Smart City Development

Seoul Institute of Technology

Smart Management Technology for Infra Structures

Topic 1 Smart Monitoring & Management ; Bridges

Topic 2 Smart O&M Method for Buried Pipes

Topic 3 Water Management

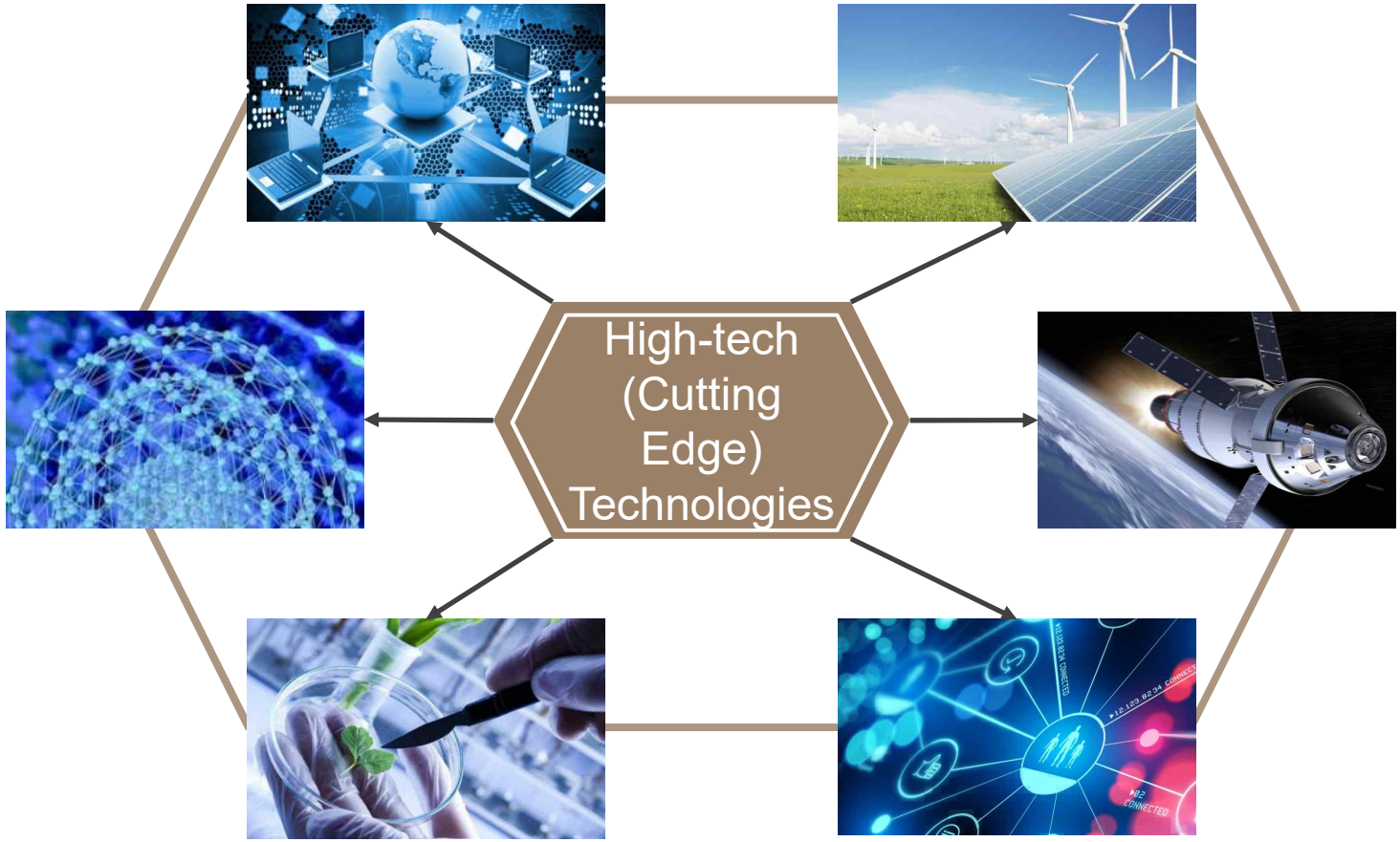
2019.10.17

