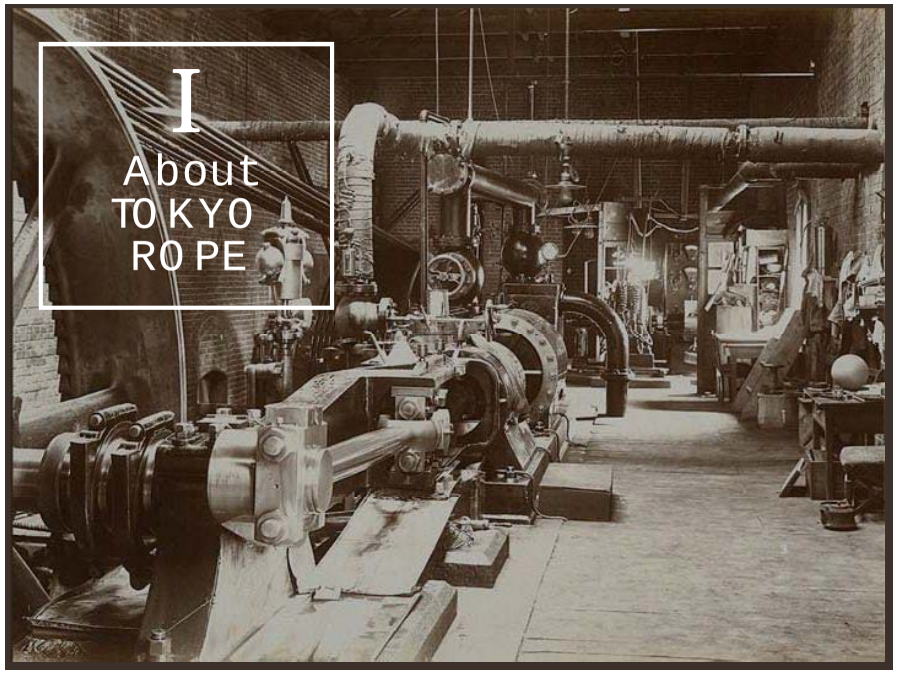
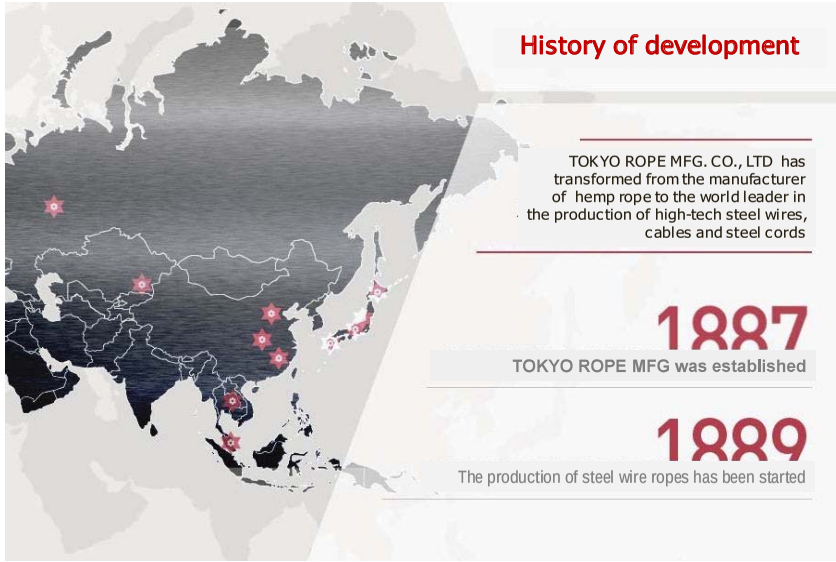
PROGRAM

TRI TOKYO ROPE INTERNATIONAL



Ⅰ-1 History of Tokyo Rope

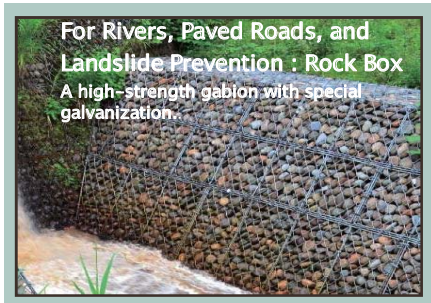
TRI TOKYO ROPE INTERNATIONAL

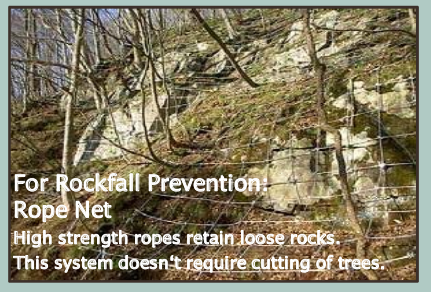


RA4-1

I -2-1 Our Products

I -2-2 Our products





I -3 History in CIS Countries

2009
- Installed 10,000m2 "Mighty Net System" in Vladivostok, Russia for APEC.
- Established Kazakhstan Office in Almaty, Kazakhstan.

2010
- Established Moscow Office in Moscow, Russia.

2011
- Installed 20,000m2 "Mighty Net System" in Medeu, Almaty, Kazakhstan for Asian Winter Game.

2012
- Established Tokyo Rope Engineering LLC (in Moscow)
- Installed 5,000m2 "Mighty Net System" in Vladivostok, Russia.

2013
- Installed 500m2 "Mighty Net System" in Kola, Murmansk, Russia (Mining company).

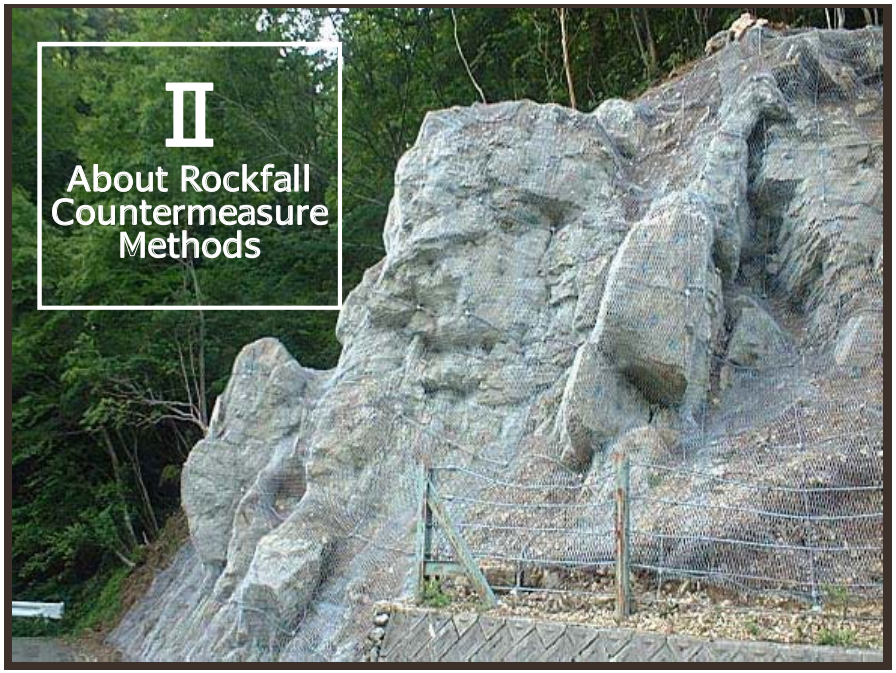
2014
- Installed 150,000m2 " Mighty Net System" and "Rope Net System" in Sochi, Russia for Winter Olympic Game.

2015
- Installed 60,000m2 "Mighty Net System" in Sochi, Russia

2016
- Established Tokyo Rope Almaty LLP.
- Installed 840m2 "Mighty Net System" in Tbilisi, Georgia

2018
- Established Tokyo Rope International INC.
- Established Tokyo Rope Construction and Mining Company LLC. in Kyrgyz

II About Rockfall Countermeasure Methods



Ⅱ-1-1 Rockfall Disasters in Japan

Rockfall hit the car directly, killing a female college student in the passenger seat.

Other rockfall disasters

Ⅱ-1-2 Rockfall Disasters in Japan

The place without a countermeasure

The place with a countermeasure

Ⅱ-2-1 Rockfall Countermeasure Methods

Protective Methods

- The methods to receive Rockfalls with a netting/fence.
- Removal work is required for accumulated rocks at the foot of the slope.

Preventive Methods

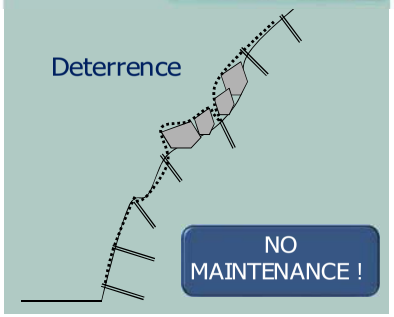
- The methods to fasten scattered loose rocks by setting a netting/rope closely against the slope.
- Maintenance/management work is not required since Rockfalls do not occur and will not be accumulated at the foot of the slope.

Ⅱ-2-2 Rockfall Countermeasure Methods

Protective Methods

Covering Type Net

Preventive Methods

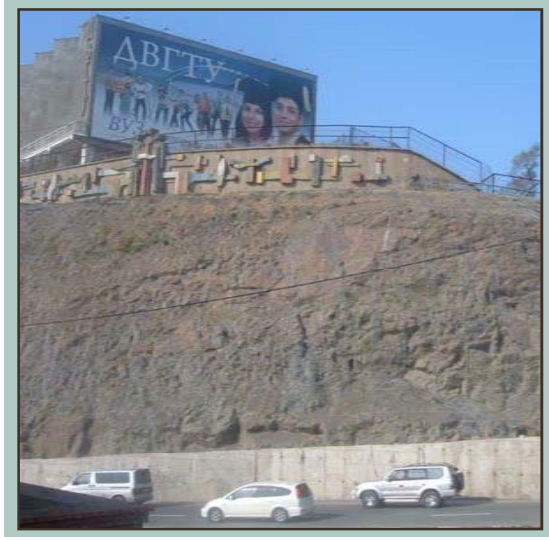


Ⅱ-3-1 Preventive Methods (Mighty Net)

Project Construction Records in Japan

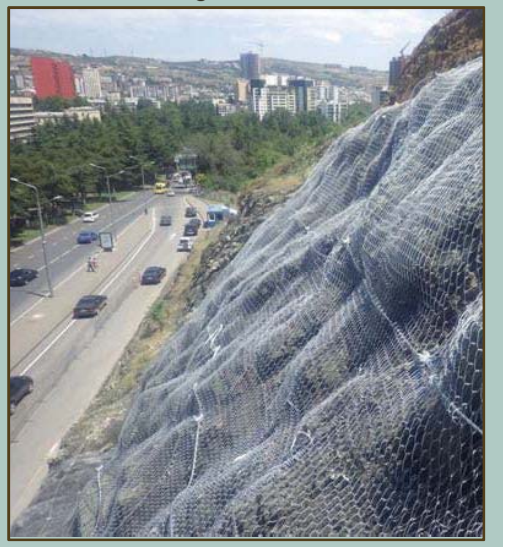
Ⅱ-3-2 Preventive Methods (Mighty Net)

Project Construction Records in Russia 2012



Ⅱ-3-3 Preventive Methods (Mighty Net)

Project Construction Records in Georgia 2016



Ⅱ-4 Preventive Methods (Rope Net and Mighty Net)

Introduction video

Ⅲ-1-1 Snow Damage Countermeasure Methods

Avalanche Prevention Methods

Object for protection	Examples	Countermeasures implementation area	Example of countermeasures
"Point"	Buildings, Steel Towers, Tunnel mouths	Origin area / Runway area / Accumulation area: The main target area depends on the positional relation between avalanche and the object to be protected.	Induction method (Breaking avalanche)
"Line"	Road, Rail road		Prevention method (Fence,Pile) Protection method (Fence,Wall) Induction method (Snow shed)
"Surface"	Village, Parking lot, Gelaende (Ski slope)	First priority : Origin area (However, when it is difficult to implement countermeasures at the origin area, the second priority would be the runway area, and the third priority the accumulation area.	Prevention method (Fence,Pile)

Prevention method being the most popular of all the snow countermeasure methods, we now introduce the most highly recommended avalanche prevention fence "△one."

Ⅲ-1-2 Snow Damage Countermeasure Methods

Snow-covered avalanche prevention fence (conventional)

Conventional fences installed vertically on slopes.

Ⅲ-1-3 Snow Damage Countermeasure Methods

Snow-covered avalanche prevention fence (conventional)

Conventional fences are susceptible to the effect of overhanging edge of snow.

Therefore, in order to prevent the damage caused by the edge of the snow falling, it is necessary to remove this snow. (Need maintenance)

Ⅲ-2-1 Introduce new designed fence (⊿ONE)

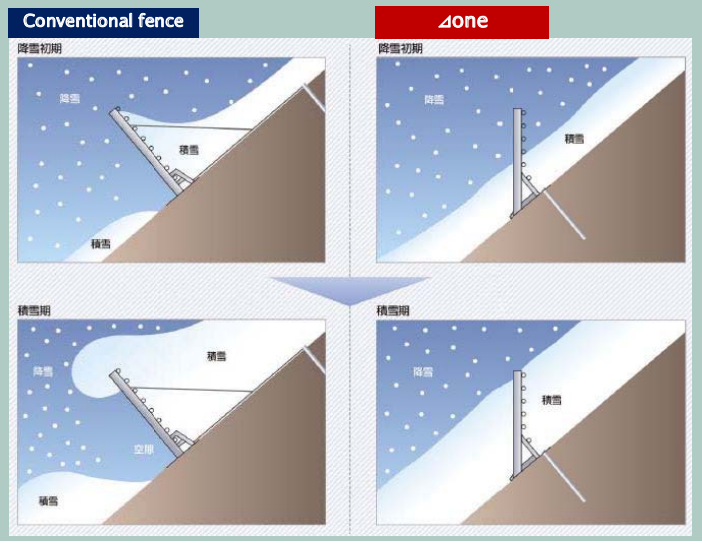
Snow-covered avalanche prevention fence (difference)

⊿ One, a newly designed avalanche prevention fence, has no overhanging edge of snow unlike conventional fences.

It is not necessary to remove the overhanging edge of snow, so maintenance will be minimal.

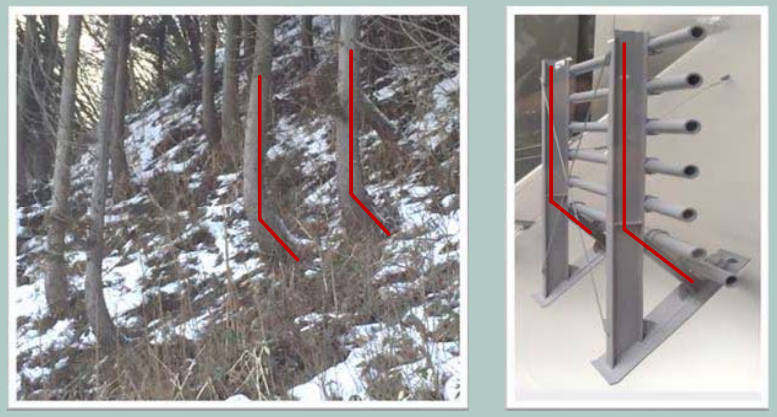
Ⅲ-2-2 Introduce new designed fence (⊿ONE)

Differences in how snow is piled up



Ⅲ-2-3 Introduce new designed fence (⊿ONE)

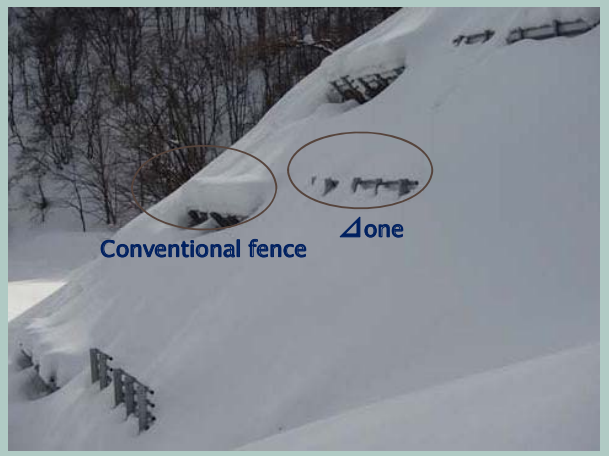
The design of ⊿ONE



The design of ⊿ONE is from the form of nature.

Ⅲ-2-4 Introduce new designed fence (⊿ONE)

Snow-covered each fences (difference)



With ⊿One, the snow accumulates parallel to the slope in a shape close to nature. Since there is no overhanging edge of the snow, only the head of the fence is visible

Ⅲ-3-1 Introduce new designed fence (ONE)

TRI TOKYO ROPE INTERNATIONAL

Project Construction Records in Japan

Ⅲ-3-2 Introduce new designed fence (ONE)

TRI TOKYO ROPE INTERNATIONAL

Project Construction Records in Japan

Ⅳ

About Sediment Disaster Countermeasure Methods

Ⅳ-1-1 What are Gabions

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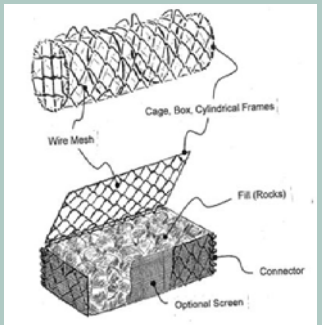
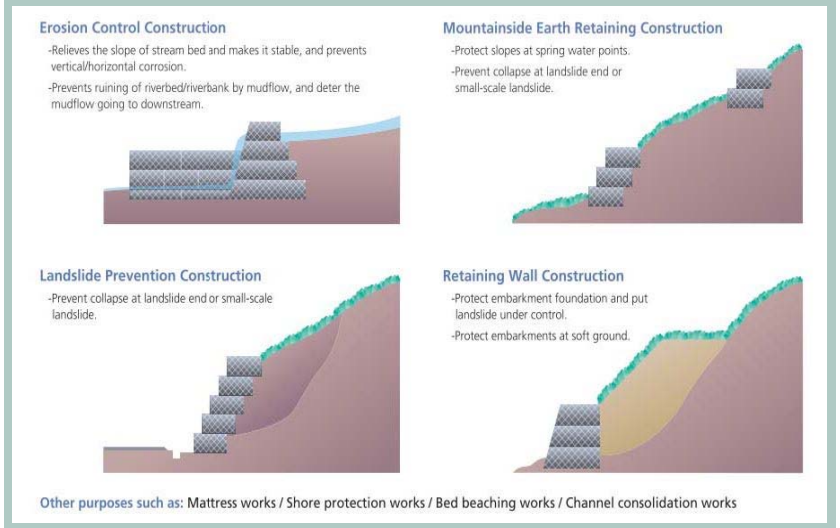
Gabions are popular products typically in the form of a cage, a cylinder or a box filled with rocks and concrete blocks. The most common civil engineering use of gabions is to stabilize shorelines or slopes against erosion.



