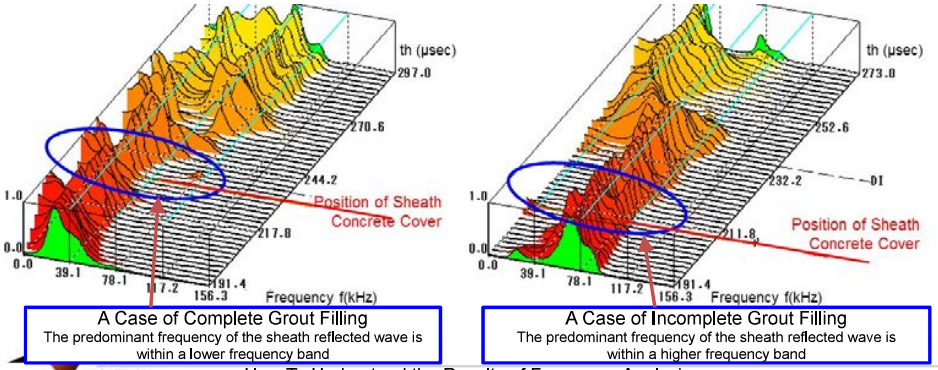
Spectrum Pattern Diagram

4-2. Concrete Structure

4-2.8 Non-Destructive Inspection Methods (Investigation of Grout Fill Conditions)

How to Confirm the Degree of Grout Filling

Determination of the degree of grout filling is made based on the waveform at the position of sheath’s concrete cover. The waveform on the left side of the figure below tells us that the peak signals of a sheath reflected wave are identified in a lower frequency band and further that the grout filling has been sufficiently completed, whereas the waveform on the right side has peak signals identified in a higher frequency band than that of the poorly grout filled sheath, which indicates that the grout filling condition is highly likely to be poor.



A Case of Complete Grout Filling
The predominant frequency of the sheath reflected wave is within a lower frequency band

A Case of Incomplete Grout Filling
The predominant frequency of the sheath reflected wave is within a higher frequency band

How To Understand the Results of Frequency Analysis

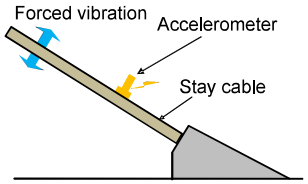
4-2. Concrete Structure

4-2.8 Non-Destructive Inspection Methods (Tensile Force of Stay Cable, External Cable)

Forced vibration method is commonly used to investigate the tensile force of stay cable or external cable, but EM Sensor can also be used for this purpose.

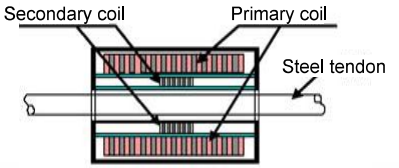
(1) Forced Vibration Method

The tensile force of cable is dependent upon its natural frequency; therefore by determining the stay cable’s natural frequency, its tensile force can be calculated. Before measuring the natural frequency, it is better to remove cable dumpers as the frequency might be influenced by the function of a dumper.



(2) Elasto-Magnetic Sensor (EM Sensor)

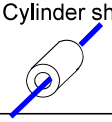
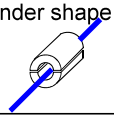
The mechanism of EM sensor is based on the characteristic that the magnetic property and crystal lattice of a magnetic material are in proportion to the tensile force applied to the material. By measuring the magnetic permeability when no tensile force is applied to the cable, it is possible to determine the stress applied to the steel tendon.



4-2. Concrete Structure

4-2.8 Non-Destructive Inspection Methods (Tensile Force of Stay Cable, External Cable)

Elasto-Magnetic sensor (EM Sensor)

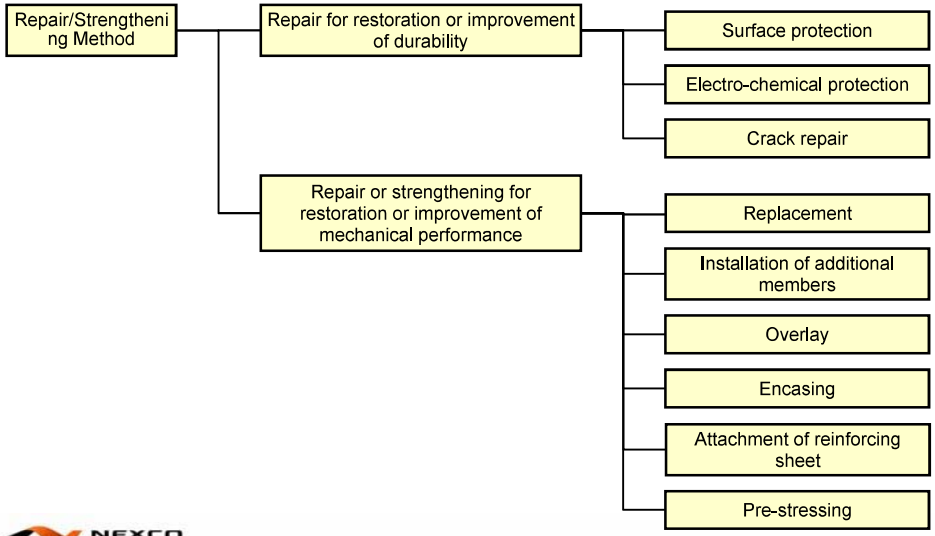
	Pre-installed type（inserted）	Post-installed type
Bobbin	Cylinder shape 	Semi-cylinder shape 
Winding of steel coil	By machine	By manual labor (on site)

Pre-installed Sensor

Post-installed sensor

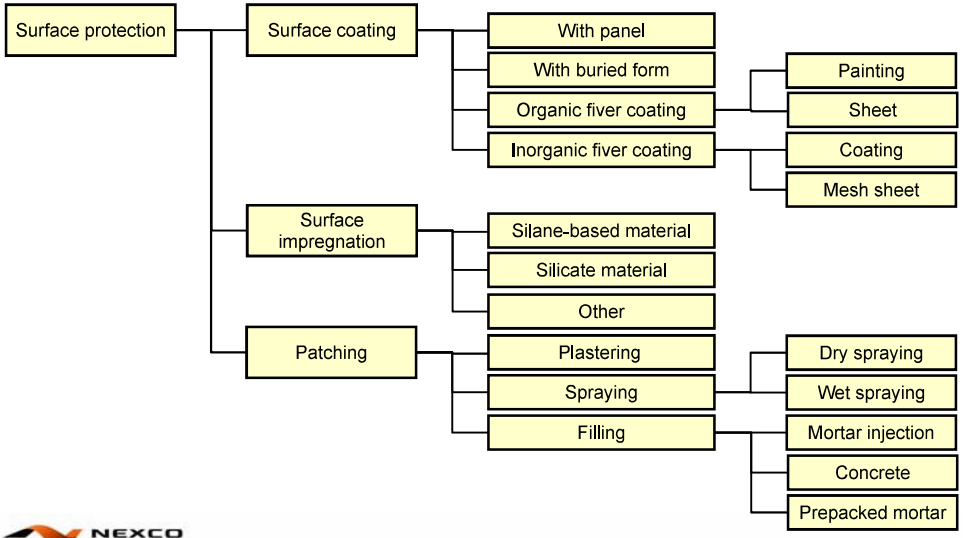
4-2. Concrete Structure

4-2.9 Repair or Strengthening for Concrete Structure



4-2. Concrete Structure

4-2.10 Surface Protection Methods

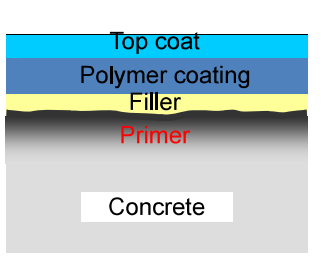


4-2. Concrete Structure

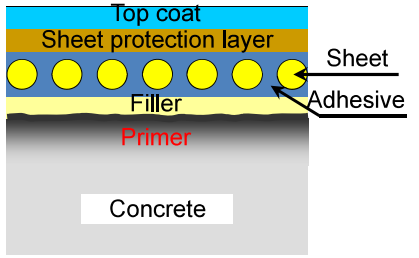
4-2.10 Surface Protection Methods

■ Surface coating (with Organic Polymer)

Organic polymer-based coating is applied over the concrete surface for repair, higher durability or better aesthetics. The coating is usually several 100μm to several mm thick, and can be implemented either by applying liquid coating or placing coating sheet over the concrete.