KEESEI LEE, Ph.D

Introduction

Infra Structure and Development

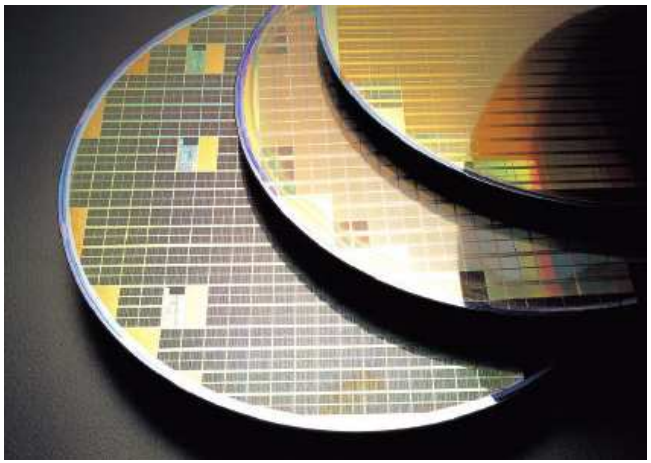
The 4th Industrial Revolution



Introduction

Infra Structure and Developement

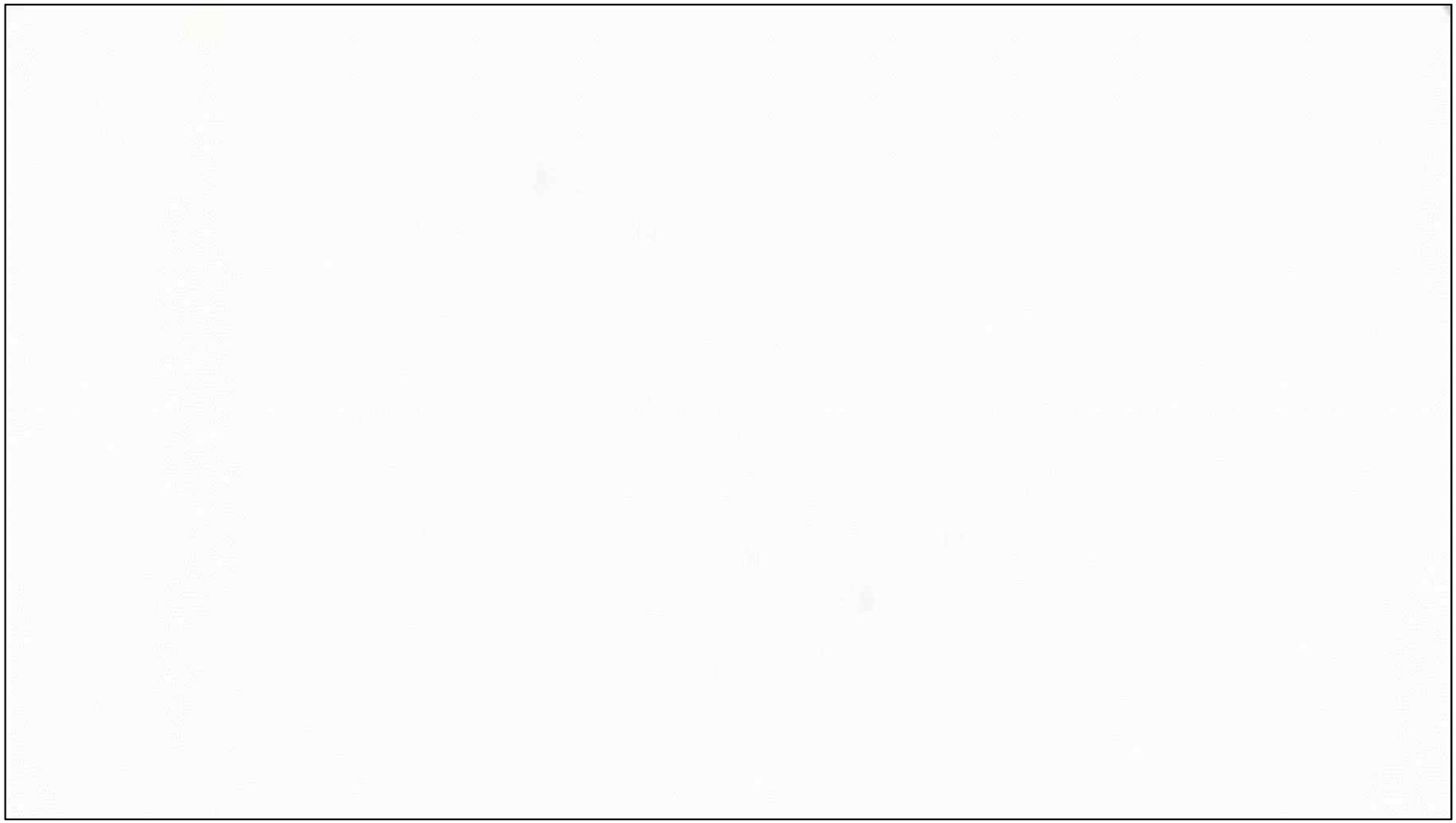
Which picture best describe the developed countries?