Ⅳ-1-2 What are Gabions

Other uses include retaining walls, temporary floodwalls, to filter silt from runoff, for small or temporary/permanent dams, river training, and channel lining. They may be used to induce the force of a flow of flood water around a vulnerable structure.

Ⅳ-2 Use of Gabion



Ⅳ-4-1 About Rock Box

Rock Box

Wire netting:

- ϕ4～8mm
- Galvanized with 10%Aluminum.

Main reinforcement:

- ϕ12～16mm

Ⅳ-4-2 Unique features of Rock Box

1. Flexibility and conformity to subsidence,
2. Nature-rich river works, keep natural landscape,
3. Free drainage of water,
4. Reducing flow speed of river,
5. Easy (manpower oriented) installation,
6. Stronger
(Paneled structure, Thicker wire and bar)
7. High durability
(Zinc and 10%Aluminum coating)

Long life and less maintenance

Ⅳ-5-1 Achievement of Rock Box for mountainside

Project Construction Records in Japan

- Construction year : 2004
- Photo date : 2016
- Volume : 1,000㎥
- Surface treatment : Zn+Al 10%

- Construction year : 1986
- Photo date : 1996
- Volume : 600㎥
- Surface treatment : Zn+Al 10%

Ⅳ-5-2 Achievement of Rock Box for mountainside

Project Construction Records in Kazakhstan

- Location : Khorgos River
- Construction year : 2017
- Volume : 750 units of Rock Box
- Surfacetreatment :Zn+Al10%
- Purpose : Rock Box used for land slide prevention

Ⅳ-6-1 Achievement of Rock Box for riverside

Project Construction Records in Japan

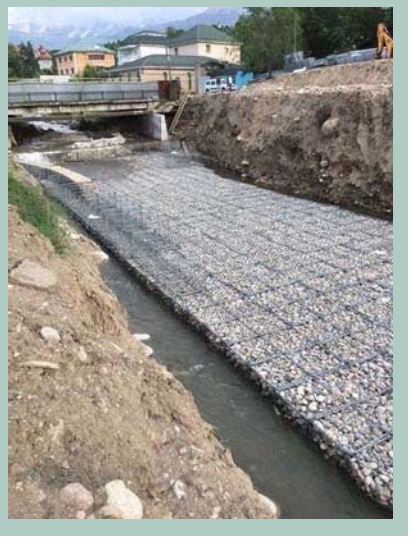
- Construction year : 2004
- Photo date : 2016
- Volume : 600㎥
- Surface treatment : Zn+Al 10%

- Construction year : 2004
- Photo date : 2016
- Volume : 500㎥
- Surface treatment : Zn+Al 10%

Ⅳ-6-2 Achievement of Rock Box for riverside

Project Construction Records in Kazakhstan

- Location : Esentai river
- Construction year : 2018
- Volume : about 10,000 units of Rock Box
- Surface treatment :Zn+Al 10%
- Purpose－Rock Box is used for Erosion control.



V Utilizing Japanese Countermeasures in the Kyrgyz Republic

V-1 Similarities between the Kyrgyz Republic and Japan

Mountainous areas

Natural disasters

High quality road disaster prevention technology required in both countries.

V-2-1 Technology Transfer to Kyrgyz Republic

In December 28, 2017 a subsidiary company was established «TOKYO ROPE CONSTRUCTION & MINING COMPANY»

Bishkek TRC

The reason the establishment of a new company is needed:

①When implementing products for the prevention of natural disasters in foreign countries, poor installation performance by unqualified specialists may significantly affect the property of the products.
② Since the installation of our products in foreign countries is not sufficiently developed, it is necessary to send our specialists to supervise and guide the installation of our products.
③ With improper installation by local companies and specialists inexperienced with our products, the products may not able to fully demonstrate their intended purposes. Such situation could cause loss of credibility for the safety measures the manufacturer and the products are truly capable of providing.

Goals and purposes for the new company:

① Use of the subsidiary company to control compliance with Japanese technology and construction quality. Creation of a management center and a base for business development abroad.
② Obtaining orders and participating in road disaster prevention projects in Kyrgyzstan (disaster prevention area).
③ Temporary staffing for installation of disaster prevention facilities in Central Asia.
④ Firm establishment in the domestic market of Kyrgyzstan and implementation of projects not related to the field of prevention of natural disasters as well.

V-2-2 Technology Transfer to Kyrgyz Republic

Tokyo Rope group provides **Technology Transfer** through TRC

V-2-3 Technology Transfer to Kyrgyz Republic

Monorail system for construction

Anchor drilling machine

We are introducing Japan's new construction machinery and technology, in pursuit of high quality and safety.

VI Contact Information

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e-mail: info@tokyorope.kg
Tel: 0312 398122
Mob .: +996 555 522221

Thank you for your attention!!

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The pavement repair materials
For all weather type

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The Advanced Infrastructure Activists
IKEE Tortoise Green I'll Concrete Kaga Aguri Biruri Yuki Chuyo IKEE Sangyoh IPS

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[Roads, Sewage Ducts Specialist]
IKEE Co., Ltd.
Roads, Sewage ducts
Paving Works, Civil Engineering Works, Water & Sewage Investigations, Maintenance & Management Services, Dredging Works, Building & Environment Materials, Various Investigations & Technology Tests, Asphalt Concrete Production & Sales

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Tortoise Green Co., Ltd.
Recycling of Building Materials

[Agriculture Specialist]
Aguri Co., Ltd.
Organic Production
Iyo Aguri Rice, Vegitables,
Organic Recycling

[Concrete Specialist]
Airu Taiheiyo Namacon Co., Ltd.
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Yuki Co., Ltd.
Design & Construction of Gardens
Stone Works, Civil Engineering Works

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IKEE Sangyo Co., Ltd.
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Restaurant, Liquor Sales

[Energy Saving Specialist]
Kaga Kogyo Co., Ltd.
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Industrial Duct Systems
Soundproofing & Fireproofing Works

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Fast Solution!
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RA5-#

Foot Compaction

After three month

RA5-3

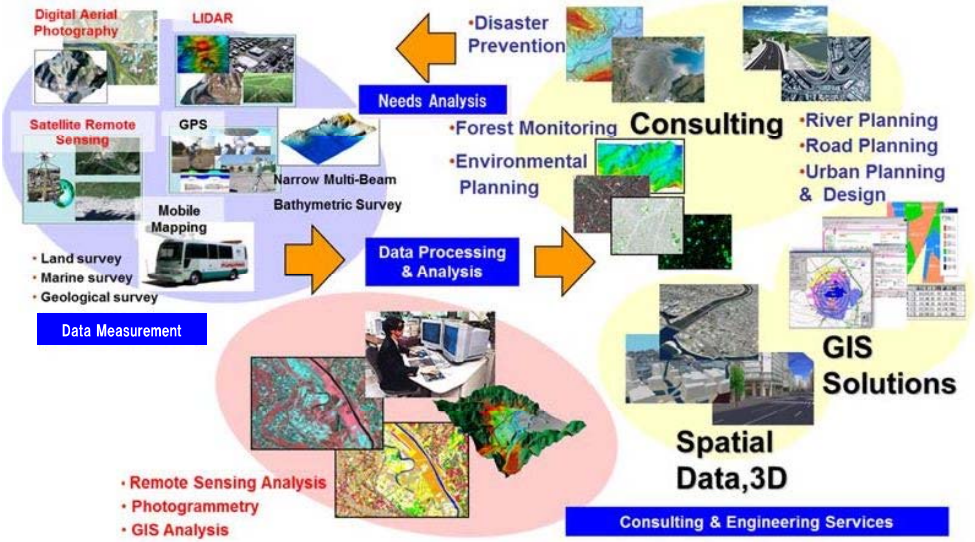
RA6-1

Wide area ground deformation monitoring from artificial satellite

Japan Asia Group
KOKUSAI KOGYO CO.,LTD.

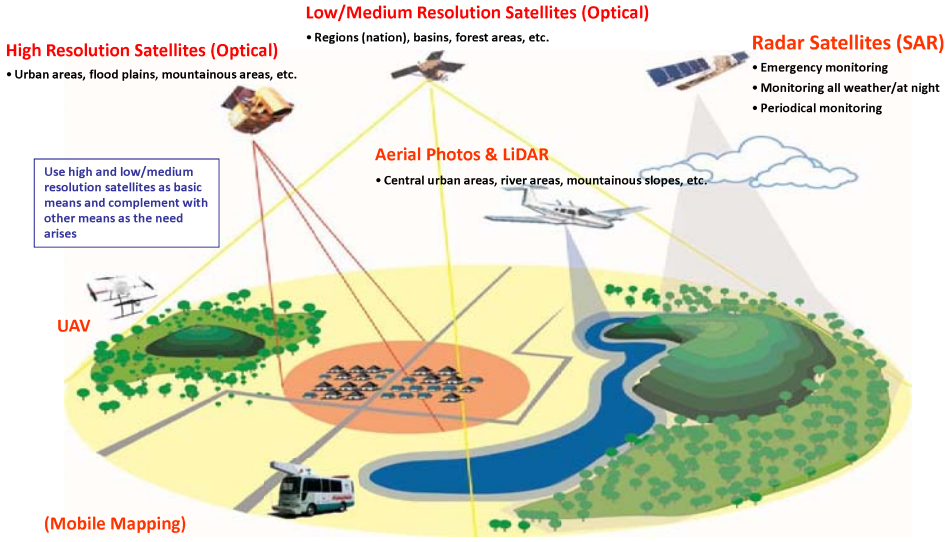
Kokusai Kogyo Co.,ltd.
Kenichi Honda
Кэнички ХОНДА

About KOKUSAI KOGYO CO., LTD.

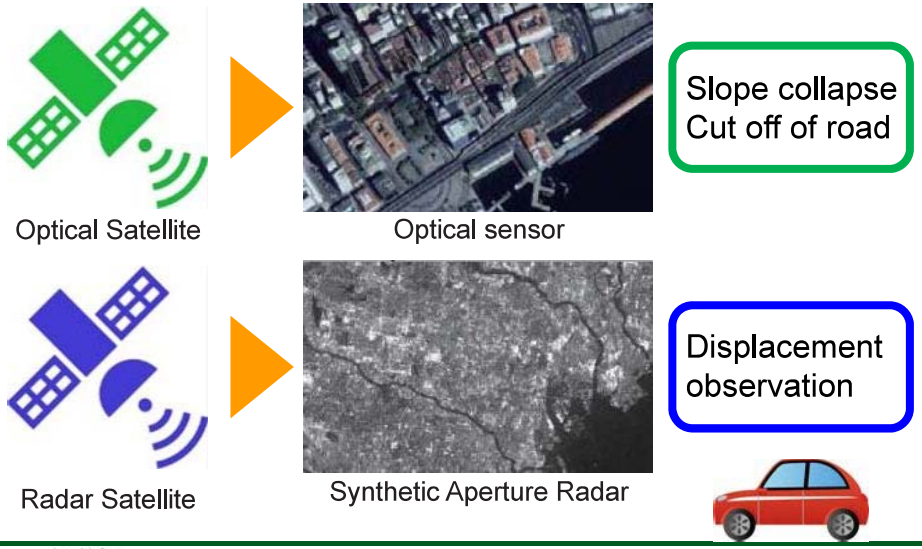


Remote Sensing Data for Forest Monitoring

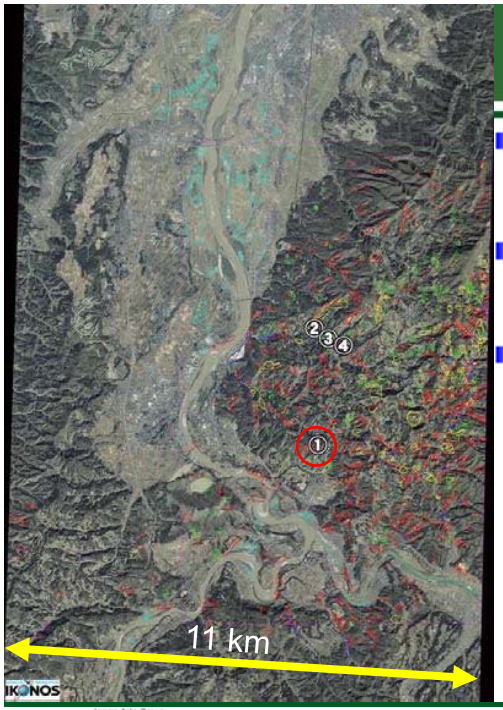
Achieve speedy data preparations by the combination use of appropriate acquisition means



What can be done using satellite?



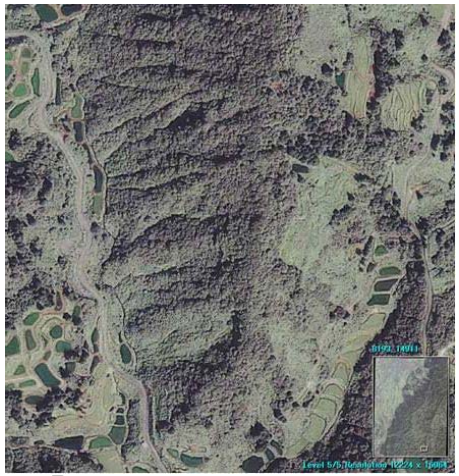
SLOPE MONITORING USING OPTICAL SATELLITE



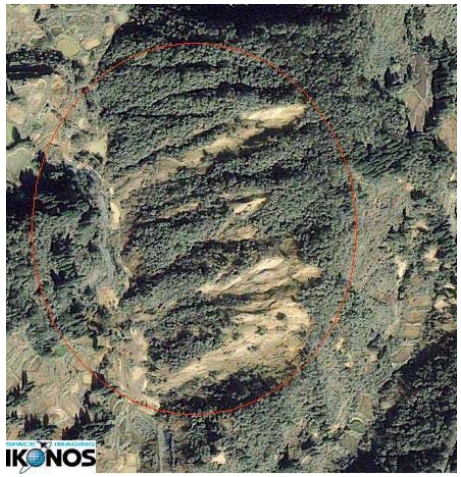
High-resolution satellite

- Chuetsu Earthquake (2004 Japan)
- Some villages were isolated by the cut off of roads caused by the landslide after earthquake
- Using high resolution satellite, damaged area was observed and distribution map of landslide was created.

①Landslide by Chuetsu Earthquake (2004)



Before the earthquake



After the earthquake

- Road was interrupted due to collapses.

Monitoring of flooding caused by river blockage

株式会社 イメージ ワン Condition of landslide dam after the Sichuan Earthquake (2008)

- What can be done using optical satellite
  - Able to see as what human eyes can see
  - Location of the large collapse, condition can be grasped in wide area
  - Possibility of observing area of interest is high, as the number of satellite is many.
- What cannot be done using optical satellite
  - Cannot observe under the cloud
  - Cannot observe during night time
  - Cannot observe small displacement

Effective for grasping condition of emergency

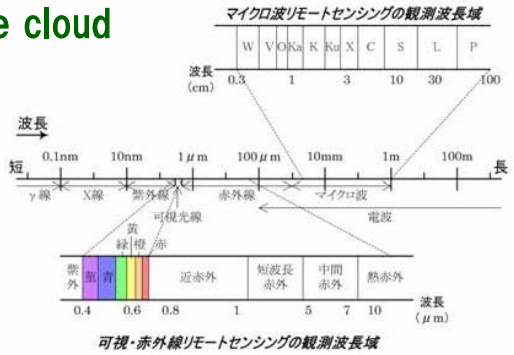
SLOPE MONITORING USING RADAR SATELLITE

The wavelength used for remote sensing

- Radar Satellite observe "micro-wave".
- Features of microwave sensor (SAR)
  - ➢Black and white image
  - ➢Not affected by the cloud

Optical image

Radar image



可視・赤外線リモートセンシングの観測波長域

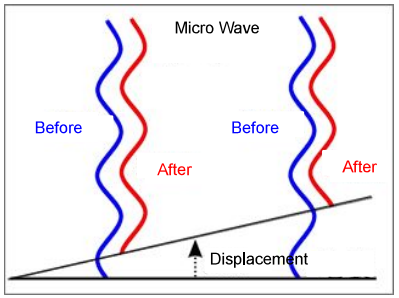
Feature of radar satellite

"Phase" measured by radar satellite display the distance information between satellite and the ground

Displacement between two period can be calculated

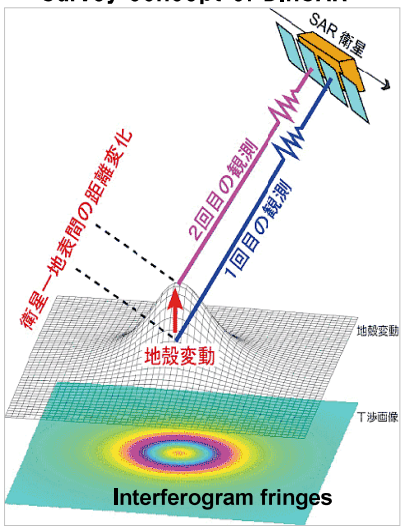
DInSAR

Differential Interferometric SAR



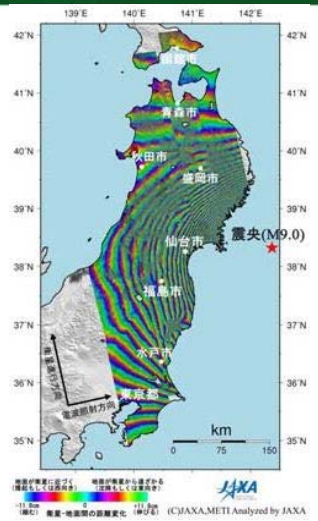
Relation of displacement and phase difference