Application of coating



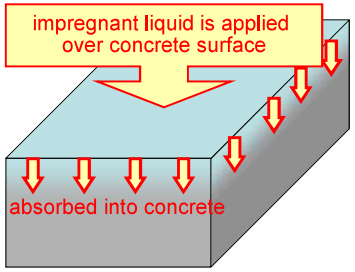
Application of sheet

4-2. Concrete Structure

4-2.10 Surface Protection Methods

■ Surface Impregnation

Impregnant liquid is applied over concrete to alter the composition of concrete surface, serving the function of protecting concrete structures and improving its durability. The following types are mainly used as impregnant: silane, silicate mineral and other materials.

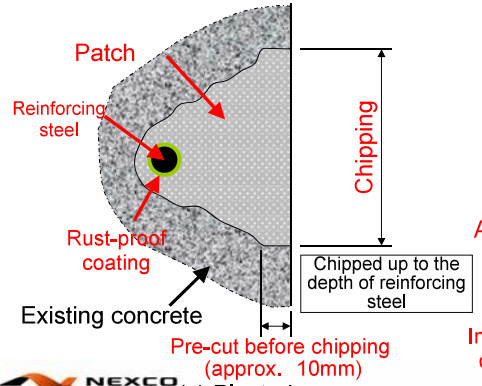


4-2. Concrete Structure

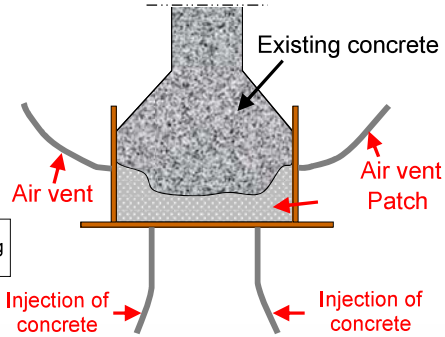
4-2.10 Surface Protection Methods

■ Patching

Patching is a method to improve the durability of concrete structure and repair/prevent deterioration. After removing deteriorated concrete, corroded area of reinforcing steel or other defects that would lead to deterioration, the affected area is patched to recover the original performance and the shape.



(a) Plastering

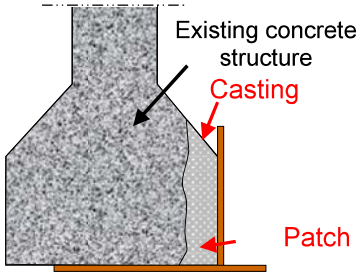


(b) Casting (Pre-packed concrete)

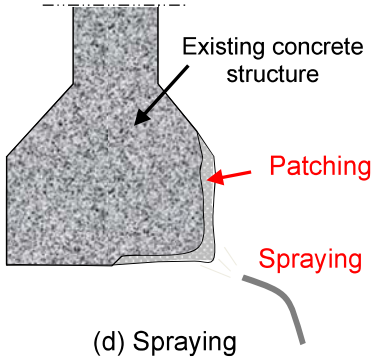
4-2. Concrete Structure

4-2.10 Surface Protection Methods

■ Patching



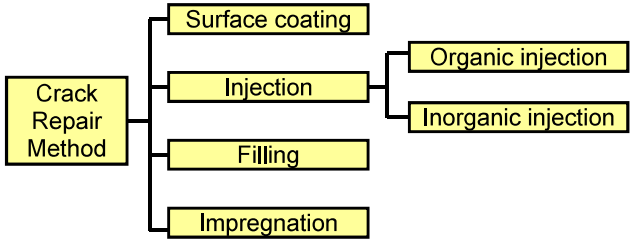
(c) Casting (post-casted)



(d) Spraying

4-2. Concrete Structure

4-2.11 Crack Repair Methods



1. There are two types of concrete cracks: progressive and non- progressive.
2. Non-progressive Type: cracks formed due to hydration of cement, subsidence/bleeding of concrete or defective construction are non-progressive type of cracks as they develop in the early stages of construction but will become dormant after a few years. Such cracks can be repaired by implementing one of the crack repair methods shown above.
3. Progressive Type: cracks caused by corrosion of reinforcing steel, alkali-silica reaction or repeated loading are progressive type. Such cracks should be repaired by implementing a combination of crack repair methods and other maintenance methods.

4-2. Concrete Structure

4-2.11 Crack Repair Methods

(1) Surface Coating

Surface coating refers to the method of applying coating on microscopic cracks (generally under 0.2mm in width) to form a membrane over the crack and improving its waterproof performance and durability.

(2) Injection

Injection refers to the method of closing up cracks by putting organic materials (e.g. acrylic resin, epoxy resin) or inorganic materials (e.g. cement type) into cracks (generally 0.2 to 1.0mm in width), to improve its waterproof performance and durability.

(3) Filling

Filling method is implemented for relatively large cracks (0.5 to 1mm in width) in concrete with the reinforcing steel being intact (not corroded). It involves cutting out of a crack in a U-shape and filling the area with sealant.

(4) Impregnation

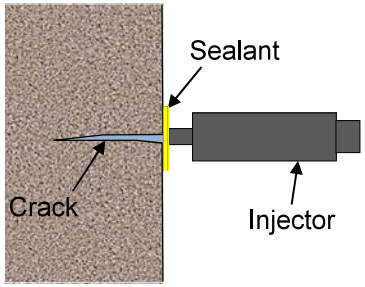
Impregnation method is implemented for microscopic cracks (generally 0.2mm in width). It involves impregnation of cracks with acrylic resin, epoxy resin or other penetrative solvent to harden the surface. It performs the same functions as the filling method to repair cracks, but without the use of special tools such as injection guns or pressure-injection pumps.

4-2. Concrete Structure

4-2.11 Crack Repair Methods

■ Injection

The method of closing up cracks by putting organic materials (e.g. acrylic resin, epoxy resin) or inorganic materials (e.g. cement type) into cracks (0.2 to 1.0mm in width, to improve the waterproof performance and durability



Injection method

During the injection process

Challenging in Bridge Management

Aging increases the occurrence and progress of deterioration

↓

Proper Implementation of Inspection/Diagnosis/Repairing/Reinforcing

- Be sure to secure the necessary frequency assignment for the inspection (To be Looked at) → Systemization of Inspection Process
- Be sure to make a detection and evaluation of any damage (Not To be Overlooked) → Diagnosis Technology
- Be sure to conduct necessary repairing/reinforcing work (Not To be Postponed) → Responding Method

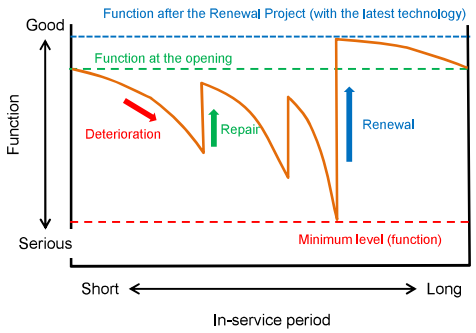
↓

Improvement of Bridge durability

5. Expressway Renewal Project

5-1. What is “Renewal Project” ?