Introduction

Infra Structure and Developement

Construction Tech-Modular Structure in China(2011.12.31)

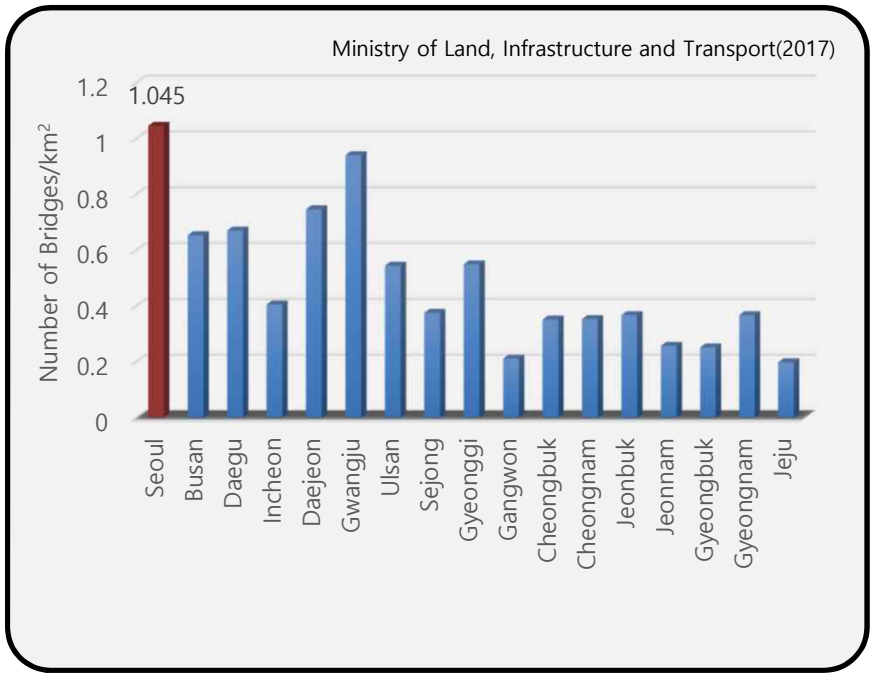


Introduction

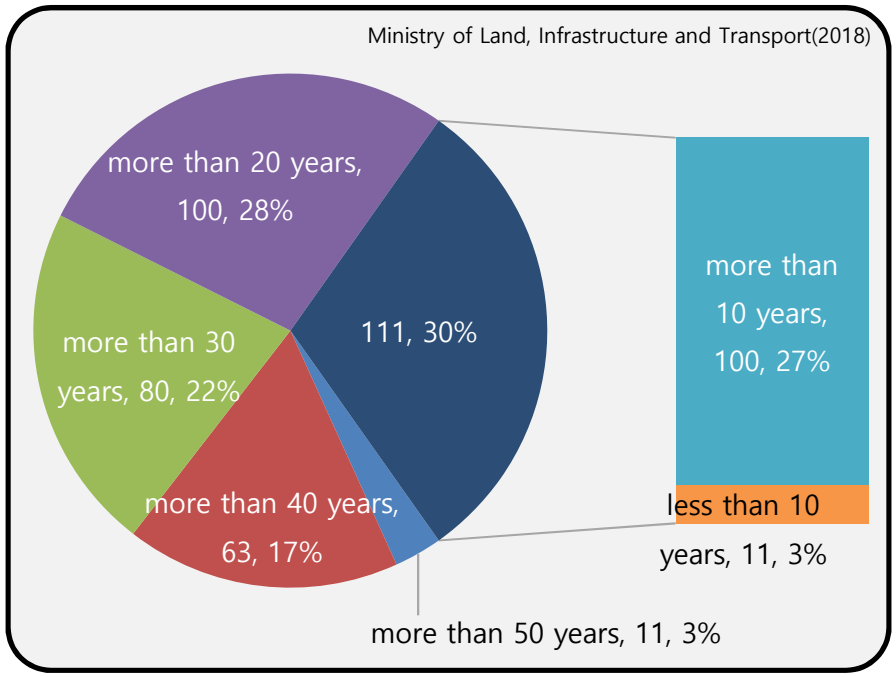
Structure Maintenance

Bridges in Seoul

▪ Bridge distribution



▪ Service life of bridges in Seoul

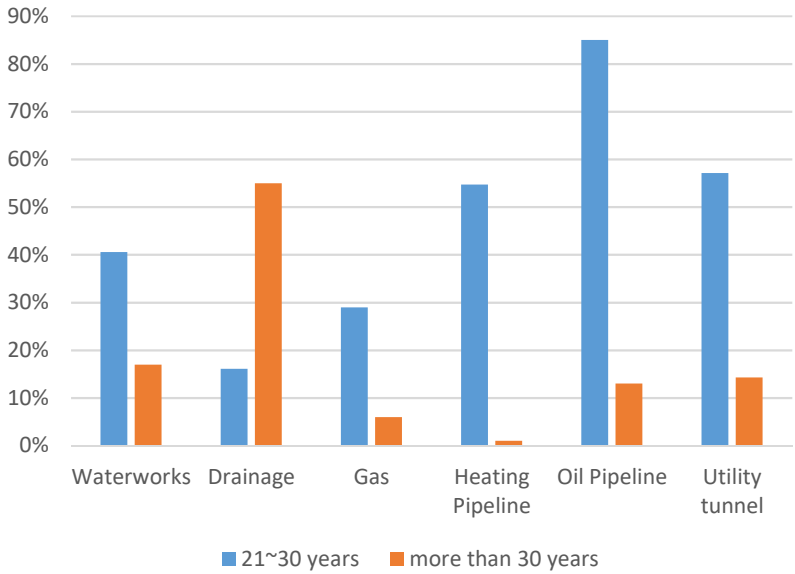


- Average bridge construction growth rate for recent 10 years : 3.03% (※Ministry of Land, Infrastructure and Transport, 2018)
- Depreciation rate of a bridge structure : Approximately 2~2.5% (※Expected service life of a bridge ≈ 40~50 years)

Introduction

Structure Maintenance

Buried Pipes in Seoul



(km)	Waterworks	Drainage	Gas	Heating Pipeline	Utility tunnel
Length	13898	1533	15235	1103	69