Survey concept of DInSAR

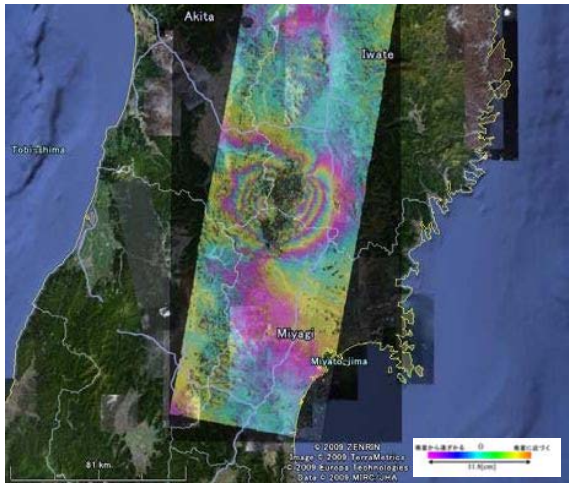


Reference : Geographical Survey Inst.「干渉SARを知る」
https://vldb.gsi.go.jp/sokuchi/sar/mechanism/mechanism.html

Example of displacement analysis

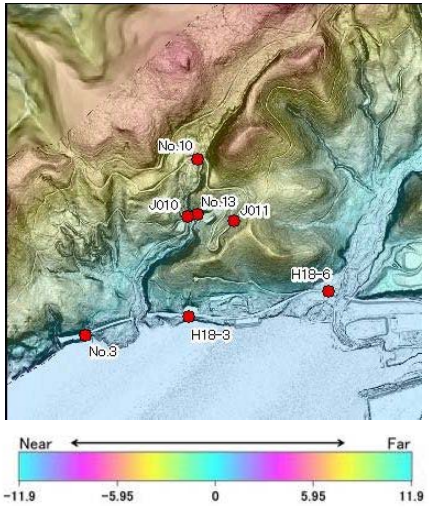


Interference analysis of before and after the Great east Japan earthquake
(Result of analysis by JAXA)



Crustal deformation of Iwate, Miyagi inland
(Result of analysis by KKC)

Landslide Monitoring



- What can be done using radar satellite
  - Small displacement in wide area can be measured
  - Ground observation without affected by the cloud
- Issues
  - Falling in of the mountain and shades cannot be observed
  - Delicate to vegetation, snow cover, atmospheric condition
  - Cannot measure collapse and large displacement
  - Small number of satellite so far

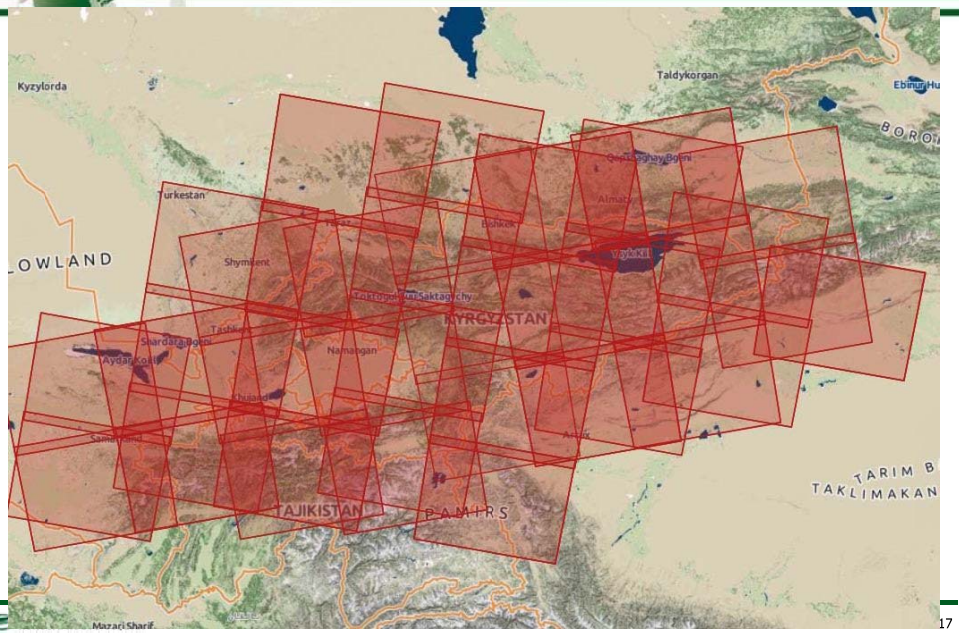
Effective for regular monitoring

WHAT CAN BE DONE IN KYRGYZ REPUBLIC?

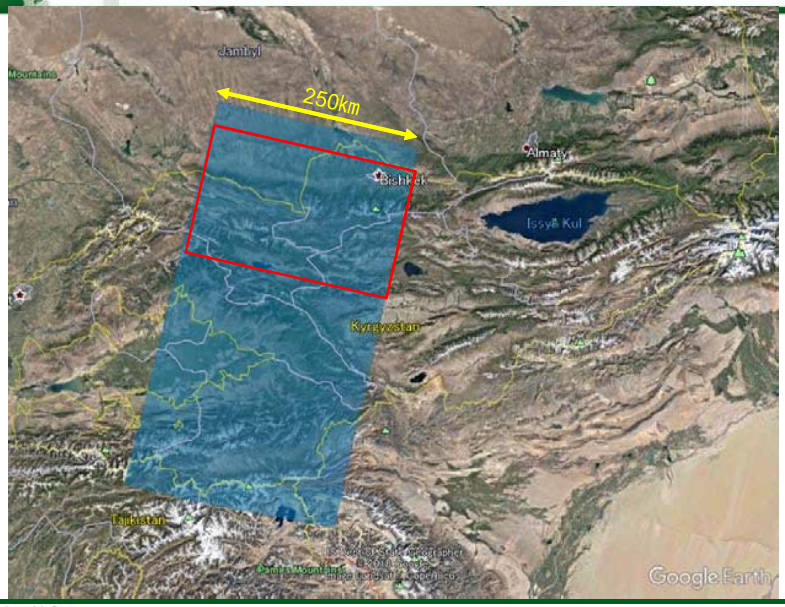
Main radar satellites

Satellite sensor	TerraSAR-X	COSMO-SkyMed	RADARSAT-2	Sentinel-1	ALOS-2
Operating country	Germany	Italy	Canada	EU	Japan
Launched year	2007	2007	2008	2014	2014
Return date	11 days	16 days	24 days	12 days	14 days
Wave length	X Band	X Band	C Band	C Band	L Band
Resolution	3 m	3 m	10 m	5×20 m	10 m
Observation width	30 km	50 km	50 km	250 km	70 km

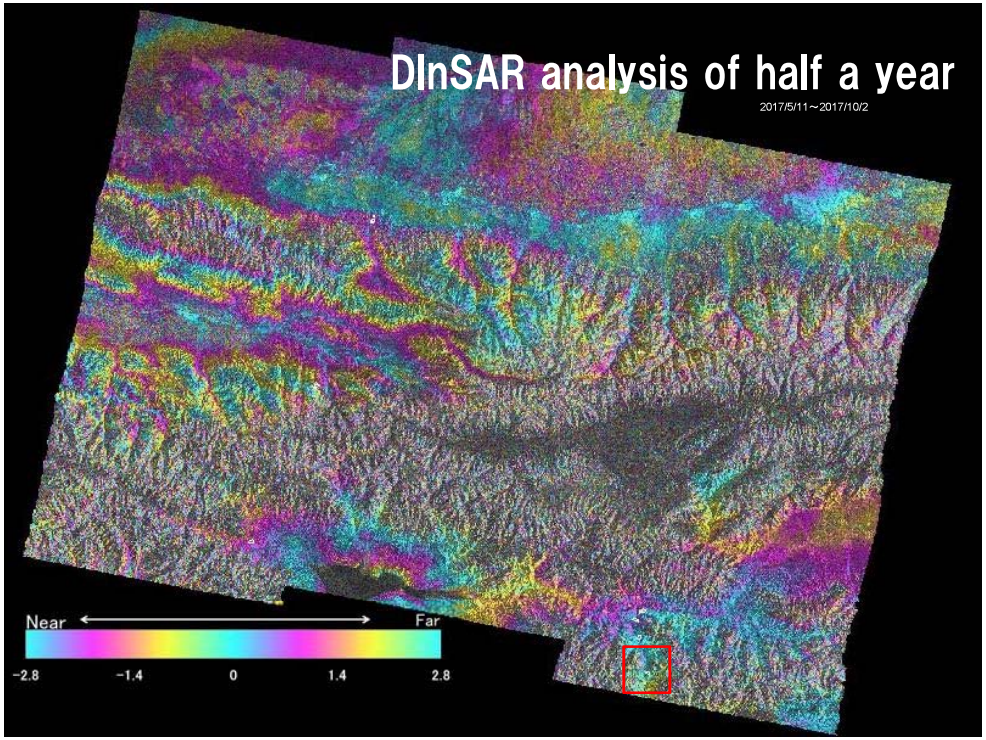
Sentinel-1 Observation Area in each 12days



Observation area of Sentinel-1

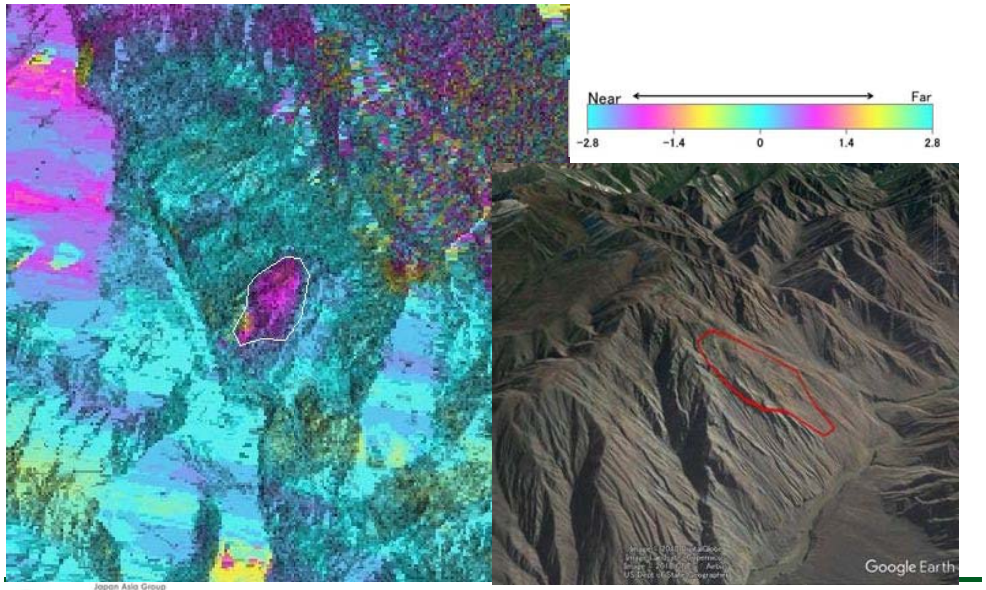


DInSAR analysis of half a year

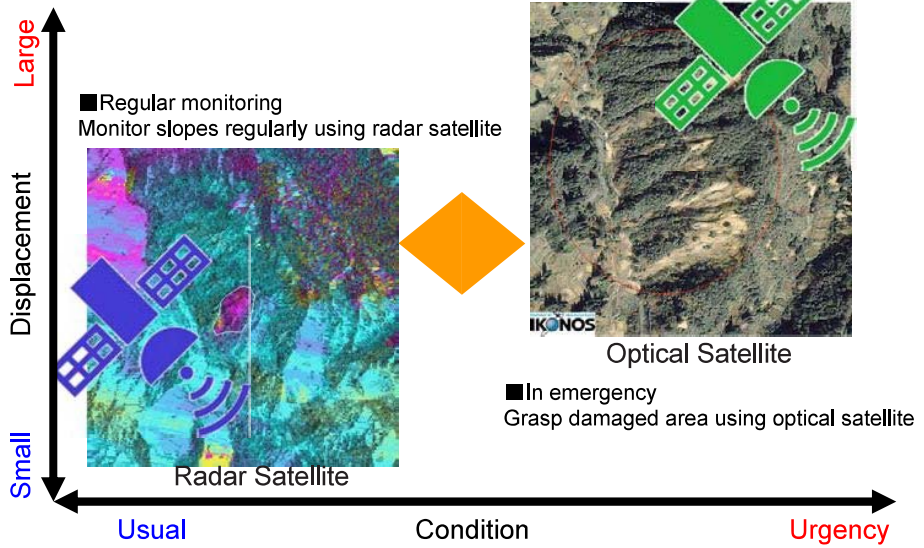


RA6-5

Example of fluctuating slope extraction



Summary



Wrap up

- Kyrgyz Republic matches good condition, having small area of vegetation
- Presence of high-frequency wide area observation satellite
- Sensitive to snow cover
- Some area cannot be observed depending on slope direction and angle

- Possibilities of improving accuracy in many season, high frequency
- Some high-frequency monitoring satellites are planned to be launched
  - ・ALOS-4(Japan)(Scheduled in 2021)
  - ・NISAR(NASA-ISRO)(Scheduled in 2021)

National land monitoring using satellite observation

The Japanese technology for the slope movement in Kyrgyz -Remote sensing, Drone and other slope risk assessment technology-

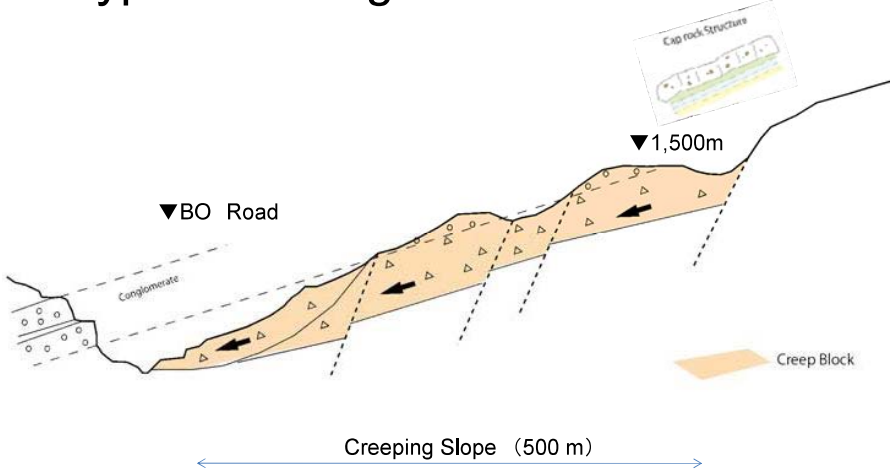
CSC T.Sasaki

Characteristics of slope disaster in Kyrgyz national highway

- Many mountain roads along a large-scale slope are required to evaluate vast slopes
- Geologically, there are many old age rocks causing deformation, landslide is distributed in many cases by a trigger for slope cuts and erosion at the end of deformation slope
- Avalanche is difficult to grasp actual condition by its large scale and complicated terrain

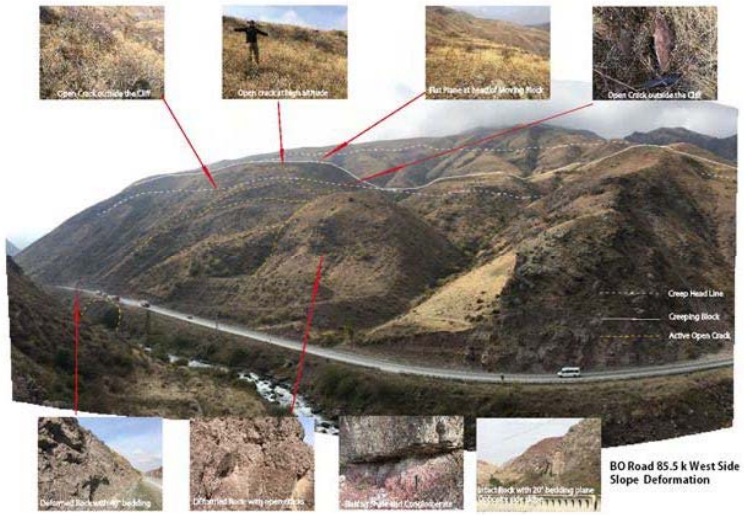
Slope Deformation along BO Road

Typical Geological Section 85-87 k



RA7-1

Slope Deformation at 85.5 k



Rational slope survey and evaluation technology

①Extraction of dangerous slopes in entire country

➡ Evaluation of wide area over time by satellite technology

②Detailed investigation targeting dangerous slopes

➡ Detailed geographical grasp / survey conducted by drone

③Maintenance of landslide

➡ Activity monitoring using communication technology

Search for slope movement location by remote sensing technology

- Using DInSAR by Satellite SAR (Synthetic Aperture Radar) Image
- Capable satellites of DInSAR in Kyrgyzstan country

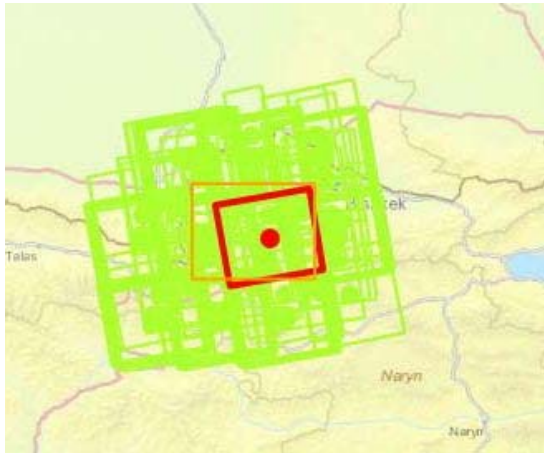
Satellites	Organization	Monitoring date	Regression Period	Band
ALOS-1	JAXA	2006/1/24～2011/4/22	46日	L-band
ALOS-2	JAXA	2014/5/24～	14日	L-band
Sentinel-1	ESA	2014/4/3～	12日	C-band （weak in vegetation areas ➡ highly applicable in Kyrgyzstan）

Sentinel-1

There are also many images, many data sets that can perform interference analysis

RA7-2

ALOS-1



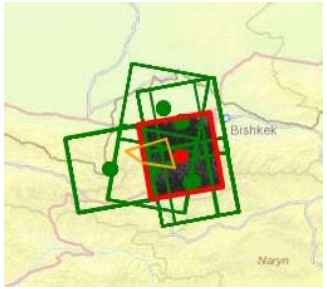
There are also many images, with data sets that allow interference analysis, About 15 times in 5 years