- In order to secure the road structural function, the management cycle, such as inspection, diagnosis and repair/reinforcement is implemented regularly. However, the function will have been declined gradually in spite of repair work, and structures may result in the condition that needs to be repaired.
- “Expressway Renewal Project” will be implemented in terms of life cycle costs minimization, preventive maintenance, function upgrade in order to secure the expressway network for the far-distant future.



Definition

➢ large-scale renewal

By working on the old structures of the expressways with the latest technology, we attempt to maintain the functioning and enhance the performance, securing the quality as good as or better than the new structures.

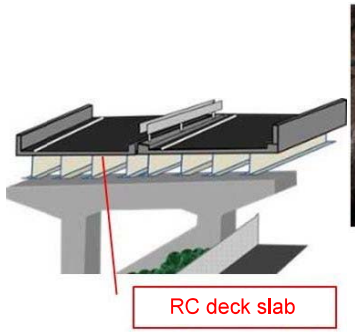
➢ large-scale repair

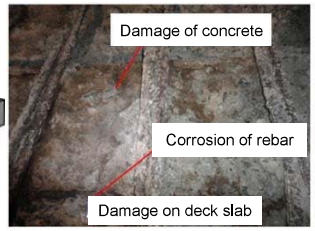
By repairing and reinforcing the old structures of the expressways with the latest technology, we attempt to restore the functioning and quality that is as good as or better than when they were first constructed, in order to extend their longevity.

5. Expressway Renewal Project

5-2. Damage on Structure (Bridges)

Predominant case of damaged bridges (RC deck slab)





5. Expressway Renewal Project

5-3. Strategy for “Expressway Renewal Project”

■ Targeted site

● Selection of target sites based on the deterioration factor

Targeted sites have been selected based on **the potential deterioration factor** from inspection results and the damage analysis.

- Damage due to aging, increase of large-sized vehicles, anti-freezing agents, and old standard etc.

■ Effective measures

● Durability

The large-scale renewal/repair will be implemented with **the latest knowledge & technical standard** in terms of preventive maintenance in order to improve the durability of structures in the future.

- Use of PC deck slab, high performance deck slab waterproof etc.
- To intensify crackdown on over-weighed vehicles

■ Strategy

● Periodic check of the plan

“Expressway Renewal Project” plan will be modified to the latest plan based on the result/analysis of the detailed inspection/investigation

● Alleviation of the traffic influence

Traffic regulations (road closure, lane regulation) are essential for “Expressway Renewal Project”. It is imperative to use precast deck slab in order to mitigate the traffic influence.

5. Expressway Renewal Project

5-4. Project Plan

	Structure	Member	Main measures	Volume	Costs (billion JPY)
large-scale renewal	Bridge	Deck slab	Replacement	74 km	696
		Girder	Replacement	-	-
	Subtotal				696
large-scale repair	Bridge	Deck slab	High performance deck slab waterproof etc.	100 km	39
		Girder	Girder reinforcement etc.	59 km	1,32
	Earth structure	Embankment, Cut slop	ground anchors, drainage boring etc.	4,977 points	74
	Tunnel	Lining	Invert etc.	35 km	70
	Subtotal				315
Total					1,010

5. Expressway Renewal Project

5-5. Example of Expressway Renewal Project

■ Replacement (RC Deck Slab to PC Deck Slab)

- Kobayakawa Bridge (Chuo Expressway, Nagano Pref.)
  - Opening; 1981 (33 years old, as of 2014)
  - Extention; 132m (outbound lane)
- Bridge condition
  - Fatigue due to the heavy traffic volume (29,000 vehicles per day, as of 2013)
  - Chloride attack due to anti-freezing agents

In spite of the reinforcement/repair, cracks and peeling have been progressing due to aging.

Repair data up to 2018

FY1998;
- Overlay
- High performance deck slab waterproof

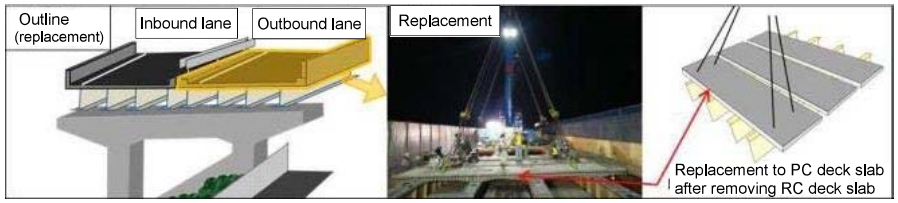
FY2006
- Overlay
- High performance deck slab waterproof

5. Expressway Renewal Project

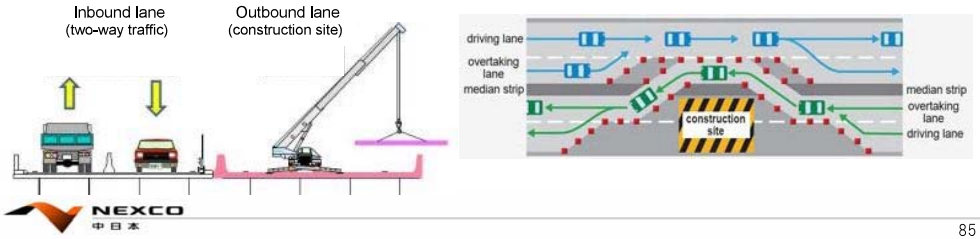
5-5. A case of Expressway Renewal Project

■ Replacement (RC Deck Slab to PC Deck Slab)

- Operation process
  - Replacement to PC deck slab (more durable than RC deck slab)



- Traffic regulation plan
  - Adoption of the two-way traffic regulation for alleviation of the traffic influence



6. Bridge Condition in Kyrgyz

■ Soundness Rating of Bridges in Kyrgyz Republic (as of Nov.21 2013)

Territory	Classification of Roads	Number of Inspected Bridges	Soundness Rating					Total number of bridges
			Good	Fair	Poor	Critical	Imminent	
PLUAD#1	International	5	1	2	1	1	0	32
	National	29	16	6	3	2	2	76
# 3	International	0						12
	National	0						72
# 4	International	50	30	6	9	5	0	131
	National	0						24
# 5	International	11	6	3	0	2	0	11
	National	0						38
# 6	International	0						9
	National	0						71
UAD BO	International	100	86	8	6	0	0	108
	National	0						64
UAD BNT	International	45	32	6	5	2	0	45
	National	0						57
UAD OSI	International	0						76
	National	0						54
UAD OBI	International	8	2	3	0	2	1	28
	National	0						3
Total	International	219	157	28	21	12	1	452
	National	29	16	6	3	2	2	459
	%	27%	70%	14%	10%	6%	1%	
	Total (Int'l+Nat)	248	173	34	24	14	3	911

6. Bridge Condition in Kyrgyz

■ PLUAD 1 DEP 958 30.5KP (National Road)

☆ Lack of load carrying capacity by extremely deteriorated main structure

6. Bridge Condition in Kyrgyz

■ **Road Administrators in all the countries have the responsibility of:**

- Provide the safe / secure / comfortable / reliable road network to the people;
- Contribute to the socioeconomic development of the country and daily lives of people.

■ **Different bridge condition between Kyrgyz and Japan**

- More sever natural environment in Japan than Kyrgyz.
- Deterioration in Kyrgyz will progress more slowly than Japan.
- However, in the future, serious situation of bridges will be observed.

■ **Towards sustainable bridge management**

- It is desirable that the bridge management cycle be sustainably implemented. (inspection, diagnosis, repair plan, repair work)
- It is imperative to improve the quality management during the construction.

Characteristics of landslide disasters in Kyrgyz and a proposal for counter measures

Keywords : Landslide, Mapping, Geomorphology, Geology, Early Warning System

Go SATO
Teikyo Heisei University

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Topics

① Introduction

② What is landslide?