Presentation Contents

Smart Management System

Topic 1

Smart Monitoring & Management; Bridges

Topic 2

Smart O&M Method for Buried Pipes

Topic 3

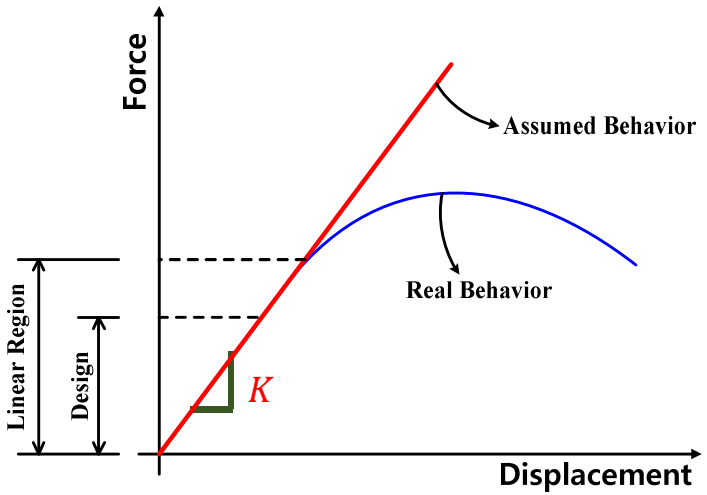
Water Management

Smart Monitoring & Management; Bridges

Structure Health Monitoring with Smart Sensor

SHM based on displacement data

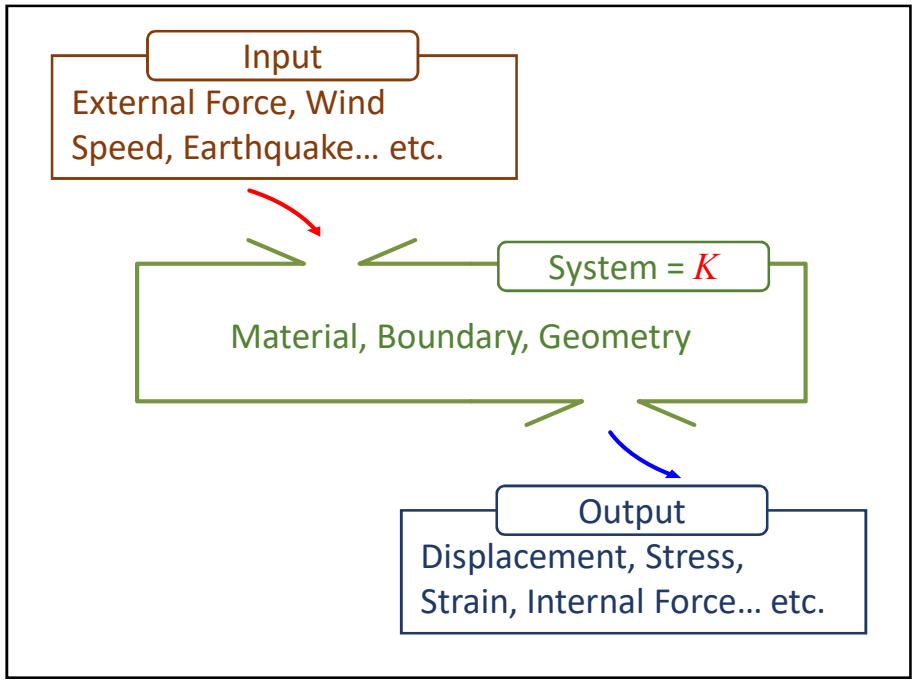
- Structural Behavior



$$Force = K \times Displacement$$

Stiffness ;
Relationship between
Input and Output

- Structural Analysis

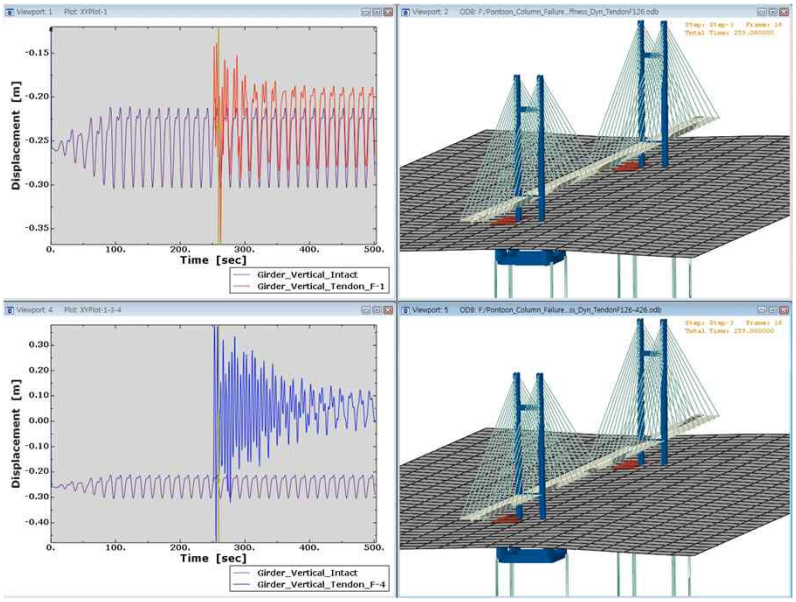


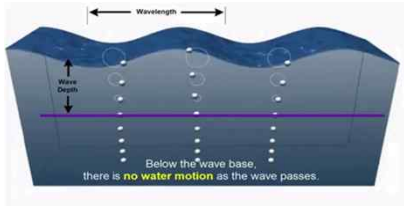
Smart Monitoring & Management; Bridges

Structure Health Monitoring with Smart Sensor

SHM based on displacement data