High Availability in Kyrgyz

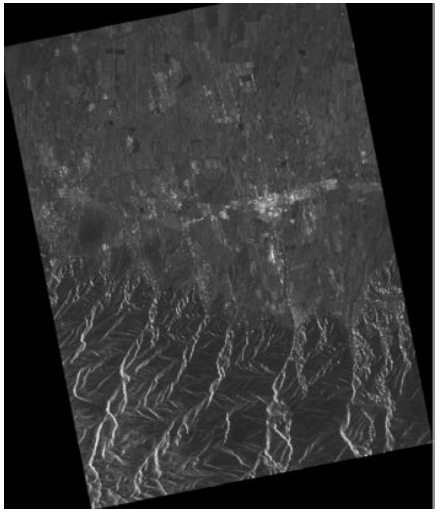
ALOS-2

There are many images and data sets that can perform interference analysis

Within 85.5 kp, there are 15 data sets in 3 years

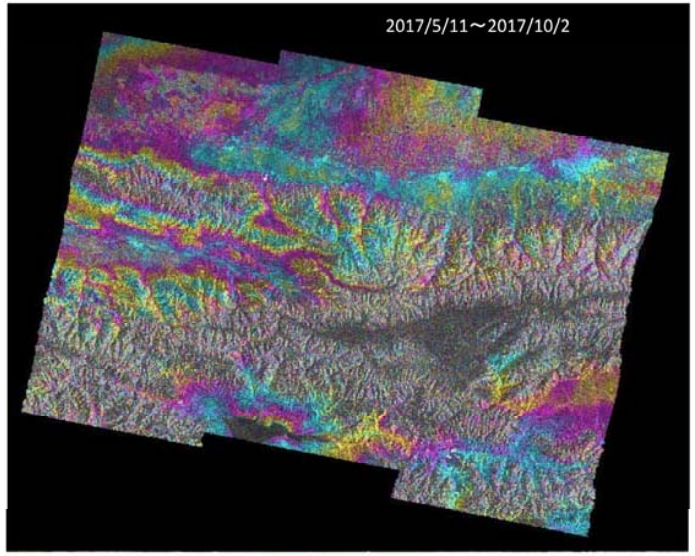


High Availability in Kyrgyz



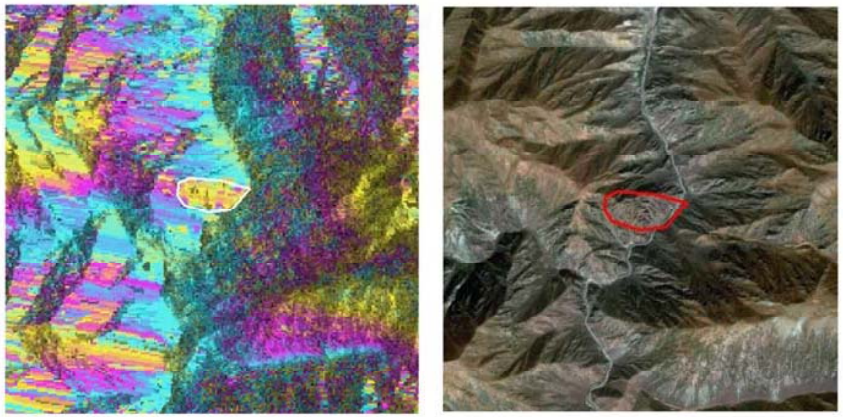
DInSAR Example in Kyrgyz

DInSAR image during 5 months



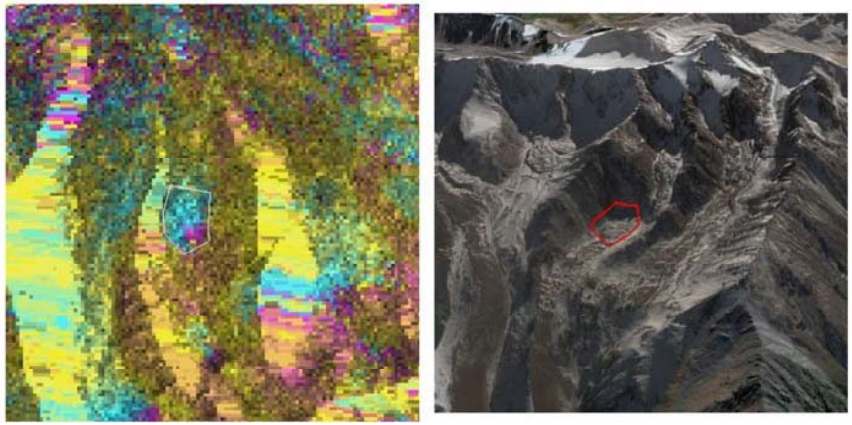
RA7-3

BOROAD 92 kp

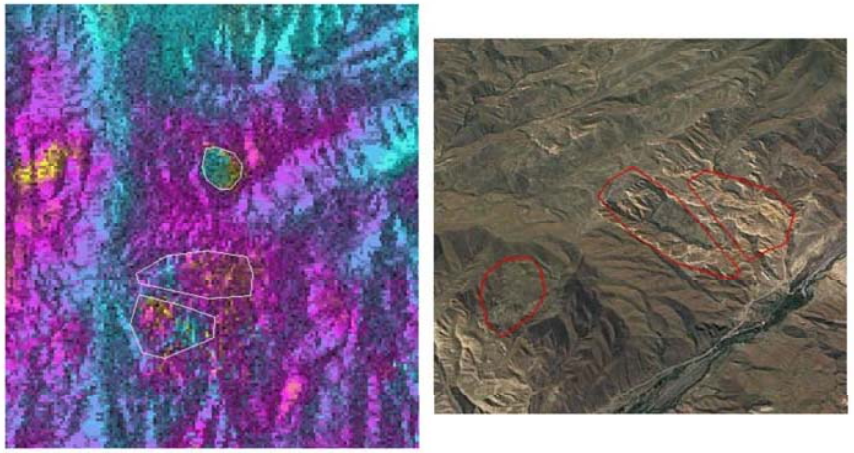


Large Scale Talus Deposits ➡ Active Rock Fall Slope

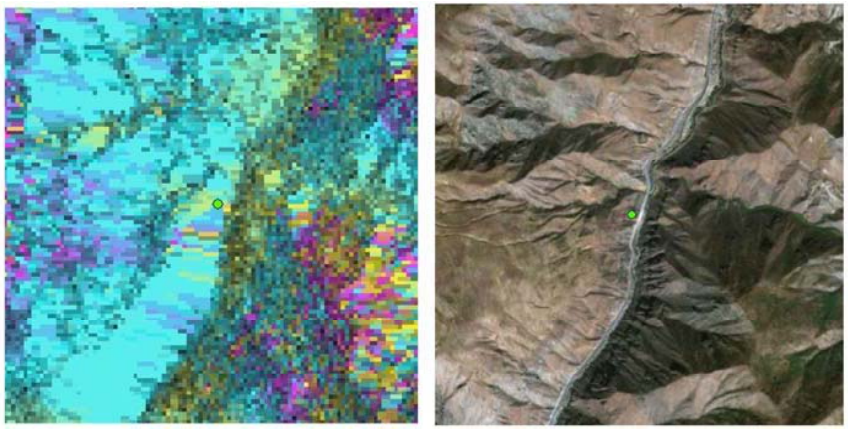
⑤ Land slide by melting snow



① Active landslide



BOROAD 85.5 kp



Long Period Analysis is required for deep sheeted Land slide

Real Time Slope Movement Monitoring Technology Using UAV

Case Study of the Debris Flow in Japan
Detect the volume of the debris flow deposits and correlated with the ground survey result

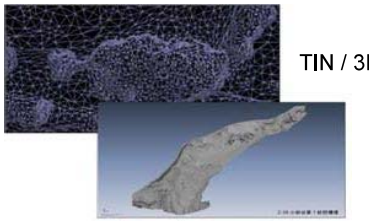
General Flow and Terrain Model

Development of Terrain Model

Image Analysis → Terrain Model → Movement Volume Calculation

Image detection

Position proofing



TIN / 3D Model Creation

Terrain Model Development

Calculation of Movement Volume

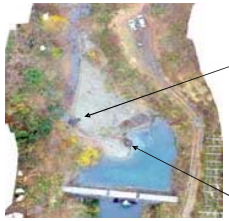
First Time 3D Terrain Model

Second Time 3D Terrain Model

Calculation of the Difference between Two times

Evaluation of Movement Volume

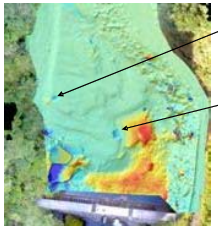
Artificial Movement Set



Depth 0.50 m

Depth 0.70 m

Calculation of the Volume by UAV Image



Depth 0.47 m

Depth 0.58m

Error is less than 20%

Recommended for Avalanche Evaluation

MoTR Cleaning work after Avalanche

Steep and Complicated Topography
Prevent them from confirming safety

Using UAV technology to evaluate snow condition
Especially for Artificial Avalanche

UAV → Artificial Avalanche → **UAV**

Clarify the movement Area and Volume

To evaluate safety of the slope condition

To collect movement data
for further Avalanche Evaluation

This Remote sensing technology shall be followed up by these , which introduced in this seminar as follows,

Detailed Landslide evaluation technology by UAV

Landslide Realtime Monitoring technology for Maintenance

Landslide prevention Measures

With these Japanese Technology promoted in Central Asia,
Slopes in Kyrgyz could be protected, and
Safety and Security could be enhanced in Entire Roads

Application of Drone Survey for Slope Monitoring Assessment

September 2018

Earth System Science CO,LTD.

UAV & SfM Technology

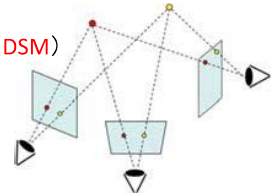
UAV and SfM Technology

■UAV (Unmanned Aerial Vehicle: DRONE)

- Early 2010th: Explosive growth of UAV market (DJI is now 80% share of the market)
- Used by common people: Aviation Law in Japan (2015) in Sri Lanka(2017)
- UAV has GNSS / IMU (Inertial Measurement Unit) for positioning

■Structure from Motion / Multi View Stereo (SfM / MVS)

- Extracting "Tie Points" from multiple photos.
- Analyzing shooting location and angle of Camera.
- Generating Dense Cloud points. → Digital Surface Model（DSM）
- Creating 3D Wire Frame Model. → Ortho-Photograph



UAV and SfM Technology

■Recently, UAV became Smaller, Higher Spec. and Safer

In 2014…

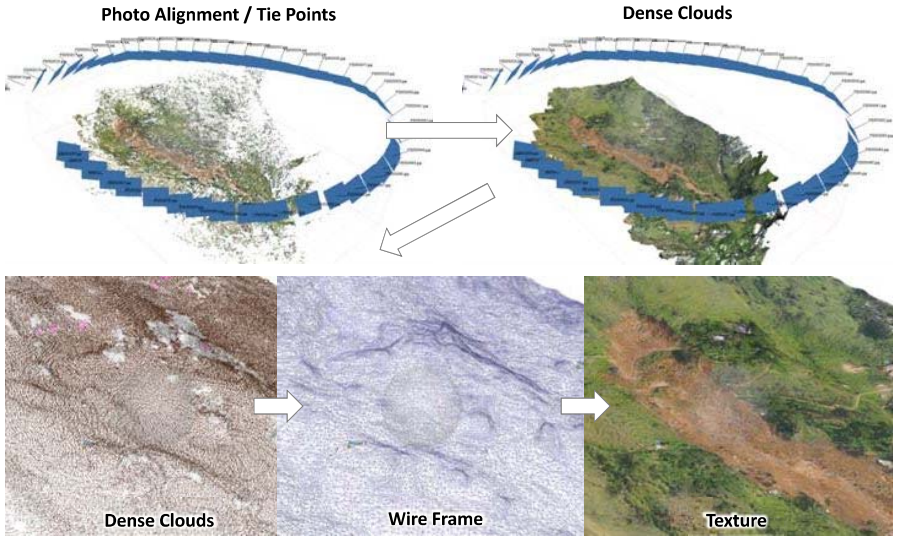
In 2018

SOLO with GoPro by 3D Robotics

UAV and SfM Technology

■Procedure of SfM by PhotoScan

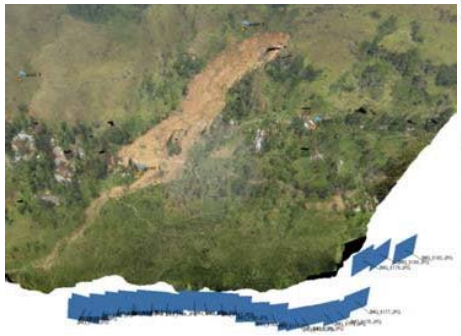
- Almost automatic procession (excepting GCP setting and Vegetation removal)

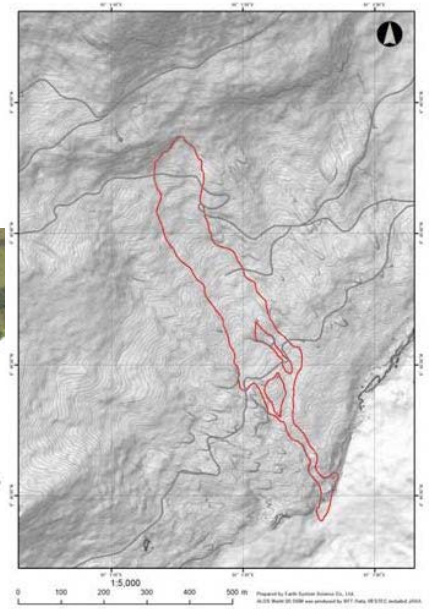


UAV and SfM Technology（Sri Lanka）

■Application in Quick Reports

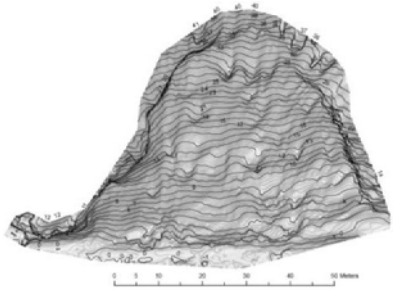
- Case study at Meeriyabedda
- Photos taken from opposite bank
- Enough resolution DSM for post disaster reports.

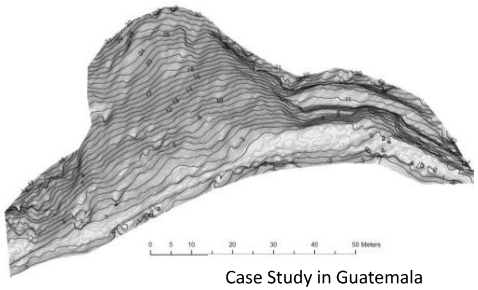




UAV and SfM Technology（Guatemala）

■Application in Road Maintenance



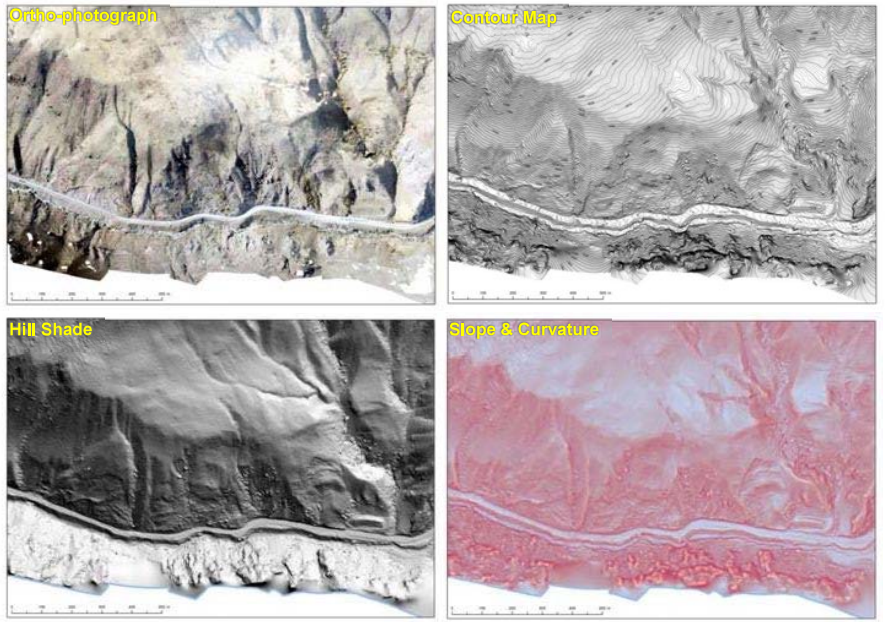


Case Study in Guatemala

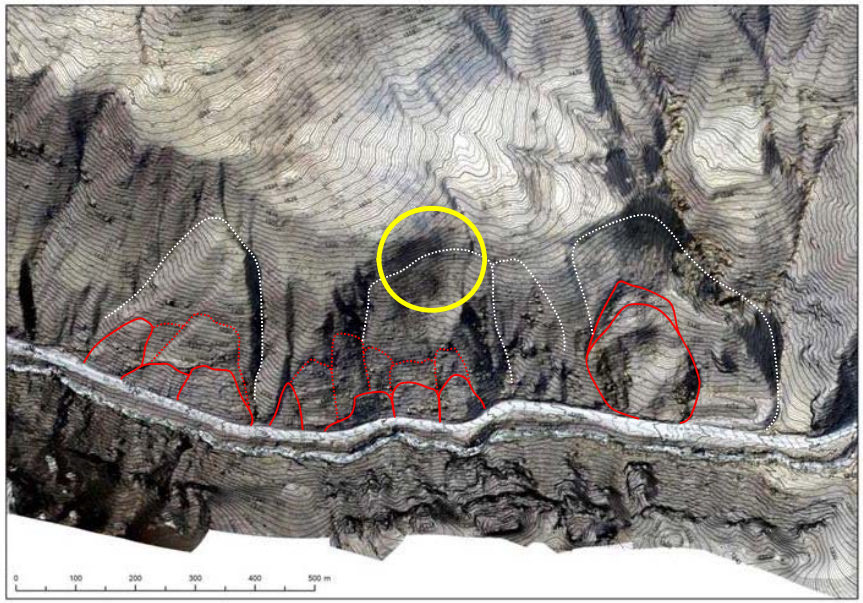
Example of Utilization in Road Slope Investigation

Example in Kyrgyz

Example in Kyrgyz



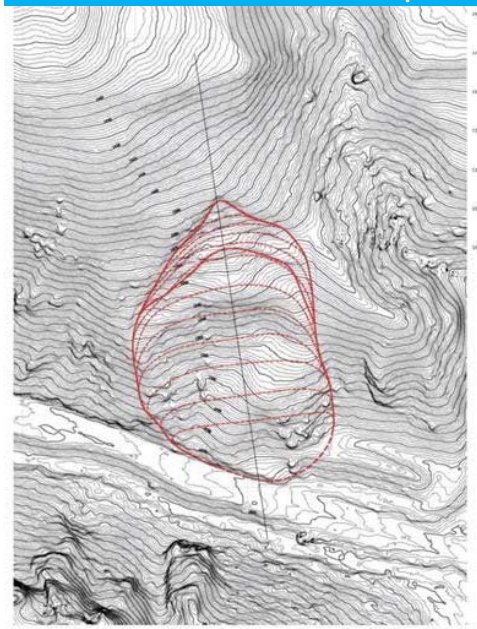
Example in Kyrgyz

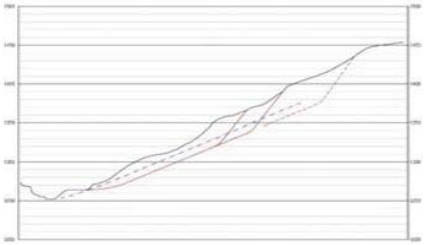


Example in Kyrgyz

RA8-3

Example in Kyrgyz



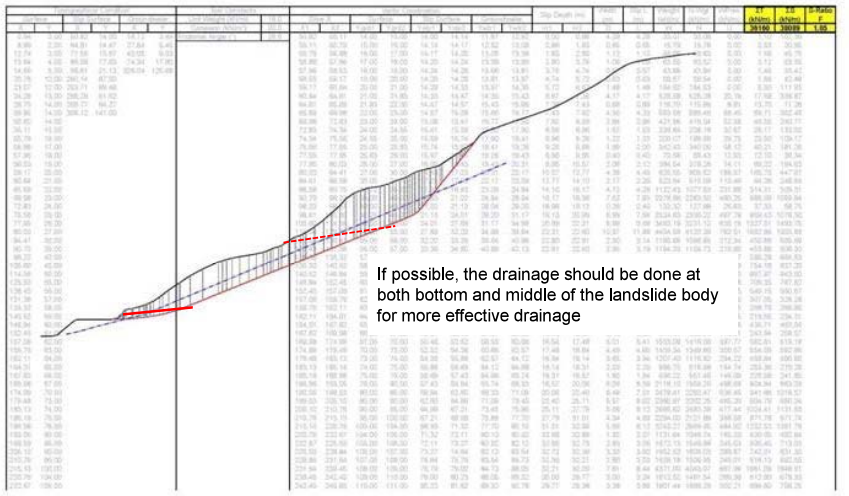


■Analysis Condition

- Slip depth is estimated 1/7-1/10 of landslide width (=18-25m).
- Slip plain is presumed parallel to the ground surface.
- Landslide toe is located at roadway elevation.
- Groundwater level is estimated about 10m above of the slip plain (constant), considering springs along the road.