③ Fundamentals of landslide research

④ Landslide map and inventory

⑤ Monitoring and Early Warning System

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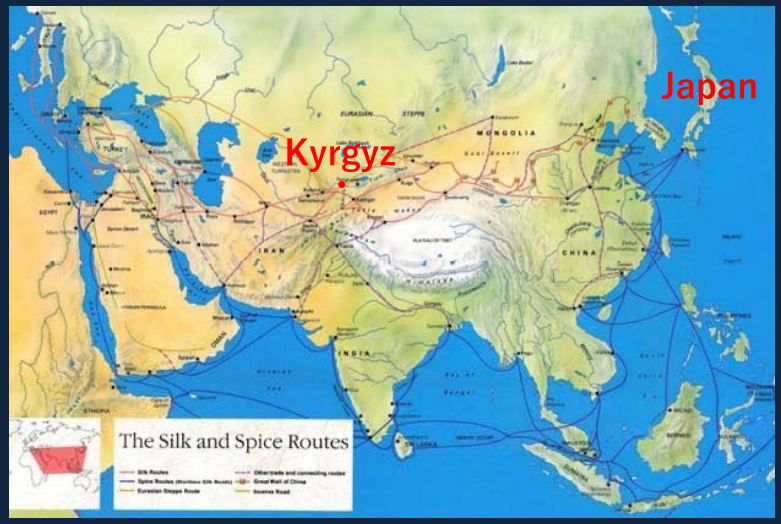
National treasures of Shoso-in (正倉院)

The Shosoin Repository is located within the grounds of the temple Todaiji in the city of Nara, and was built in eighth century AD.

the Silk road



RA2-1

Ak-Beshim, UNESCO World Heritage site

Ak-Beshim, UNESCO World Heritage site

Ak-Beshim site, The picture was taken in 1967

Deformation of castle's wall

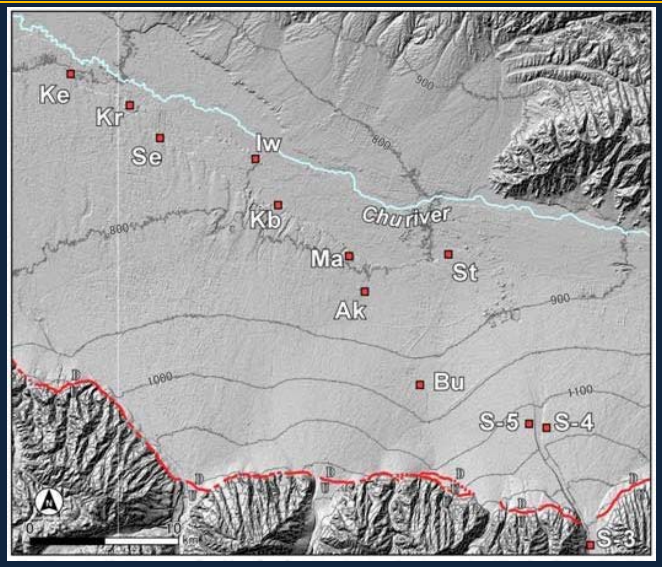
The wall was constructed in 7C

Deformation of castle's wall

RA2-2

Deformation of castle's wall

Active faults



Active faults

Active faults and landslides

RA2-3

Active faults and landslides

Landslide, Slope failure, Active fault

Active faults and landslides

People has been suffered by landslides for a long time in Kirgiz

Topics

① Introduction

② What is landslide?

③ Fundamentals of landslide research

④ Landslide map and inventory

⑤ Monitoring and Early Warning System

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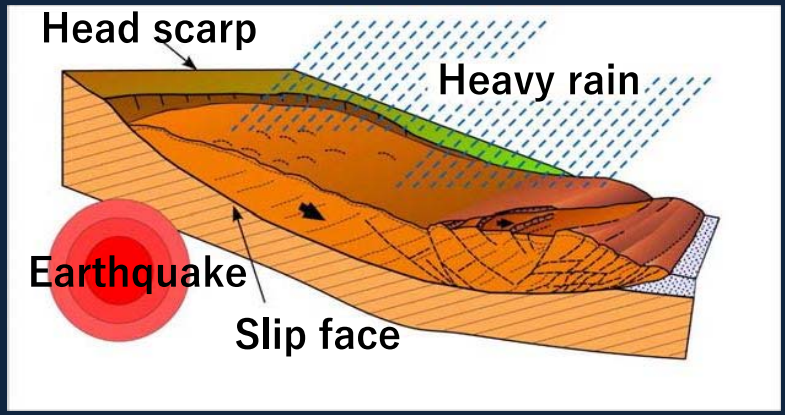
What is landslide?



What is landslide?

168号線地すべり

Topics

① Introduction

② What is landslide?

③ Fundamentals of landslide research

④ Landslide map and inventory

⑤ Monitoring and Early Warning System

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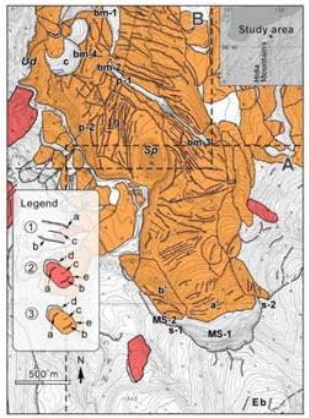
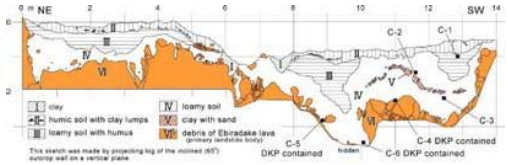
Fundamentals of landslide research



Landslide map



Geological survey

Fundamentals of landslide research

Understanding of landslide process

Where / When / How

Causes of landslide

Predisposition	Geomorphology, Geology
Trigger	Rainfall, Snow melting, Earthquake (Groundwater)

Landslide mapping, Making landslide inventory

Topics

① Introduction

② What is landslide?

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④ Landslide map and inventory

⑤ Monitoring and Early Warning System

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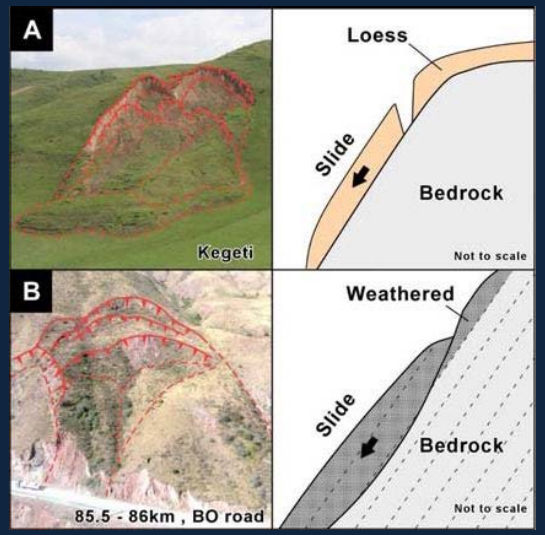
Landslide map and inventory



Landslide map in capital city of Honduras

Inventory

Iwate Prefecture

- ☑ Location map
- ☑ Geomorphology
- ☑ Geology
- ☑ Property of preservation
- ☑ Description
- ☑ Active level
- ☑ Plan of countermeasure

Making original format of Kirgiz is important

Topics

① Introduction

② What is landslide?