- Example : Structural Analysis





$$Force = K \times Displacement$$

Known — Unknown

$$Displacement = \frac{Force}{K}$$

Can be Calculated — Known

Objectives :

To know the displacement of a structure with given force & system.

Structure Health Monitoring

$$Force = K \times Displacement$$

Should be Calculated — Known

Objectives :

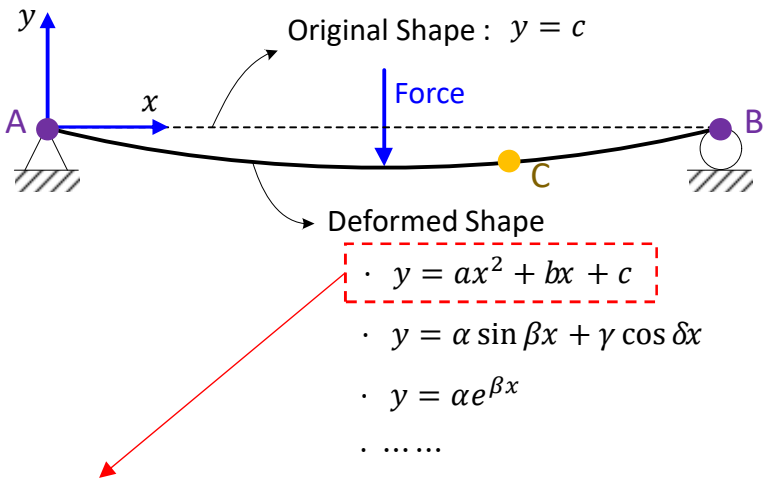
To know the internal force of a structure based on the deflection of structure

Smart Monitoring & Management; Bridges

Structure Health Monitoring with Smart Sensor

SHM based on displacement data

- SHM Concept



We need at least 3 points to evaluate constants a, b and c.

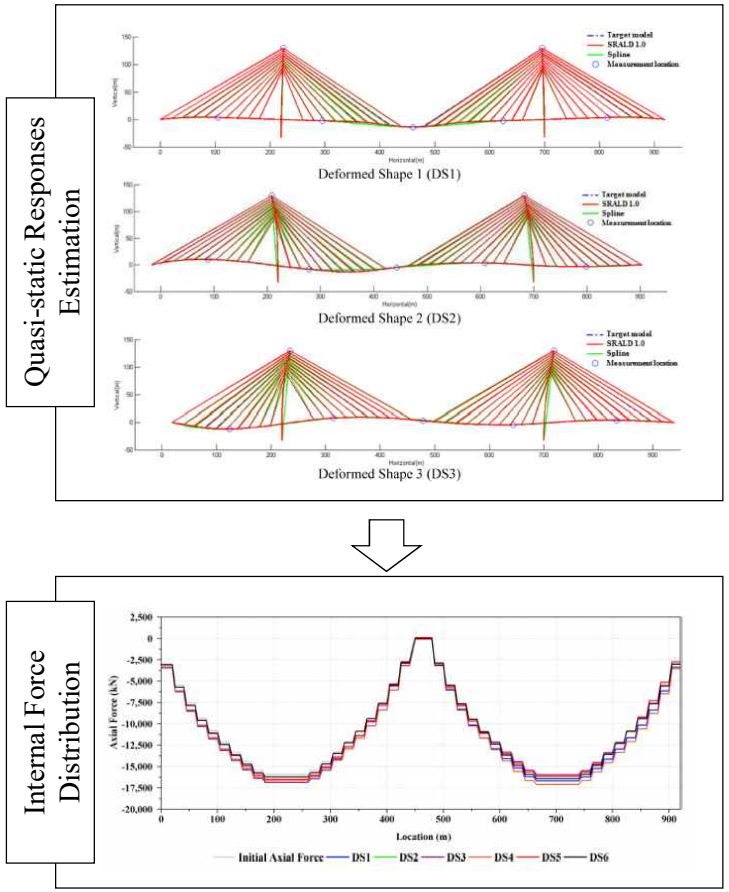
Point A & B : known (boundary condition)