All information should be verified based on additional inspection.

Example in Kyrgyz

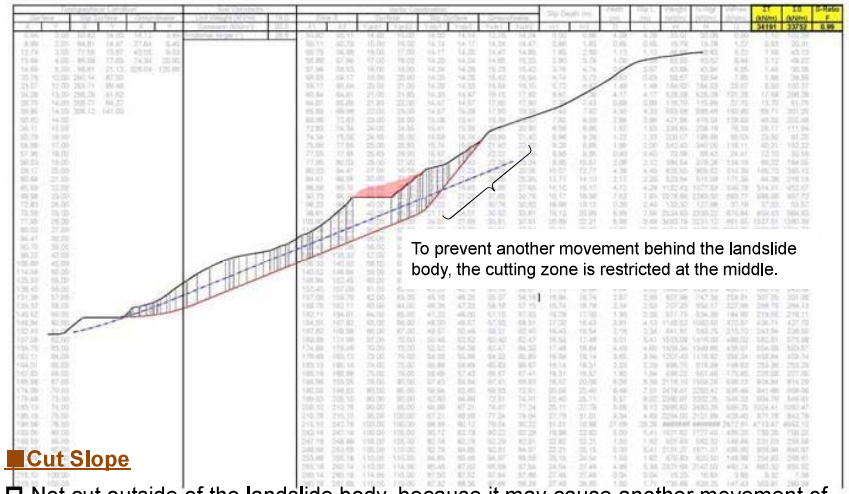


■Drainage by Horizontal Bores

- Horizontal bores from road level. 3m groundwater lowering is estimated.

⇒ FS = 1.05

Example in Kyrgyz



■Cut Slope

- Not cut outside of the landslide body, because it may cause another movement of upper mass
- Cut angle is 1:1.0. Cut slope height = 20m

⇒ FS = 0.99

UAV survey result for yen loan disaster mitigation project at BO-road

- 8月の現地調査成果（斜め写真、地形測量図）を示す（Will be arranged on September）

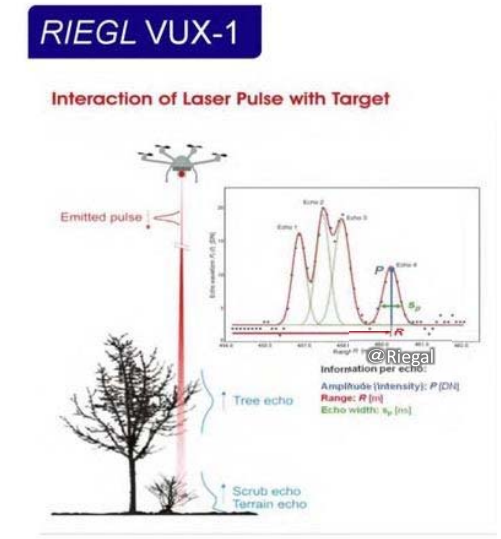
Future Application

Future Application

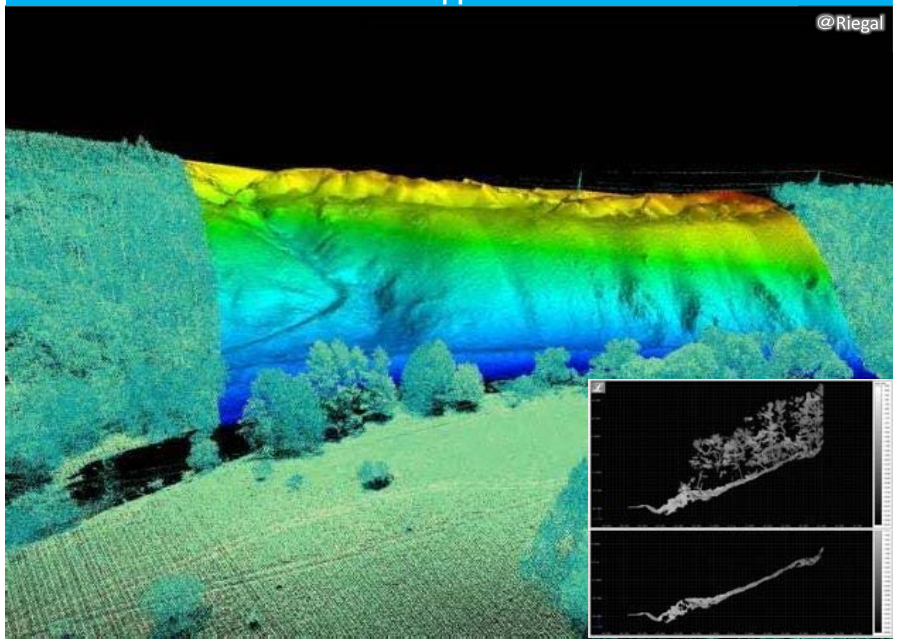
■Laser Scanner with UAV

- Velodyne (USA)
- Yellow Scan (France)
- RIEGL (Austria)
- Amuse Oneself (Japan)

※US$ 150,000～500,000



Future Application



Conclusion

■Advantages of UAV / SfM

- UAV / SfM is one of the tools, but effective for post-disaster reports and planning & designing landslide countermeasures.
- For post-disaster reports, certain accuracy topographical information can be produced by SfM without UAV.
- For planning & designing of landslide countermeasures, UAV / SfM provide precious topographical information, that can be used for slope stability analysis and investigation planning.

■Challenges and Recommendation

- Further training on slope stability and investigation planning based on topographic information produced by UAV survey.
- Installation of Laser-scanning UAV should be considered for future.

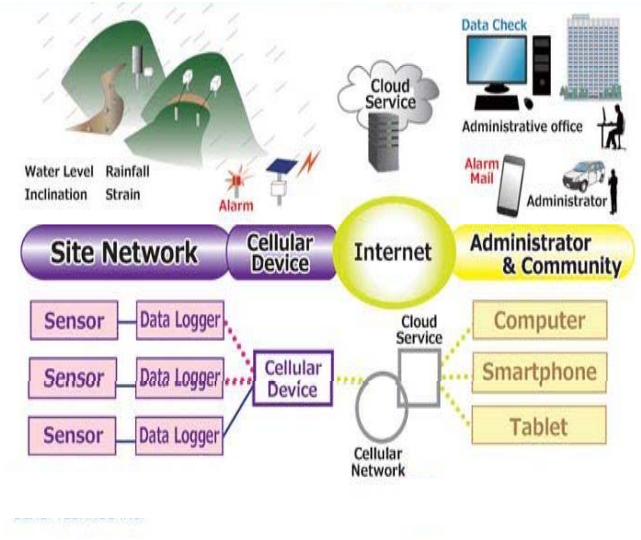
Automatic landslide monitoring system by various equipment

September 2018

Earth System Science CO,LTD.

Remote Monitoring System for Landslide

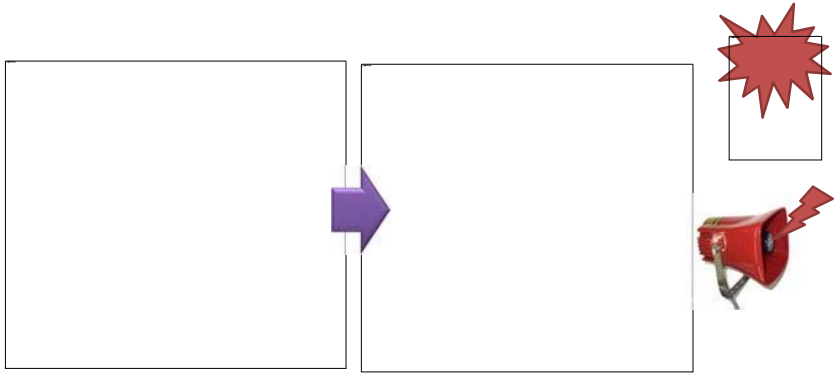
Remote Monitoring System



Extensometer with LCD

SLG-10E

The extensometer is mainly used for the purpose of grasping landslide situation. This instrument is installed across the tension crack of landslide to measure the moving of landslide. .



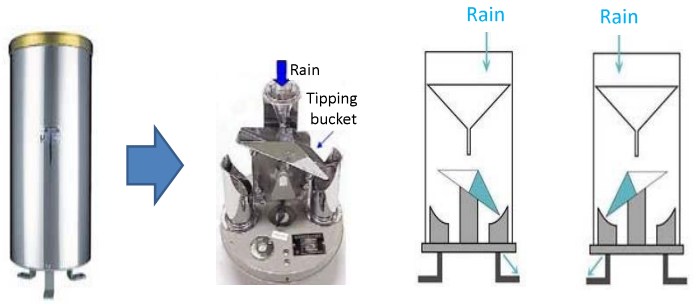
Extensometer with LCD
Instrument installed

Extensometer with LCD
Instrument installed


■ Liquid crystal display

Precipitation data logger (NetLG-201E) Tipping bucket rain gauge (RS-2)

This product easily records accurate rainfall data using a tipping bucket rain gauge.
It has very simple operation.



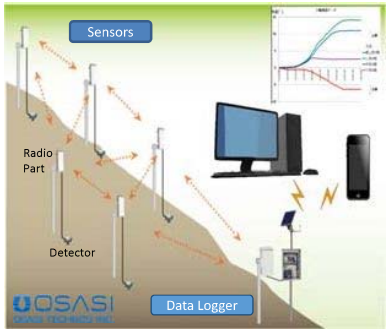
Instrument installed

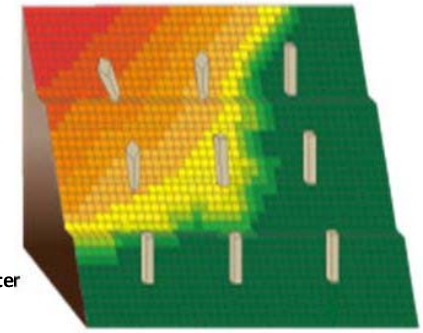
Precipitation data logger &

Tipping bucket rain gauge

Multi-Point Inclinometer (NetBC-30L・S)

These instruments can measure inclination of ground surface of many points.
Therefore you can grasp displacement of ground as plane.





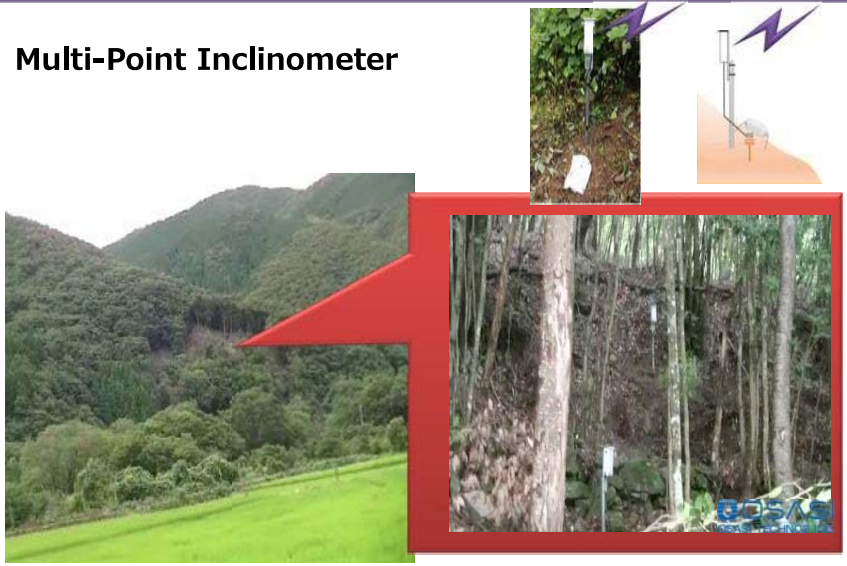
Multi-point Type Ground Surface Inclinometer

Instrument installed

Multi-Point Inclinometer

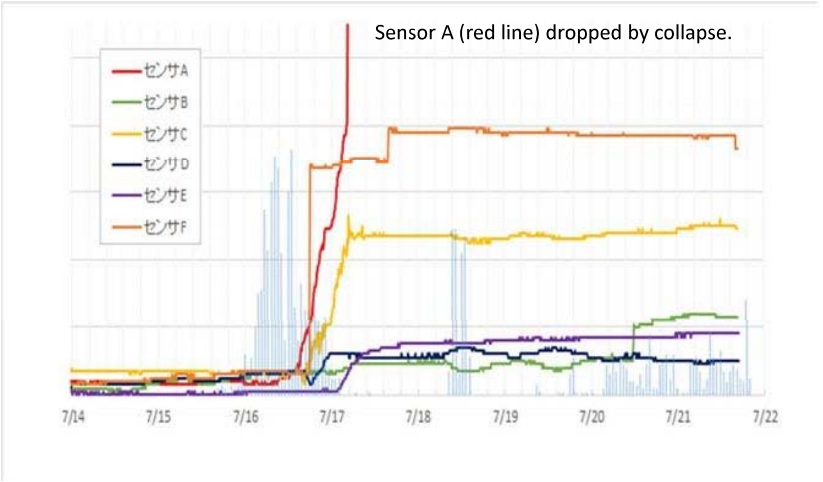
Instrument installed

Multi-Point Inclinometer



Graph of measurement data

Multi-Point Inclinometer



Verification survey in Sri Lanka

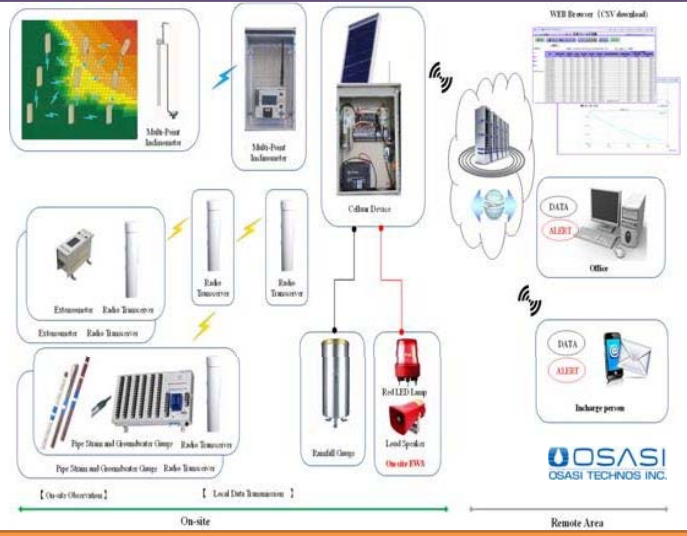
Landslide Remote Monitoring System

～Two pilot sites～

Ratnapura

Nuwara Eliya

Landslide Remote Monitoring System

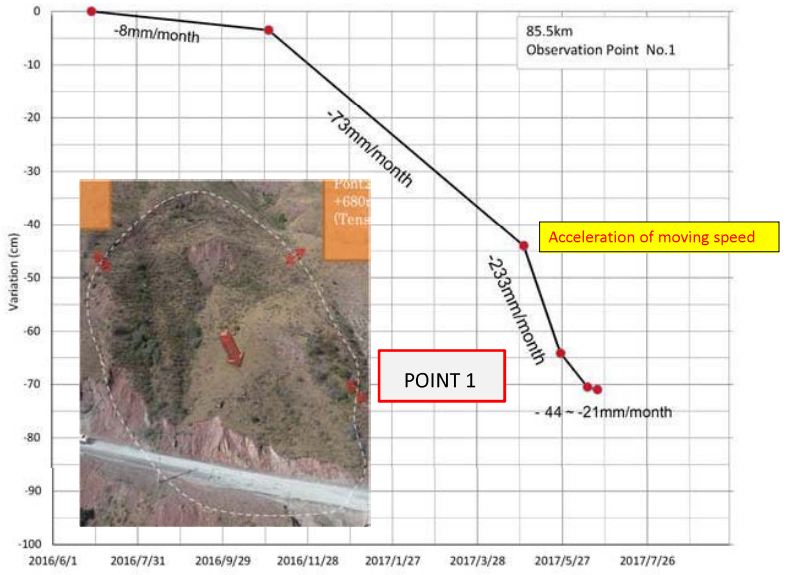


Provide the data which using for judgement by alarm issuance or emergency evacuation to the management center

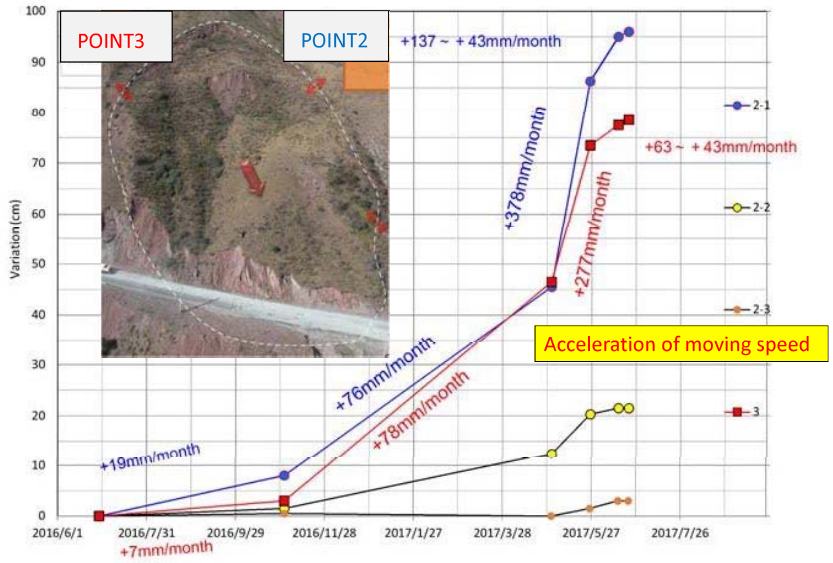
RA8-9

Monitoring plan for Landslide in Kyrgyzstan

Monitoring Result of 85.5km BO road, POINT 1



Monitoring Result of 85.5km BO road, POINT 2 and 3



Current issues for monitoring system at 85.5km BO-road

【Equipment】

- Monitoring work is only at the land surface around the cracks.
- Extensometer is very simple structure by steel wire.
- The accuracy of monitoring is not high.
- The wire has been stolen once.