③ Fundamentals of landslide research

④ Landslide map and inventory

⑤ Monitoring and Early Warning System

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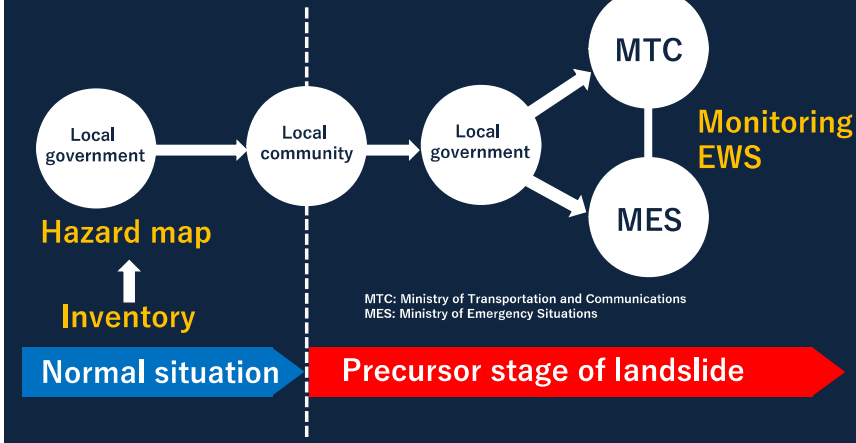
Monitoring and Early Warning System

Ayu village, Osh

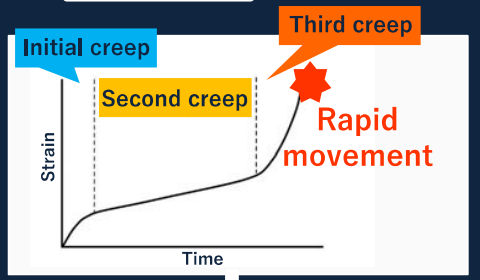
Monitoring and Early Warning System



Making original format of Kirgiz is important

Methods of monitoring for individual landslide

Monitoring



Alarming

Countermeasure

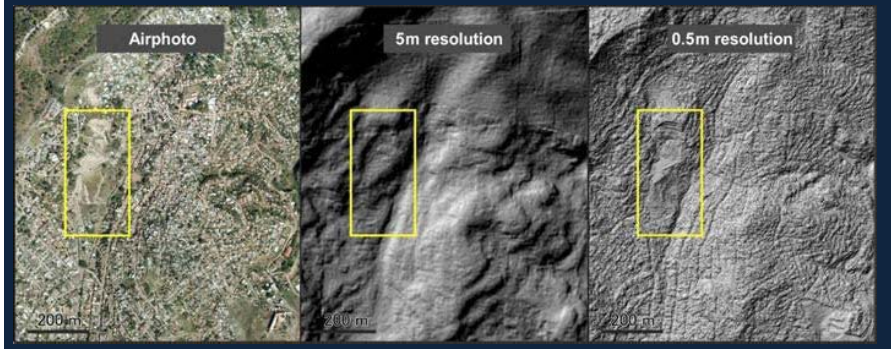
Methods of monitoring for wide area

LiDAR data

Japan　　Kirgiz

Kirgiz has an advantage of Remote sensing, because of poor Vegetation. It can conduct advanced scientific survey using UAV and/or SAR survey.

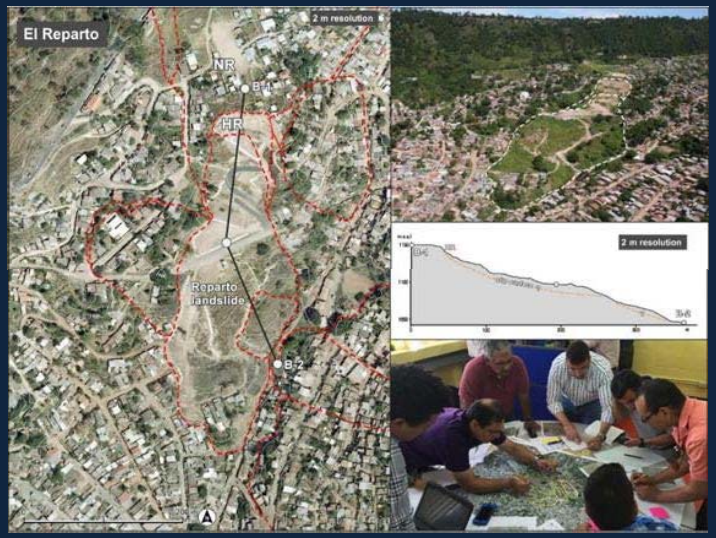
Methods of monitoring for wide area



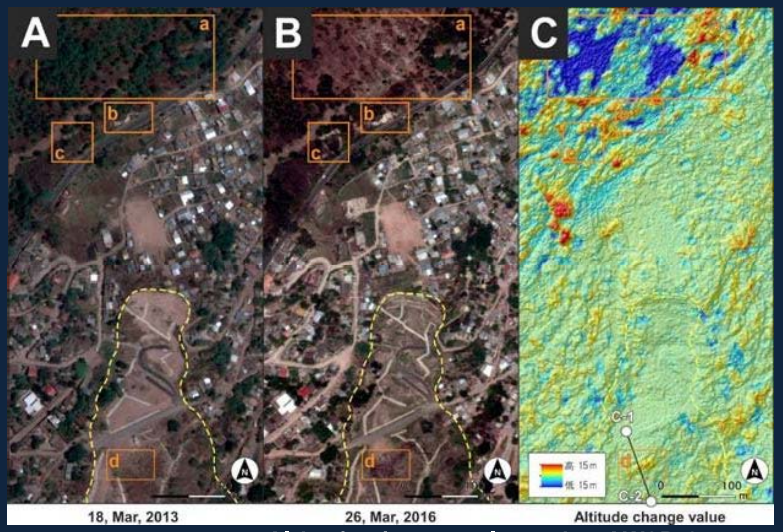
AW3D® 5m / AW3D® 0.5m

AW3D was produced by NTT data and RESTEC, Japan. It is digital 3D topographic data covering the land of the entire world which shows undulations of terrain over the world with 5m, 2m, 0.5m spatial resolution with vertical and horizontal.

Methods of monitoring for wide area



Methods of monitoring for wide area



Altitude change value using AW3D 0.5m

Conclusion

☑ **Fundamentals of landslide research**

⇒ Understanding of landslide process
Predisposition / Trigger

☑ **Landslide map and inventory**

⇒ Mapping and creating of inventory
⬇
Basic data for planning of disaster management

☑ **Monitoring and Early Warning System**

Individual ⇒ Tension meter
Wide area ⇒ Remote sensing ➡ EWS

TEIKYO

Road Spatial Information Management by MMS

Takeo SUGIMOTO
PASCO Corporation

RA3-1

Table of contents

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What is MMS ?

Mobile Mapping System

MMS, it enables faster and more accurate 3D Road information capturing.

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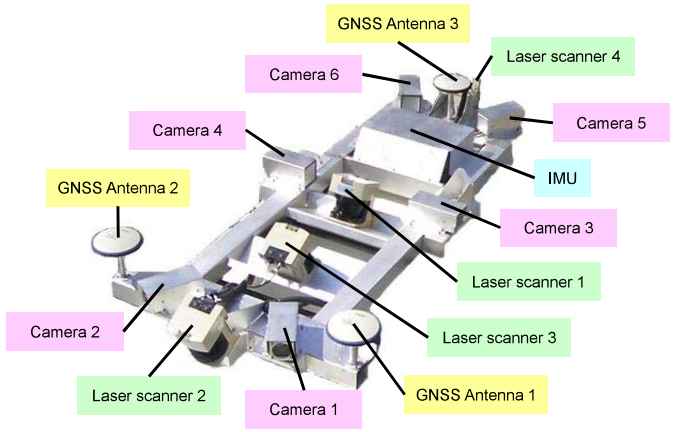
MMS Overview

Capturing by Laser scanner and Camera
Localization by GNSS/IMU/Odometer



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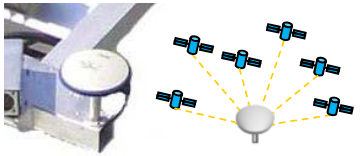
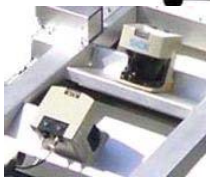
MMS Equipment

Camera
500Mega pixel
10 pics/s



GNSS



Laser scanner
Angle : 180 degrees
Scan Rate : 27,100 points/s
Scan Range : 65m

Odometer

IMU
(Accelerometer and Gyro)

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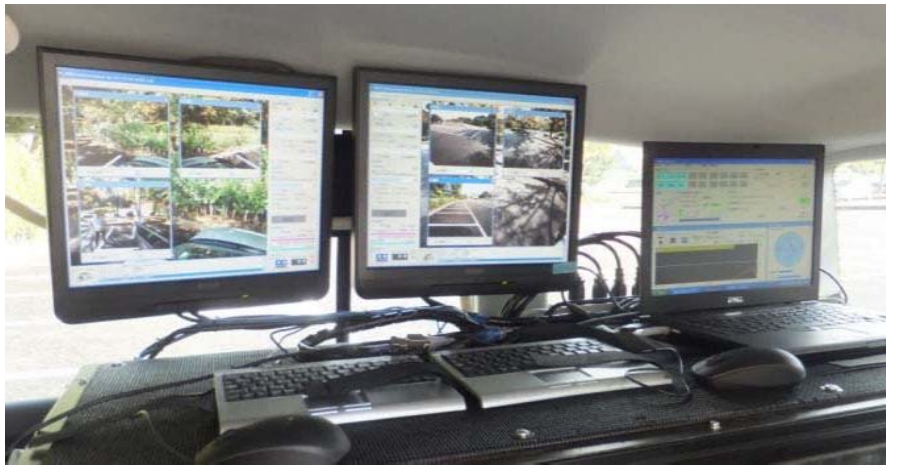
MMS Equipment



Interior

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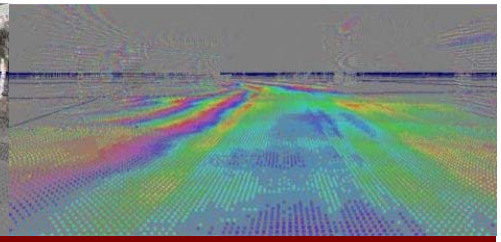
MMS Outputs

Data

Image data

3D Point Cloud data

3D Point Cloud color data



3D Elevation color data

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MMS Outputs

Accuracy
(by measurement conditions in Japan)

MMS vehicle positioning : 10cm (Horizontal)

Point cloud accuracy:
- 10cm(Absolute/Horizontal)
- 1cm(Relative/Horizontal)

→ Applicable to 1:500 scale mapping (According to the regulation in Japan)

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All-round vision camera

Left backward | Left | Center | Right | Right backward

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All-round vision camera

Spec (Ladybug3)

Number of cameras : 6
Angle : 360 degrees
Pitch : 5m (70km/h)
Resolution :1.9Mega pixel
Color : 8bit
GNSS link : Available
Capturing : Automatic

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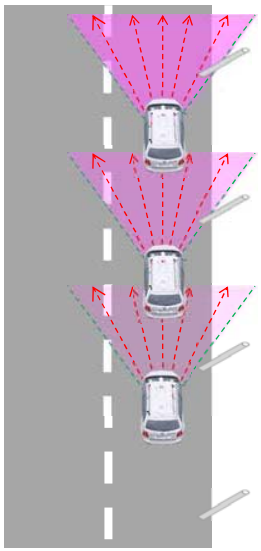
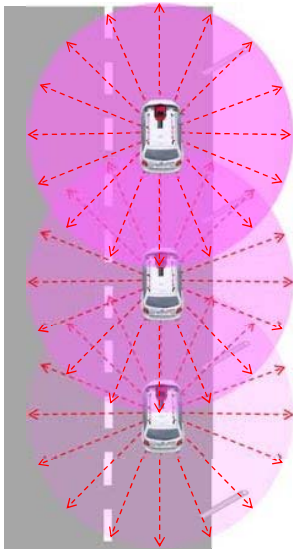
Advantage of 360-degrees Capturing

Front-view camera



All-round vision camera



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PADMS – MMS 3D data / 360-degrees image viewer –

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PADMS – MMS 3D data / 360-degrees image viewer –

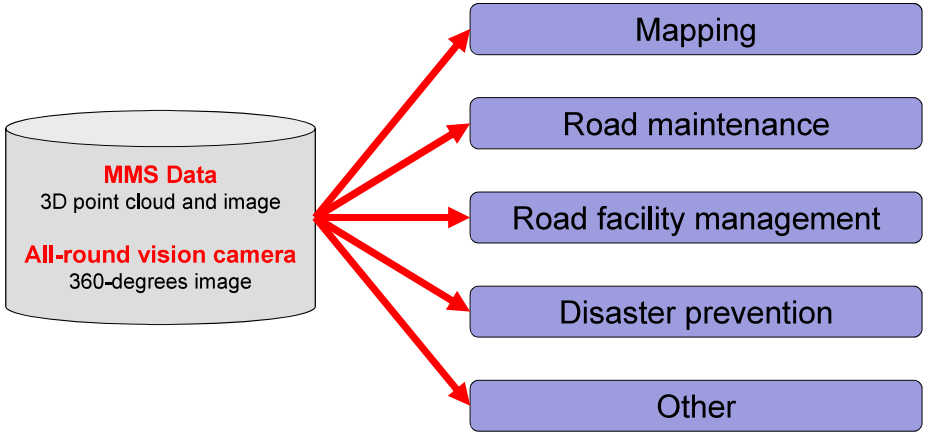
Function

3D Measurement

Information Tag
with Attribute information

Utilization

Utilization of captured data



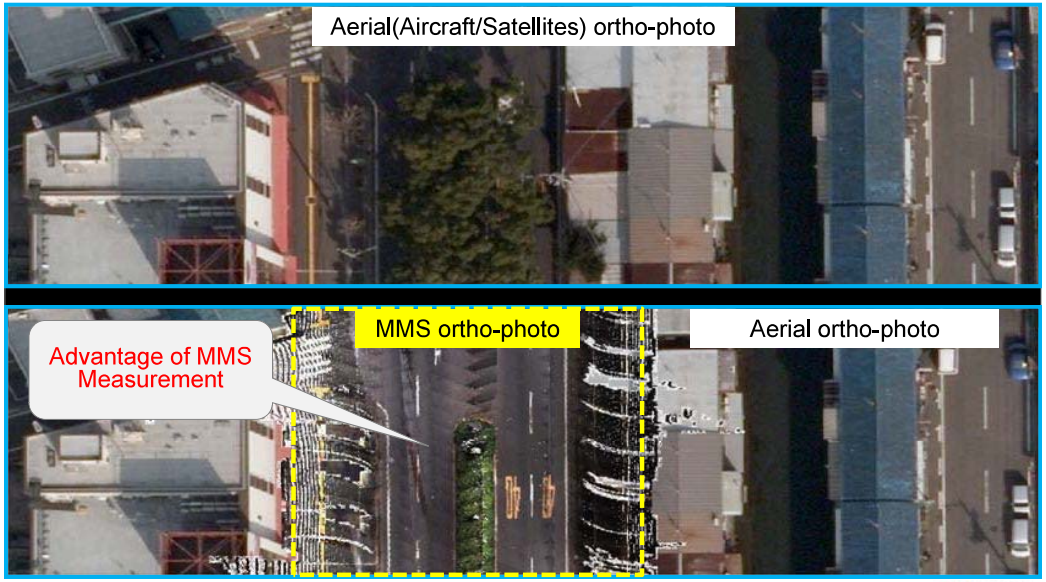
Utilization – Mapping –

Mapping

Advantage
> Accurate 1:500 scale digital mapping
> Automatic Logging of Image and 3D point cloud data in one measurement simultaneously