【Location】

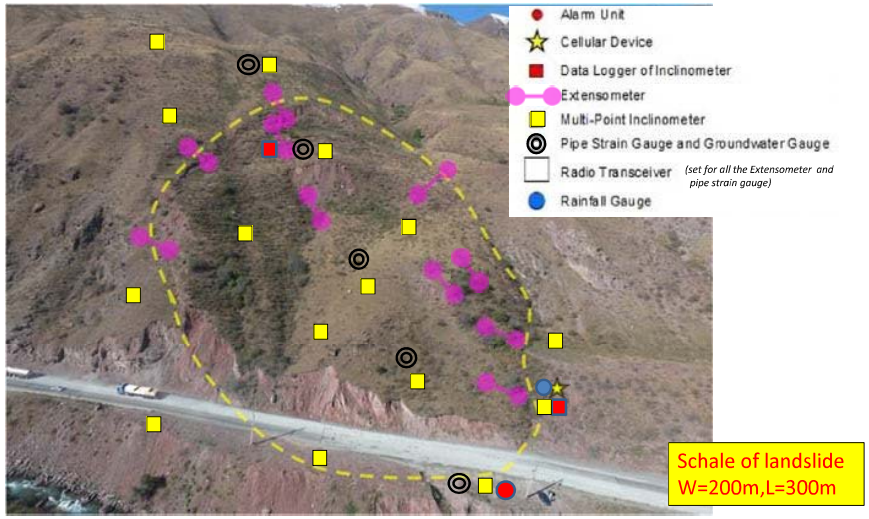
- Monitoring work will need two hours climbing up hill by two person.
- If something will happen around the site, it is not so easy to check the present situation for real time.

【Conclusion】

- Social damage will be so large if 85.5km BO-road landslide will be collapsed.
- Monitoring system is necessary to prepare for future measures.

Monitoring Plan for 85.5km BO-road Landslide

Enhance the monitoring system for remote type



Monitoring Plan for 85.5km BO-road Landslide

Enhance the Monitoring System

Item	Number of points	Remarks
Alarm Unit	1	
Cellular Device	1	
Data Logger of Inclinometer	2	
Extensometer	10	
Multi-Point Inclinometer	15	
Pipe Strain Gauge and Groundwater gauge	5	Vertical borehole for geological survey
Radio Transceiver	15	Set with all the Extensometer and pipe strain gauge
Rainfall Gauge	1	

Thank you very much

株式会社 地球システム科学
EARTH SYSTEM SCIENCE CO.,LTD.

OSASI
OSASI TECHNOS INC.

橋梁維持管理に関する先進事例
（ｱｾｯﾄﾏﾈｼﾞﾒﾝﾄ、維持管理上の工夫）

2018年 9月

株式会社　建設技術研究所

RA9-1

1. はじめに

◆ 建設技術研究所の概要

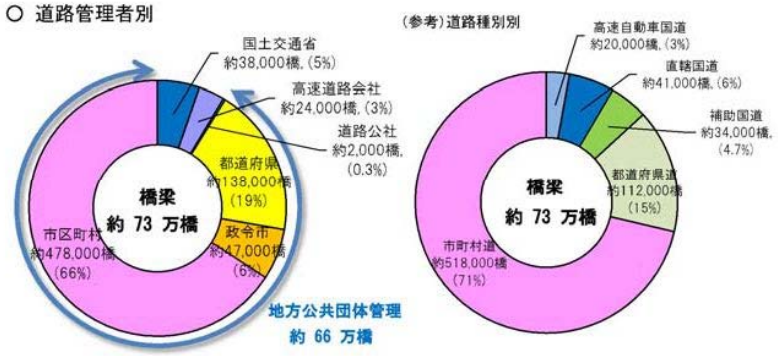
- 当社は、技術士約680名を擁する国内トップクラスの総合建設コンサルタント
- さまざまな社会資本の整備に向けて、調査・計画・設計・管理・事業マネジメントなどを実施

安全・安心の確保に貢献するとともに、産業や社会の発展と、人々の豊かな暮らしを支えている。

◆ 道路インフラを取り巻く現状

①管理者別の橋梁数

- 日本には橋梁が約73万橋あり、このうち、地方公共団体が管理する橋梁は66万橋であり、9割以上を占める。



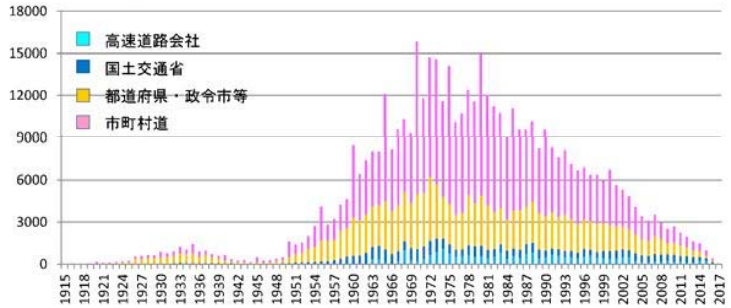
出典：道路メンテナンス年報　国土交通省　道路局　平成29年8月

◆ 道路インフラを取り巻く現状

②建設年度別の橋梁数

- 建設後50年を経過した橋梁の割合は、現在約23%
- 10年後には約48%に急増　⇒　急速な老朽化
- 建設年度が不明な橋梁が約23万橋あり、大半が市町村管理の小規模橋梁（橋長15m未満）

○建設年度別橋梁数



出典：道路メンテナンス年報　国土交通省　道路局　平成29年8月

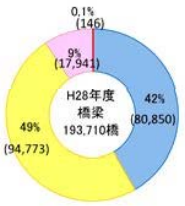
◆ 道路インフラを取り巻く現状

③橋梁の状態

- 2014年に道路法が改訂され、各道路管理者が統一的な基準（4段階）に基づき、橋梁の健全性を診断
- 橋梁点検の結果、約1割の橋梁において早期に補修が必要な状態（判定区分Ⅲ、判定区分Ⅳ）

※　判定区分Ⅰ：健全（構造物の機能に支障が生じていない状態）
　　判定区分Ⅱ：予防保全段階（構造物の機能に支障が生じていないが、予防保全の観点から措置を講ずることが望ましい状態）
　　判定区分Ⅲ：早期措置段階（構造物の機能に支障が生じる可能性があり、早期に措置を講ずべき状態）
　　判定区分Ⅳ：緊急措置段階（構造物の機能に支障が生じている、又は生じる可能性が著しく高く、緊急に措置を講ずべき状態）
※　判定区分の割合は、四捨五入の関係で合計値が100%にならない場合がある。

○ 判定区分



○ 判定区分と建設経過年数

出典：道路メンテナンス年報　国土交通省　道路局　平成29年8月

◆ 維持管理の課題

①維持管理予算

- 本来は増やすべき　⇒　十分な修繕費用が確保できていない。

②維持管理体制

- 地方公共団体（町の約5割、村の約7割）で橋梁保全業務に携わっている土木技術者が存在しない。

③メンテナンス産業

- 修繕工事は新設工事と比べて手間がかかり、人件費や機材コストが割高になり、規模などの発注条件によっては利益が出にくい。

④国民の理解

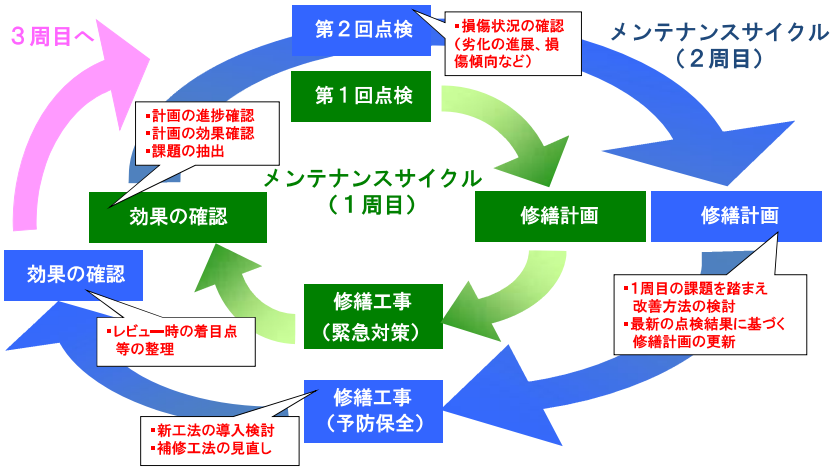
- 国民が道路施設の老朽化の状況等を知る機会は少なく、道路管理者等による情報発信が不十分

2. 橋梁のアセットマネジメントの概要

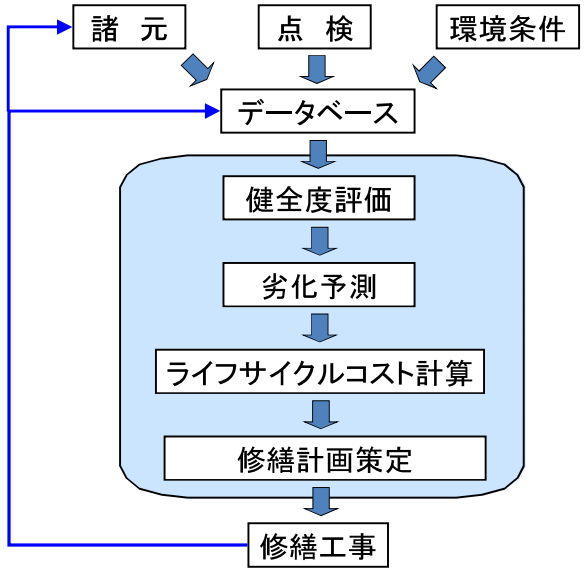
◆ メンテナンスサイクルの構築

● 老朽化対策における課題を解決するためにはメンテナンスサイクルの構築、推進、改善が重要（改善しながら回し続けることが重要）

＜メンテナンスサイクル例＞



◆ メンテナンスサイクルに基づく維持管理の流れ



◆ 橋梁点検（老朽化への対応の現状と課題）

橋梁点検の実態（足場を用いた点検）

開川大橋下り（北陸地方整備局）

《課題》
・足場の設置に時間とコストが掛かる
・高所は、危険が伴う
・点検箇所とその状態が的確に記録できない
・人によって判断にバラツキがある

橋梁点検の実態（橋梁点検車を用いた点検）

黒川大橋（北陸地方整備局）

《課題》
・点検車を搬入するスペースが必要（通行規制を伴う）
・橋梁型式（トラス構造等）によっては、対応出来ない
・時間と手間が掛かる

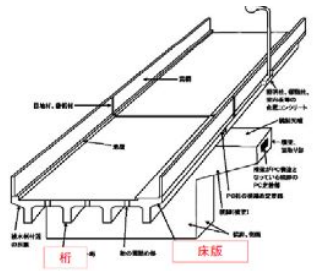
◆ 点検技術の高度化（技術開発に対するニーズ）

近接目視

・鋼橋において、桁の「腐食、亀裂、破断、ゆるみ・脱落、防食機能の劣化」について、点検要領に基づく近接目視の代替ができる装置

・コンクリート橋において、桁の「ひび割れ、剥離・鉄筋露出、漏水・遊離石灰、うき等」、点検要領に基づく近接目視の代替ができる装置

・鋼橋・コンクリート橋の床版において、「床版ひび割れ、剥離・鉄筋露出、漏水・遊離石灰、うき、抜け落ち等」、点検要領に基づく近接目視の代替ができる装置



打音検査

・鋼橋においては、桁の添接部のボルトやリベットの「ゆるみ、折損」、コンクリート橋において、桁の「うき」について点検要領に基づく打音検査の代替ができる装置

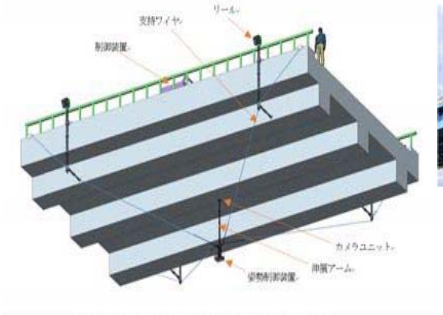
・鋼橋・コンクリート橋の床版において、「うき」について点検要領に基づく打音検査の代替ができる装置

作業台車

・鋼橋・コンクリート橋において、点検者を点検箇所に近づけることができる装置

◆ 点検技術の高度化（当社の取り組み事例）

名称：橋梁点検ロボットシステム
目的：点検作業の省力化、効率化
概要：4本のワイヤにより吊り下げられた点検用ロボットで、橋梁のすべての場所を写真撮影し、点検結果をデータベース化



伸展したアームによる点検

橋上からゲームコントローラを使用しロボットを操作

◆ 点検技術の高度化（当社の取り組み事例）

名称：無人ロボット点検
目的：近接困難な箇所での点検、構造物寸法計測、経過観察等
概要：マルチヘリによる点検の効率化、3Dデータ化による寸法計測技術

◆ 点検結果に基づく健全度評価

橋梁の健全度評価　⇒　橋梁の維持・更新費を縮減・平準化するために、
「いつ」、「どの橋梁」を対策するか
を合理的に判断できる評価であることが重要

【例】 ※現状、道路管理者により健全度の定義は異なる（課題）。
- 落橋に対する安全性
- 長期耐久性（長寿命化）
- 第三者に対する安全性

などに着目した健全度（対策判定）評価を行っている。

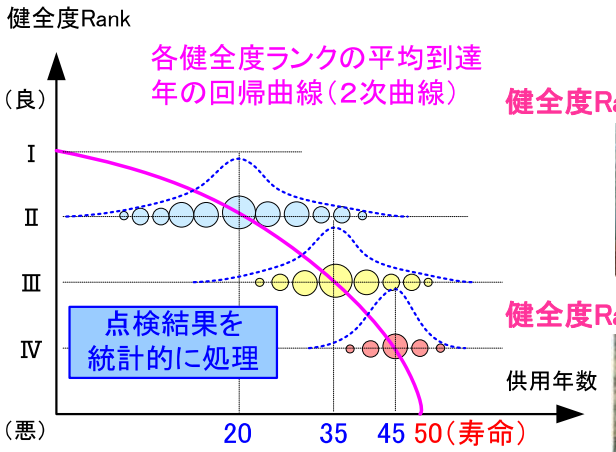
対策の緊急性 低 → 高

【健全度の区分（4段階）】 国の点検要領における定義

区分		状態
Ⅰ	健全	道路橋の機能に支障が生じていない状態。
Ⅱ	予防保全段階	道路橋の機能に支障が生じていないが、予防保全の観点から措置を講ずることが望ましい状態。
Ⅲ	早期装置段階	道路橋の機能に支障が生じる可能性があり、早期に措置を講ずべき状態。
Ⅳ	緊急措置段階	道路橋の機能に支障が生じている、又は生じる可能性が著しく高く緊急に措置を講ずべき状態。

◆ 劣化予測モデルの構築

（例）統計的手法



健全度Rank Ⅱ

健全度Rank Ⅲ

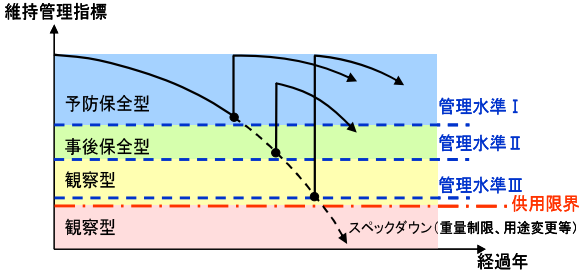
健全度Rank Ⅳ

◆ 橋梁の重要度に応じた管理水準、維持管理シナリオ

●すべての管理橋梁を同一の管理水準で維持管理することは非効率
●路線や橋梁の重要度に応じて、橋梁ごとに管理水準を設定

管理水準、維持管理シナリオの設定例

橋梁重要度	管理水準	シナリオ	内容
重要度：高 グループA	管理水準Ⅰ	予防保全型	・重要な橋梁に対して、損傷が軽微なうちに損傷の進行を防止するために、予防的に対策を実施
重要度：中 グループB	管理水準Ⅱ	事後保全型	・損傷が進行し顕在化した後に、損傷状況に対応した比較的大規模な対策を実施
重要度：低 グループC	管理水準Ⅲ	観察型	・損傷が深刻化した時点で、部材の取替えまたは更新を実施



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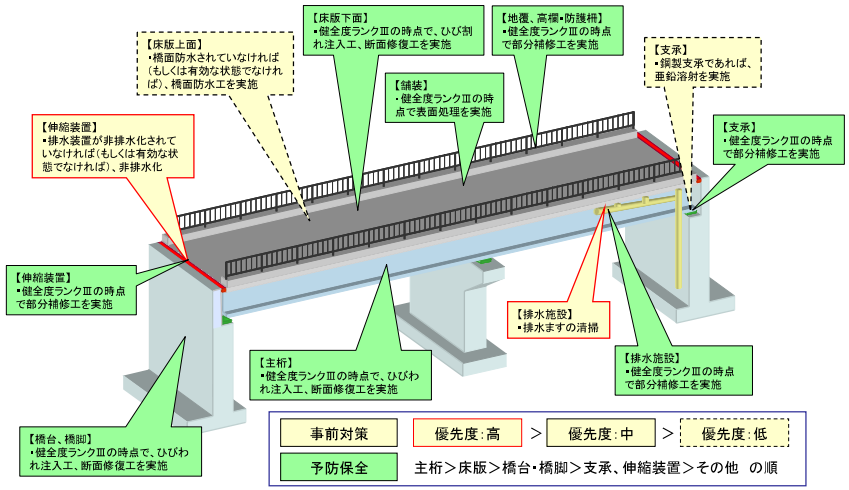
◆ 維持管理シナリオの設定例

＜維持管理シナリオの設定例：コンクリート橋　管理水準Ⅰ＞



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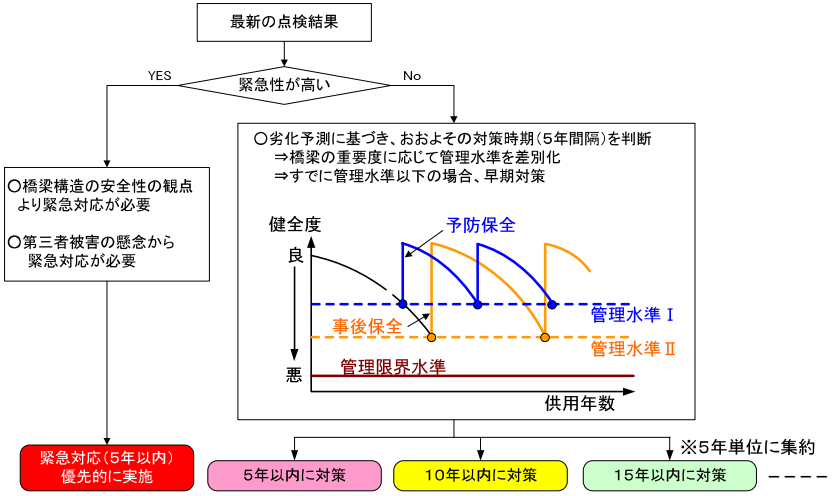
◆ 劣化予測に基づく対策時期の判断

●緊急対応が必要な橋梁を優先的に対策
●劣化予測に基づきおおよその対策時期（例えば5年間隔）を判断



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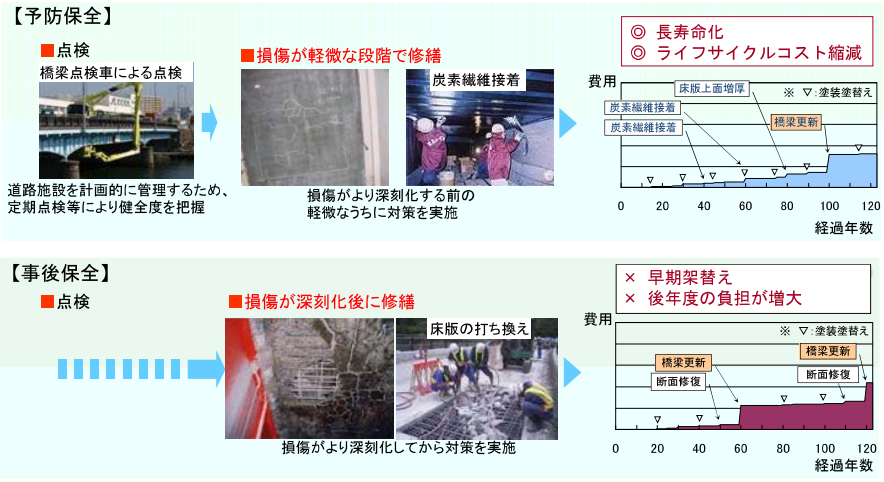
◆ ライフサイクルコストの計算

●維持管理シナリオに基づき各橋梁のライフサイクルコストを算出



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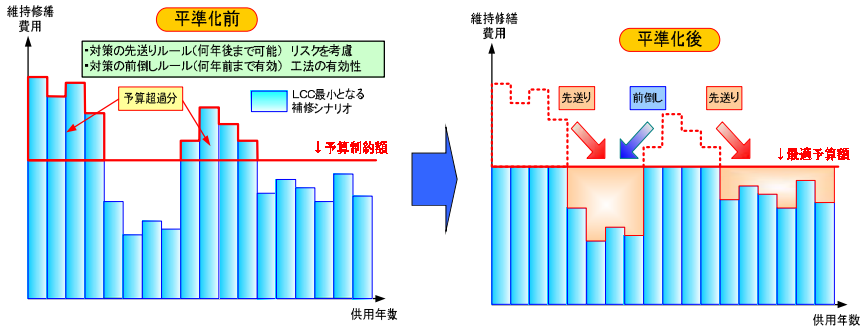
◆ 予算の平準化

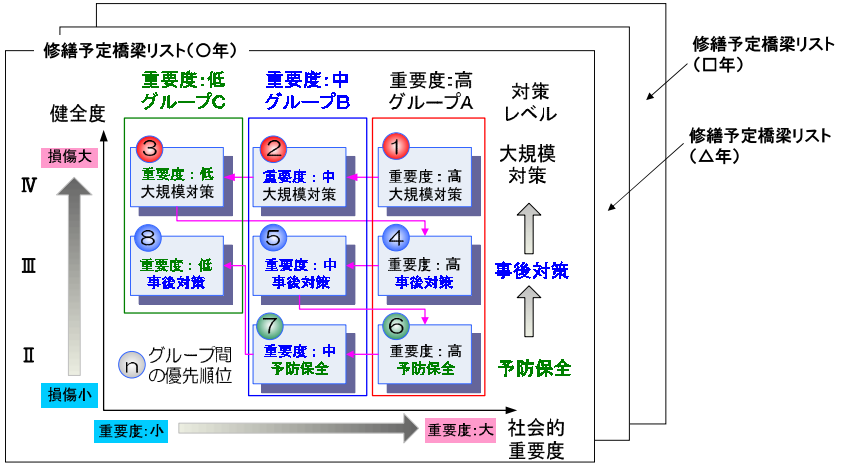
管理橋梁すべてのライフサイクルコストが算出された段階で、財政状況を考慮に入れ、合理的な予算の平準化を行う。

【予算の平準化のイメージ】



◆ 事業優先度の評価

●ある年の修繕予定橋梁に対して、「橋梁の重要度」と「橋梁の健全度」に着目した2軸のマトリックスにより、事業の優先順位付けを行う。



◆ 長寿命化修繕計画のアウトプット

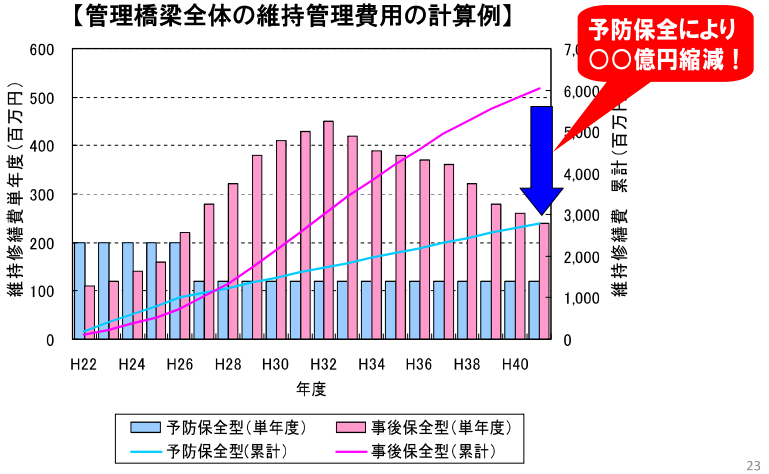
【長寿命化修繕計画リスト出力例】

橋梁名	道路種別	路線名	橋長（m）	架設年度	供用年数	最新点検年次	対策の内容・時期 H21	H22	H23	H24	H25	H26	H27	H28	H29	H30
○○橋	補※	○○○号	30	1995	12	H17		次回点検								
○○橋	主※	○○○号線	80	1998	9	H19				次回点検						
○○橋	補※	○○○号	100	1970	37	H19			塗装塗替え			次回点検				
○○橋	ー※	○○○号	50	1940	66	H18				架替え			次回点検			
○○橋	〃	○○○号	18	1980	26	H20					床版補強				次回点検	
‥	〃	‥	‥	‥	‥	‥										
今後の修繕・架替え事業費（億円／年）							●	●	●	●	●	●	●	●	●	●

◆ 将来の維持管理費用の推定

●各橋梁で算出したライフサイクルコストを合計し、必要な維持管理費用を推定
● 2パターンの維持管理シナリオ（予防保全型、事後保全型）について試算を行い、予防保全型の維持管理を行うことによるコスト縮減効果を確認

【管理橋梁全体の維持管理費用の計算例】



◆長寿命化修繕計画に基づく修繕工事例(1)

＜鋼鈑桁橋　1975年建設　橋長15.5m＞

①点検時(建設後30年経過)


②修繕工事時

③修繕工事後



◆長寿命化修繕計画に基づく修繕工事例(2)

＜RCT桁橋　1934年建設　橋長8.0m＞

①点検時(建設から70年経過)

②修繕工事時

③修繕工事後



長寿命化修繕計画に基づく更新工事例

①A橋　RC橋　→　鋼橋　2010年竣工　橋長26m



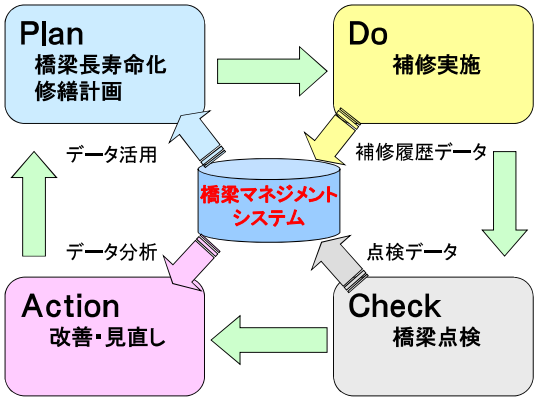
②B橋　RC橋　→　PC橋　2010年竣工　橋長15m



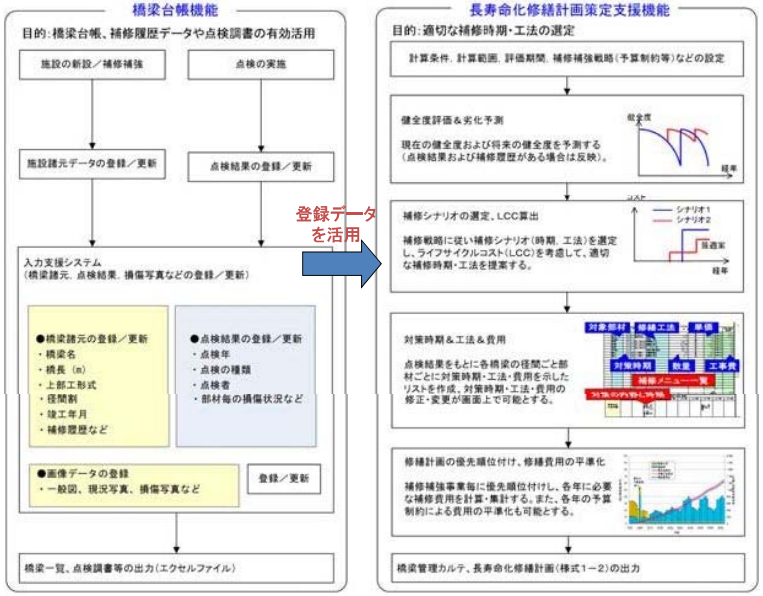
◆ 橋梁マネジメントシステムによる支援

●橋梁マネジメントシステムを導入することにより、メンテナンスサイクルの推進および改善を効率的かつ効果的に支援

【メンテナンスサイクルと橋梁マネジメントシステムの関係】



◆橋梁マネジメントシステムの主な機能例



◆橋梁マネジメントシステムの主な画面例（1）

橋梁台帳機能の画面例

①管理橋梁一覧画面

②橋梁台帳画面

③点検結果登録画面

④その他画面（例：添付書類登録）

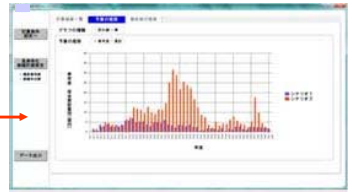
◆橋梁マネジメントシステムの主な画面例（2）

長寿命化修繕計画策定支援機能の画面例

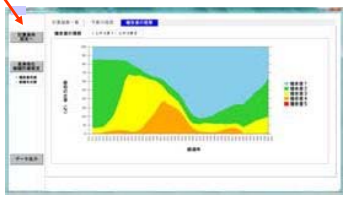
①試算条件の設定画面

②個別橋梁の計画

③予算の推移画面（橋梁群）



④健全度の推移（橋梁群）



3. 日本における維持管理上の工夫

①橋梁設計段階における維持管理への配慮

概要

2017年7月道路橋示方書が改定された。ここでは、改定された道路橋示方書の記載内容から維持管理に関する事項を抽出して紹介する。

改定内容

１）許容応力度法から限界状態設計法・荷重抵抗係数法へ書式の変更

加えて

２）設計計算書に明示するべき事項の明確化

例えば

①橋梁設計の前提条件（要求性能・維持管理条件の明確化）
- 道路計画や維持管理計画との整合

②耐久性能・耐荷性能・その他の性能
- 耐久性能の確保に対する配慮事項・方法の記載
- 耐荷性能の確保　〃
- その他性能の確保　〃

1. 維持管理を行うために配慮される事項

①通常時・緊急時の点検方法、定期点検の方法（アクセス方法など）
②不測の事態に対する配慮
③点検のための空間確保
④部材の交換が必要となる場合の対応
⑤鋼部材の塗り替え塗装が必要となる場合の対応
⑥耐久性を確保する手段の更新（塗装の塗り替え等）

2. 橋梁計画の段階で配慮すべき事項

設計の前提条件により橋に求められる要求性能が異なる。前提条件に応じた維持管理への配慮が求められる。

(1) 橋の重要度
- 1)物流等の社会・経済活動上の位置付け
- 2)防災計画上の位置付け
- 3)路線の代替性

(2) 設計供用期間

(3) 架橋位置特有の条件

①路線条件　②自然環境条件　③周辺環境
④使用材料の条件及び製造に関する条件
⑤施工に関する条件　⑤維持管理に関する条件（点検方法（通常時、緊急時））
⑥被災時の修繕方法（作業空間、作業場の制約など）
⑦維持作業計画（除雪・凍結防止など）

3. 設計の段階で配慮されるべき事項

(1) 橋梁計画上の配慮

1) 橋の一部の部材や接合部の損傷が原因になって橋の機能回復が困難となることを回避するための配慮

①各部材等に不具合が生じた場合の対応の確実性や容易さの検討
②補修や部材更新の方法
③補修や更新の時期を判断する方法
④点検や維持修繕作業に必要な空間確保

2) 設計供用期間中の点検及び事故や災害における橋の状態を評価するために行う調査を適切に行うための配慮

①点検や調査の方法の検討（通常点検、異常時点検、定期点検など）
②点検経路の検討、点検空間の確保（通常点検、異常時点検、定期点検など）
③維持管理設備の設置の有無や範囲、構造の配慮

(2) 構造設計上の配慮事項

1) 設計で前提とする施工品質が満足されるための配慮

①残留応力への配慮（コンクリートの打設順序、打継目位置、製作や架設の条件など）

②品質管理や検査が容易な板組

③施工段階における部材の上げ越し量の算出

④架設途中と完成時における応力の照査

2) 設計供用期間中の点検及び事故や災害における橋の状態の評価するために行う調査を適切に行うための配慮

①点検が容易となるような継手の位置の検討

②施工段階で必要となる形状保持や輸送・架設のための各種の仮設物、仮補強材や鉄筋の配置の検討　など

3) 耐久性能の前提となる条件との乖離を小さくすることができる細部構造とするための配慮

①排水、水の滞留対策

②補剛材の位置関係

③継手の位置

④仮補強材や鉄筋の配置が局所的な応力状態に与える影響を小さくすること

4. 維持管理に引き継ぐ事項

(1) 設計における留意点

1) 維持管理方法の条件

①点検の手段、頻度

②部材の更新の想定

2) 橋の耐震設計にて各部材等の状態を想定するにあたって塑性化を期待する部材並びにその塑性化する位置や範囲

3) 通常点検、異常時点検、定期点検のアクセス方法の考え方や留意事項

4) 施工時の仮設物や用心鉄筋など部材内部に残留されるもの

5) 維持管理設備

6) 維持管理における留意点

②コンクリート構造物に対する最新の維持管理技術

コンクリート構造物の維持管理軽減のための2つのアプローチ

1. ひび割れのない、密実なコンクリートを使用して構造物を構築することで、コンクリートの劣化を抑制する
2. 寒冷環境、湿潤環境でも使用可能な補修材料を用いて素早く、温度養生、乾燥養生なしで補修工事を実施する

②コンクリート構造物に対する最新の維持管理技術

ひび割れのない、密実なコンクリートを使用して構造物を構築することで、コンクリートの劣化を抑制する

シリカ質混和材の使用

②コンクリート構造物に対する最新の維持管理技術

シリカ・ホワイトのご紹介

1. 通常のシリカ質混和材（シリカフューム，金属生産副産物/超微粉末）より粒径が大きく（セメントの1/4程度の微細粉末），取り扱いが容易
2. 通常のAE減水剤で対応可能
3. 日本国内産の火山灰、ケイ酸白土を原材料とする「天然シリカ質混和材」

②コンクリート構造物に対する最新の維持管理技術

シリカ・ホワイトのご紹介

4. 微粉末混入により、以下の効果が期待される
① 30%程度の強度増加
② ひび割れ防止
③ 凍結融解抵抗（スリップ防止）
④ 塩害防止

7 Benefits that「SILICA WHITE」gives to concrete products

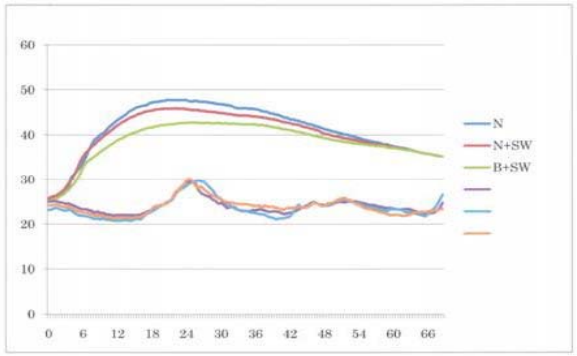
1.Concrete surface
【Micro-filler effect】
The particles of SILICA WHITE, which are finer than cement particles, fill the voids between the cement particles and then less water is kept in the voids. As the result, increased free water improves the fluidity of concrete paste and the surface of the finished concrete shall be very smooth.
Water repellent agent is no longer needed.