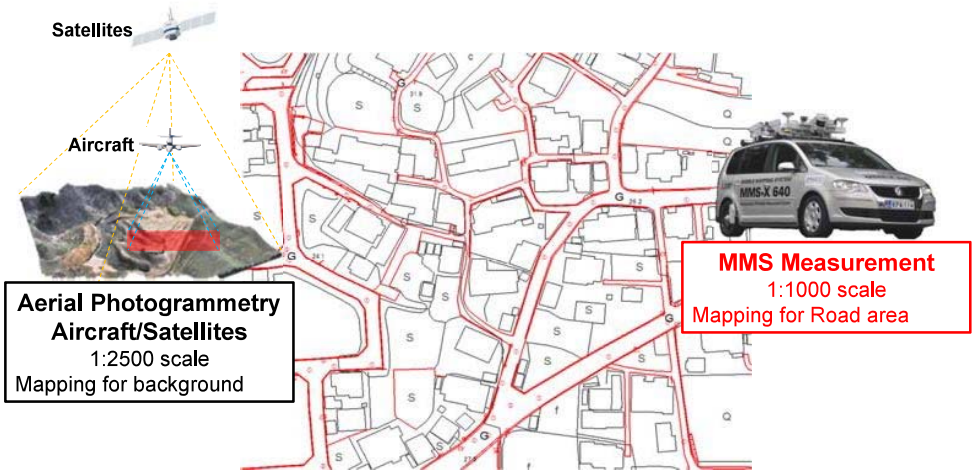
Disadvantage
> The mapping area is only visible spot from MMS (along the road)
> The inaccessible area by vehicle is unmeasurable

Utilization – Mapping –



Utilization – Mapping –

Hybrid Map by combination mapping



Aerial Photogrammetry
Aircraft/Satellites
1:2500 scale
Mapping for background

MMS Measurement
1:1000 scale
Mapping for Road area

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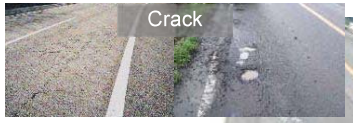
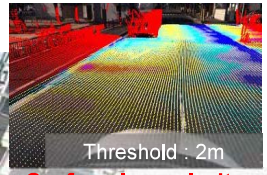
Utilization – Road maintenance –

Road Surface Condition



Pavement Condition

Inspection of Road Pavement Condition



Surface Irregularity

Identification of Road Surface Irregularity by setting threshold value

GIS management

Integrate and manage information of the Road surface condition

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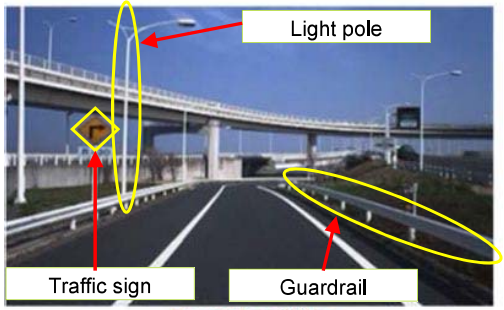
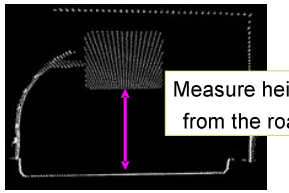
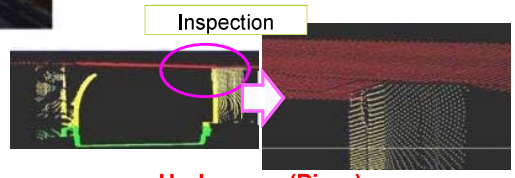
Utilization – Road facility management –



Road Facilities



Traffic sign



Underpass (Piers)

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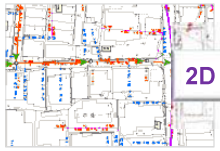
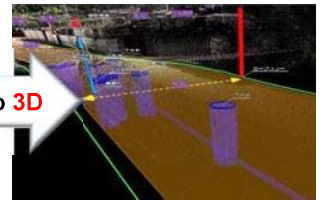
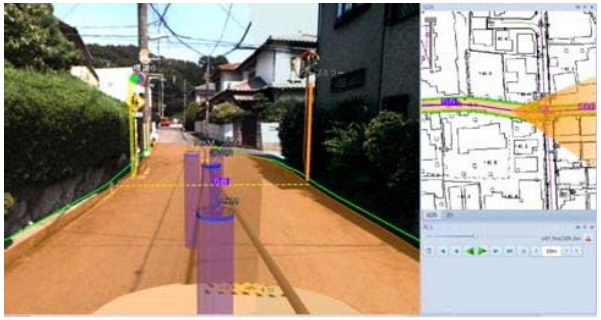
Utilization – Road facility management –

3D Facility management



2D to 3D





Underground Utilities

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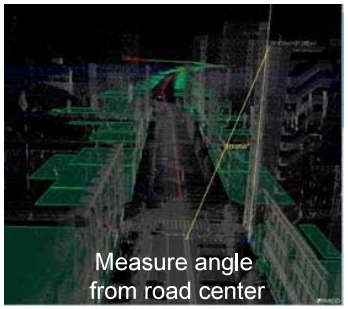
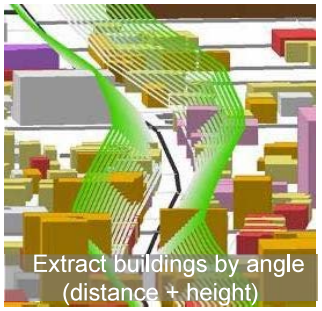
Utilization – Disaster Prevention –

Collapse building prediction





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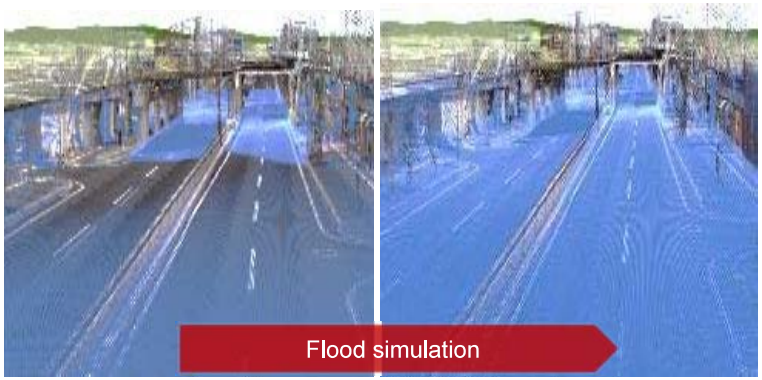
Utilization – Disaster Prevention –

Flood simulation



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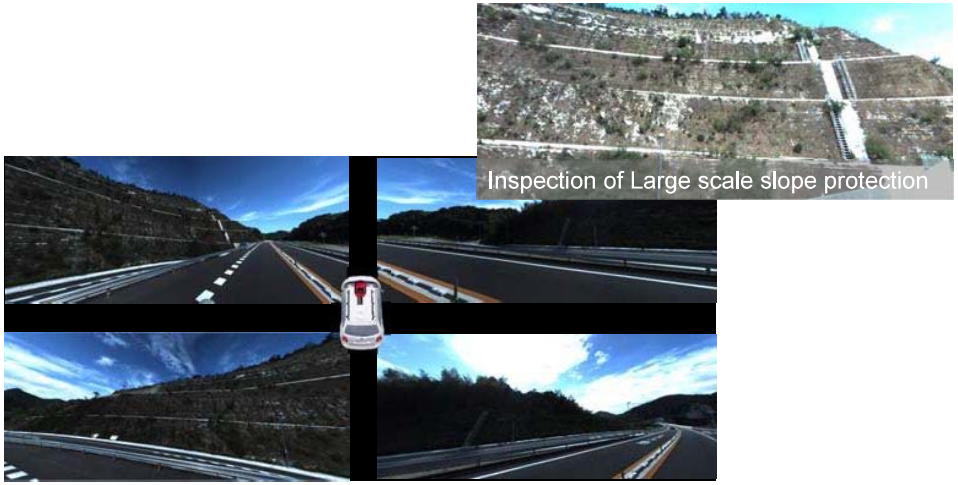
Utilization – Disaster Prevention –

Inspection of slope protection



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Utilization – Disaster Prevention –

Damage and Recovery

Before disaster

After disaster

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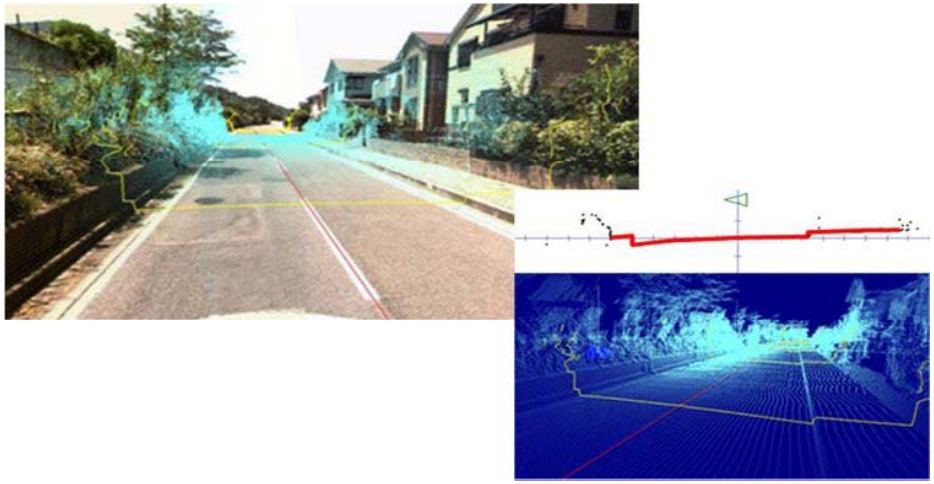
Utilization – Construction –

Road Profile / Cross section line



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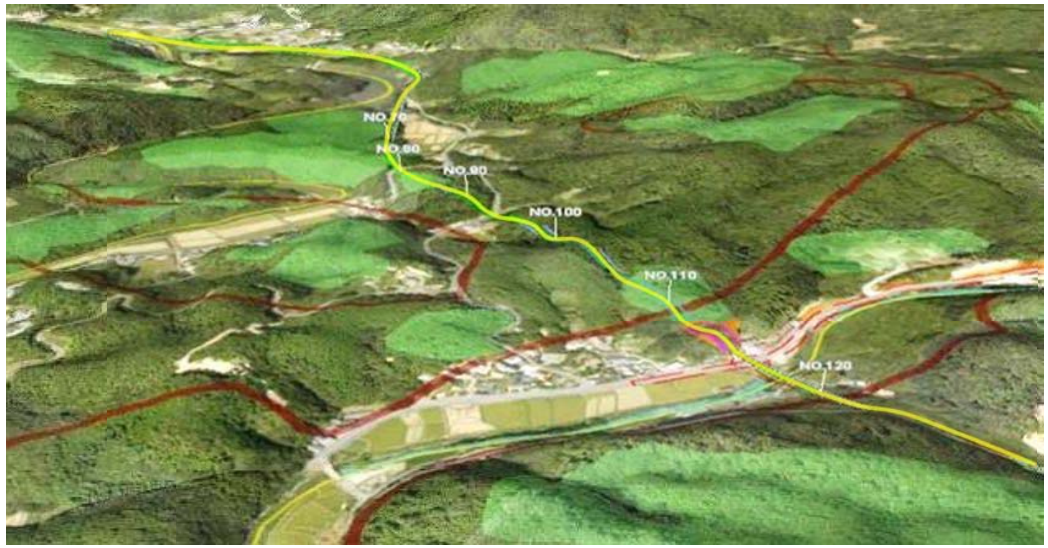
Utilization – Construction –



3D view of Planning Road

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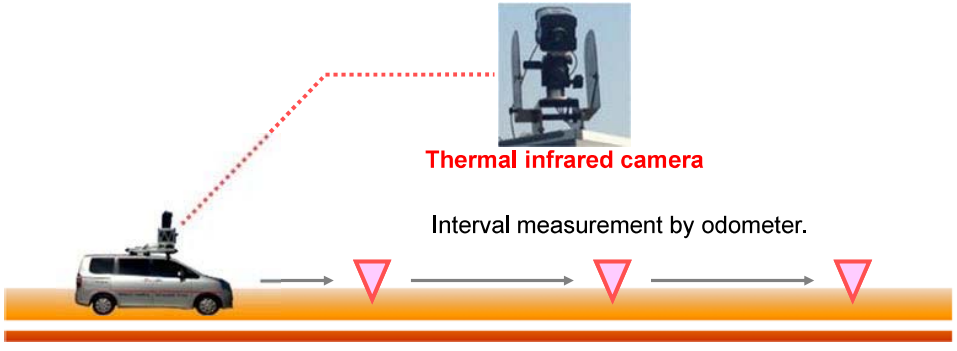
Utilization – Infrared thermography –



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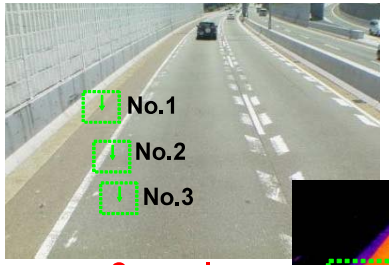
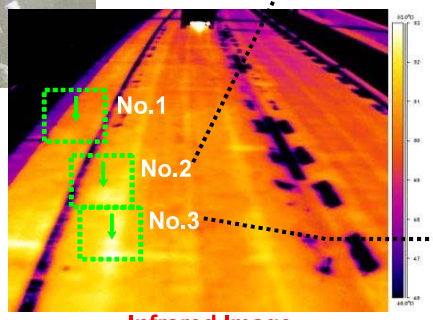
Case Study Result 1 – Infrared thermography –

Detecting cavity of the Road



Camera Image



Infrared Image

No.2: Normal temperature

No.3: **High temperature**

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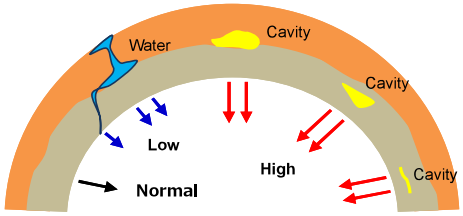
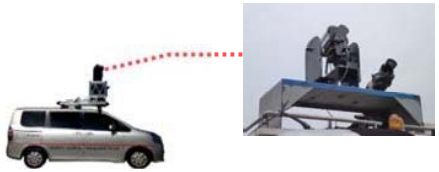
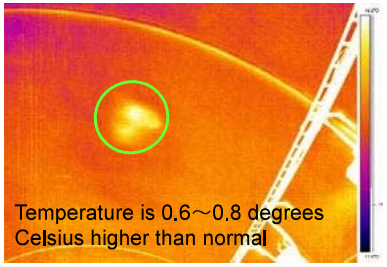
Case Study Result 2 – Infrared thermography –

Detecting cavity of the Tunnel







Utilization – PADMS –

Demonstration of PADMS with 3D data