2. Internal structure
A test result of a pore size distribution measured by the mercury porosimetry has confirmed that the high strength concrete with SILICA WHITE has very dense pore structure. Harder concrete has less cumulative volume of micro pores.

3. Low hydration heat
Generally, concrete cracking occurs due to heat of hydration. By adding SILICA CEMENT, internal temperature of concrete falls by 5 degrees Celsius which prevent concrete from cracking.

Temperature change

1. Micro-filler effect 2. . Internal structure 3. Low hydration heat



N/24-15-25N ・ N+SW/24-15-25N-SW ・ B+SW/24-15-25B-SW

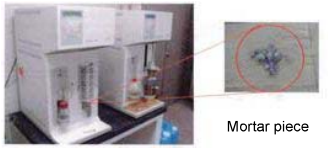
	N	N+SW	B+SW
The highest internal temperature	47.8	46.0	42.8
The maximum temperature difference between the air outside	24.3	23.7	19.5

Test results

Water Permeability Test Report Unit : N/mm2

SPECIMEN	NO.	WEIGHT BEFORE TEST (gms)	WEIGHT WATER PENETRATION AFTER 1 HOUR (gms)	WATER PENETATION
ORDINARY CEMENT	1	1,424	7.0	1.00
	2	1,435	7.0	
	3	1,437	8.0	
	AVERAGE	—	7.3	
SILICA WHITE 5%	1	1,438	5.4	0.78
	2	1,423	5.4	
	3	1,419	6.7	
	AVERAGE	—	5.8	
SILICA WHITE 10%	1	1,423	5.3	0.70
	2	1,457	5.3	
	3	1,433	4.7	
	AVERAGE	—	5.1	
SILICA WHITE 20%	1	1,442	5.1	0.68
	2	1,435	5.1	
	3	1,431	4.9	
	AVERAGE	—	5.0	

Pore size distribution test
by a mercury penetration method



Mortar piece

SILICA WHITE

TEST REPORT ON WATER PERMEABILITY AND MORTAR STRENGTH TEST

SPECIMEN	Combination (gram)				Flow RATE	Mass PerUnitVolume Kg / Litter
	SILICA CEMENT	CEMENT	AGGREGATES	WATER		
ORDINARY	0	500	1,500	274	161	2.16
SILICA WHITE 5%	25	500	1,450	276	161	2.17
SILICA WHITE 10%	50	500	1,450	276	161	2.17
SILICA WHITE 20%	100	500	1,400	276	160	2.18

Method of concrete mixing:
Cement mixer : 5 liter cement mixer
Order of input :
Aggregates → SILICA WHITE → Cement → Water
Mixing : One minute without water and then 3 minutes with water

Examples of construction in Japan

ISHINOMAKI Technical High School(2004・2005)

Project entity : Miyagi prefecture government

Opened in 2006

Application purpose of SILICA CEMENT
: Strength
Water repellence
Protection against surface deterioration

2013 (2years after the earthquake) Tsunami went up the river 2 km and attacked this school building.
The height of Tsunami was 2m but there was no major damage.

JOSAI International University

Application purpose of SILICA WHITE
:Strength
Water repellence
Protection against surface deterioration

SILCA WHITE mixed quantity : 20kg/1㎥

Completed: 1995
Photo : 2014

There is no cracking at all 19 years after completion.

4.Resistivity to the salt permeability

A test result of a pore size distribution measured by the mercury porosimetry has also confirmed that the accumulated pore volume of concrete mixed with SILICA WHITE has improved 133% compared to general purpose concrete and the mixed concrete has high resistivity against chloride penetration.

5.Freeze-thaw

Freezing and thawing test of concrete with SILICA WHITE has proved high relative dynamic elastic coefficient. The mass change after 300 cycles is 100～97.8% and the average is 2.2% relative dynamic elastic coefficient is 96.7%.

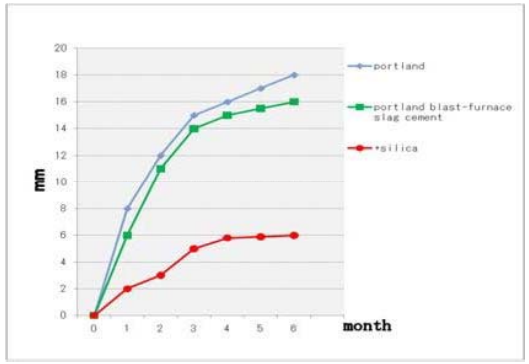
6.Abrasion resistance

Abrasion coefficient of concrete with SILICA WHITE is 555.4mm³/cm³ which evidences high abrasion resistance.

7.Acid resistance

Comparison test of mass decrease in 5% sulfuric acid shows that concrete mixed with SILICA WHITE.
(20% of cement volume) has significant acid resistance.

SALT RESISTANCE



mm		8	12	15	16	17	18
		6	11	14	15	16	16
		2	3	5	6	6	6
		1	2	3	4	5	6

Month

Examples of construction in Japan

「Po-Po ２６０°」 Ocean amenity facility in Abashiri Port

Project entity: Ministry of Land, Infrastructure, Transport and

Completed: 1994
Photo: 2012 20 years old

Application purpose of SILICA WHITE
:salt resistance and Protection against surface deterioration

SILCA WHITE mixed quantity : 40kg/1㎥

Concrete without SILICA WHITE needs to be repaired from time to time.

RA9-13

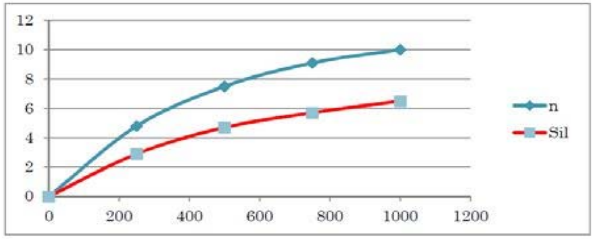
ABRASION RESISTANCE TEST DATA

6. Abrasion resistance test

Tested abrasion coefficient is 555.4mm³/cm³ which shows high abrasion resistance.

W/C = 40%	250SPINS	500SPINS	750SPINS	1000SPINS
1:2 MORTAR	4.8g	7.5g	9.1g	10g
1:2 MORTAR Silica White (10%)	2.9g	4.7g	5.7g	6.5g

Abrasion tester (testing by weight loss)



SAPPORO sidewalk under the ground (2011)

An underground passage from Sapporo Station down to central area of the city.
520m long and 150,000 people walk there every day.

Application purpose of SILICA WHITE: Surface abrasion

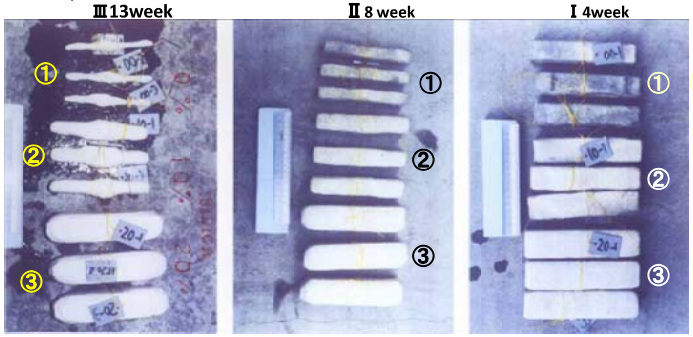
Acid resistance test

MIXING

Test item	W/C (%)	No.	MIXING(g)				SLUMP FLOW
			cement	silica	water	sand	
SILICA WHITE	65	Ⅰ	520	0	338	1040	242
		Ⅱ	468	10%	338	1040	245
		Ⅲ	416	20%	338	1040	246

results photos

Ⅲ13week　Ⅱ 8 week　Ⅰ 4week



MIXING PROCEDURE OF SILICA WHITE

◇PROCEDURE

① MIX FINE AGGREGATE AND SILICA WHITE
② MIX CEMENT
③ MIX COARSE AGGREAGATE AND MIX DRY
④ ADD WATER AND AE WATER REDUCING AGENT AND MIX TEHM

◇MIXING AMOUNT

MIXING AMOUNT OF SILICA CEMENT DEPENDS UPON THE USAGE. (ratio by weight)

Super Structure Concrete (Above Ground)	3～10～20% of the amount of cement
Sub Structure Concrete(Under Ground)	5 - 10% of the amount of cement
With Cement Mortar	10 - 20% of the amount of cement
With Cement Mortar	3 - 10% of the amount of cement
Hard Concrete - No slump	More than 7% of the amount of cement
Marine Structure (Under Water)	10 - 20% of the amount of cement

LIST OF TEST RESULTS OF CONCRETE WITH
SILICA WHITE FROM SILICA JAPAN INC.

In Japan, concrete factory is obliged to get the apporval from JIS (Japan Industrial Standard) and the concrete only from such factories can be used for constructions. If mixing design of the concrete is set at 24N, the concrete over 27N by adding 3N at 56 days' test can be used for buildings, facilities and workpieces. If the finished concrete is 26N and below, it must be reeinforced or destroyed. There is a very strict regulation for the production of normal concrete in Japan. So there is no data of normal concrete in this list.

international standard today. The function of water reducing agent and cement admixture is completely different. We use the concrete with the strength of 18N, 21N, 24N, 27N for low-rise buildings, 30N to 50N for high-rise buildings and 50N to 150N for superhigh-rise buildings. Slump test proves the quality of the concrete. If it is too big, quality of the concrete can be poor. Though there is a difference in the usage of the concrete such as buildigs and civil engenieering, the slump is set at 8 to 21cm. Slump test is performed by using test mixer (60L). There are some data which do not show the volume of each materials when 1㎥ is converted to 60L.

QUALITY ASSURANCE

PRODUCT:「SILICA WHITE」
①QUANTITY : 20kg/1BAG
②PACKAGE: IN PAPER BAG

QUALITY ASSURANCE PERIOD:
5 ～ 7 YEARS AFTER THE PRODUCTION DATE

STORAGE CONDITIONS:
① THE PRODUCT SHOULD BE SOTRED IN ROOFED WAREHOUSE
② THE WAREHOUSE SHOULD NOT HAVE MOSITURE
③ THE WAREHOUSE SHOULD BE SUFFICIENTLY DRY
④ THE BAGS SHOULD NOT BE STACKED MORE THAN 15 LAYERS AND KEEP
STUFF OFF THE TOP

WE CAN NOT GUARANTEE THE QUALITY ASSURANCE PERIOD IF THE BAGS ARE NOT STORED AS INSTRUCTED ABOVE

CONCRETE REPAIR MATERIAL WATER PROOF, PREMIXED MORTAR

SILICA ROC MORTAR

YOU ONLY HAVE TO POUR WATER

SILICA ROC MORTAR IS A PREMIXED MORTAR OF
FINE POWDER OF SILICA-WHITE (FINER THAN CEMENT PARTICLES)CEMENT AND SPECIAL AGGREGATE,
THIS PRODUCT HAS BEEN DEVELOPED AS AN ALTERNATIVE TO RESIN MORTAR
FOR BETTER QUALITY CONTROL OF CONCRETE AND FOR AVOIDING POSSIBLE WRONG MIX PROPORTION,
BY MIXING WITH WATER YOU CAN HAVE EASILY WATERPROOF ANTI-EFFLORESCENT WATER TIGHT AND STRONG MORTAR WITH HIGH WORKABILITY AND LES SHRINKAGE CRACKS.

RAW MATERIALS

CEMENT, SIZE-CONTROLED SAND, CHEMICAL AGENTS, SILICA WHITE
IN A MOISTUREPROOF BAG (20KG)

APPLICATION SAMPLES:

- FOR REPAIR PURPOSES SUCH AS : SEPARATER, ROCK POCKET, CONCRETE JOINT,
WINDOW FRAME FILLER
- FOR PLASTER WORKS SUCH AS : BLOCKS, BRICKS, BUILDING STONES, TILES ETC

MAJOR CHARACTERISTICS

PREMIXED MORTAR: HIGH WORKABILITY WITH SIMPLY MIXING WITH WATER. NO WRONG MIX PROPORTION AND EXECUTION ERROR ANY MORE
ANTI-EFFLORESCENT: BY USING SILICA-WHITE AND SPECIAL ADMIXTURE IT REDUCES
THE RISK OF EFFLORESCENT, CRACKS AND SEPARATON DRAMATICALLY
WATERPROOF: THE COMBINATION OF SILICA-WHITE AND SPECIAL ADMIXTURE REALIZES
HIGH DENSE CONCRETE THAT GETS WATERPROOF AFTER HARDENING

SILICA ROCK MORTAR CHEMICAL COMPOSITION

Item	Mixing Weight (kg)	Mixing rate (%)
Cement	7.00	34.8779
Quartz sand	10.00	49.8256
Silica cement	3.00	14.9477
Metolose	0.01	0.0498
Stearic acid	0.06	0.2990
TOTAL	20.07	100.000

Quartz sand : http://en.wikipedia.org/wiki/Quartz
Metolose : http://www.metolose.jp/e/industrial/index.shtml
Stearic acid : http://en.wikipedia.org/wiki/Stearic_acid

How to use : 1. mix it with water of 3 to 5% of cement volume.
2. adjust the hardness for the best workability.

開発コンセプト

昭和電工株式会社

寒冷地におけるコンクリート修復

○凍害だけでなく、塩害（融雪剤）等の要因も加わり他の地域より劣化進行が速い
○既存修復材料（ﾎﾟﾘﾏｰｾﾒﾝﾄ、ｴﾎﾟｷｼ材料)は、5℃未満の環境下では硬化が遅れる
また粘度上昇により作業性が低下する
○5℃未満の環境での施工は、給熱養生が必要 （工期延長、施工費のUP）

⇩ 弊社保有技術で改善提案可能

①樹脂設計技術
②低温硬化技術
③樹脂モルタル配合技術
} 寒冷地仕様 コンクリート修復材

寒冷地仕様ひび割れ注入材 リポキシ®CR-1500

昭和電工株式会社

【特長】
低温速硬化性、高密着性、低臭気、低粘度
NETIS登録済み（KT-170019-A）
【適用箇所】
凍害、塩害等で劣化したコンクリートのひび割れ補修

グレード		1500-1	1500-2	1500-3	既存エポキシ（冬用）
施工推奨温度		-10℃～5℃			5℃～20℃
可使時間(5℃)		45分			1日以上
粘度※ (mPa･s)	(23℃)	60	50	110	480
	(5℃)	270	190	340	4090
伸び率		50%	8%	168%	9%
判定(社内評価)		**1種相当**		**3種相当**	**1種**

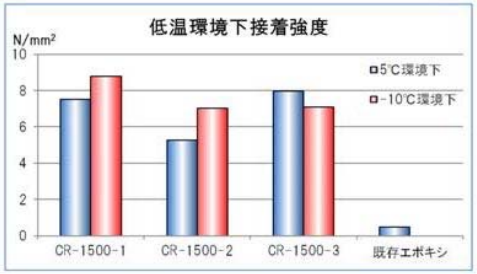
※混合後粘度 弊社実測値

寒冷地仕様ひび割れ注入材 リポキシ®CR-1500

【接着試験】

クリアランス 1mmのコンクリートクラックに対し、
5℃、-10℃雰囲気下で樹脂を注入して硬化。
24時間養生後、モルタルの4点曲げ試験実施。

写真：JIS規定 ひび割れ接着試験体



既存エポキシに比べて、短時間に強度発現！

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施工の流れ

昭和電工株式会社


施工面の処理


座金の設置、シール塗布


樹脂、硬化剤の計量


樹脂、硬化剤の混合


注入材の注入


座金・シールの撤去

試験施工事例2

昭和電工株式会社

施工場所：福島県　施工時期：1月　気温　-5～0℃

橋梁側面　全5箇所

低圧注入にて実施

ひび割れへの注入を確認

寒冷地仕様断面修復材　ショウリペア®CR-1000

昭和電工株式会社

【特長】

低温速硬化性、高強度、高密着性、低臭気

NETIS登録済み（KT-160146-A）

【適用箇所】

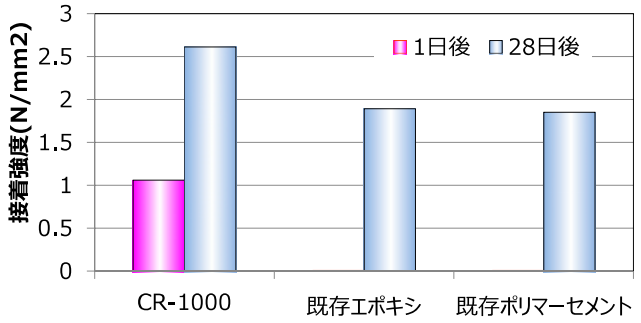
凍害、塩害等で劣化したコンクリートの補修

樹脂グレード	CR-1000-1	CR-1000-2	CR-1000-3
作業推奨温度	-25～-10℃	-10～5℃	-10～5℃
推奨厚み	10mm以下	10mm以下	20mm以下
可使時間	200分～60分	270～60分	270～45分
圧縮強度(N/mm²)	60以上	60以上	50以上
接着強度(N/mm²)	2.5以上		
温冷繰り返し試験	10サイクル異常なし		

ショウリペア®CR-1000　硬化性

昭和電工株式会社

冷熱サイクル養生での接着力変化



試験環境　：　−40℃~23℃/1日×28日（於 サイクル室）
作製条件：5℃塗工　⇒　硬化養生−40℃×16時間
材料養生：比較材料は20℃養生品

CR-1000は速硬化性、耐久性に優れる

ショウリペア®CR-1000　試験施工事例

昭和電工株式会社

○試験条件
・施工場所：福島県
　　橋梁裏天井面
・施工時期：1月
・施工時温度：-5℃
・施工面積：300×200×15mm
・表面処理：チッピングによる表面粗し
・硬化時間：約60分、1回打設

浮き、亀裂、剥離等なし