Point C should be obtained.

$$Force = K \times Displacement$$

Unknown — Known

- SHM Based on Real Displacement



Smart Monitoring & Management; Bridges

Structure Health Monitoring with Smart Sensor

SHM based on displacement data

- How to obtain the displacement we need

tiltmeter

accelerometer

GPS

- What kind of technology do we need for “Smart SHM”?
  1. Solution
  2. Means for measurement
  3. Maintenance of sensors

- Future work…
  1. Affordable sensors
  2. Accuracy of data and solution

Smart Monitoring & Management; Bridges

Facility Management System (For Bridges)

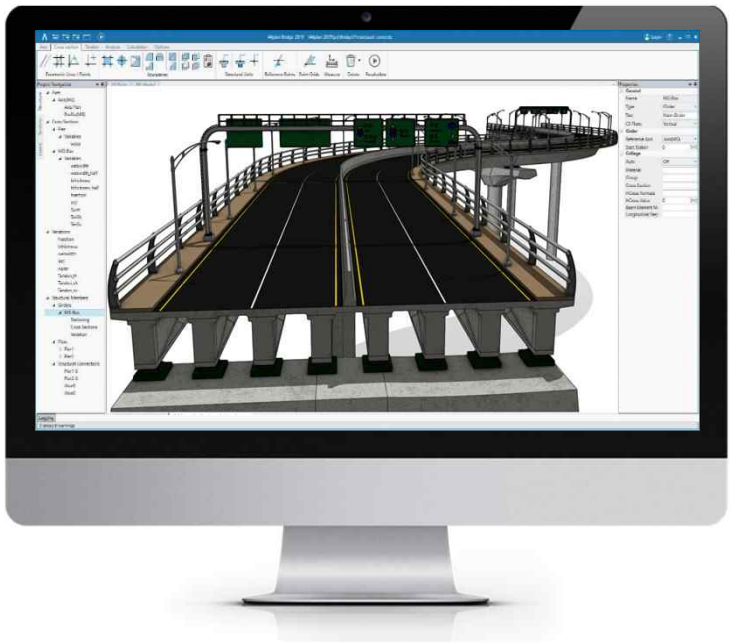
Building Information Modeling(BIM)

As is

FMS : Korea Infrastructure Safety Corporation

3D Model

To be



- Data Library Type Management System
  - O&M History
  - Facility Properties

Too complex to use
Prone to lose data
Poor condition of data

- + Graphical Model

User friendly
Easy data management
Excellent compatibility

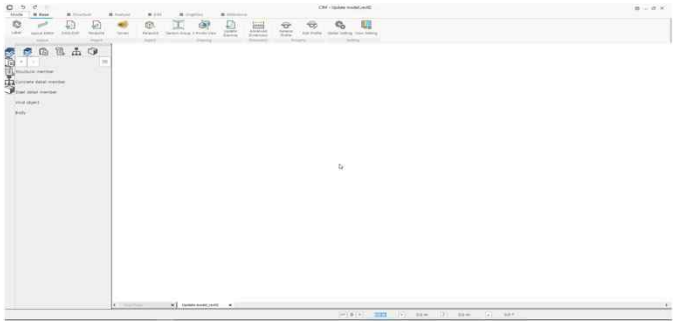
Smart Monitoring & Management; Bridges

» Facility Management System (For Bridges)

3D Modeling Technique for Advanced FMS

Present

3D Model based on 2D Drawing



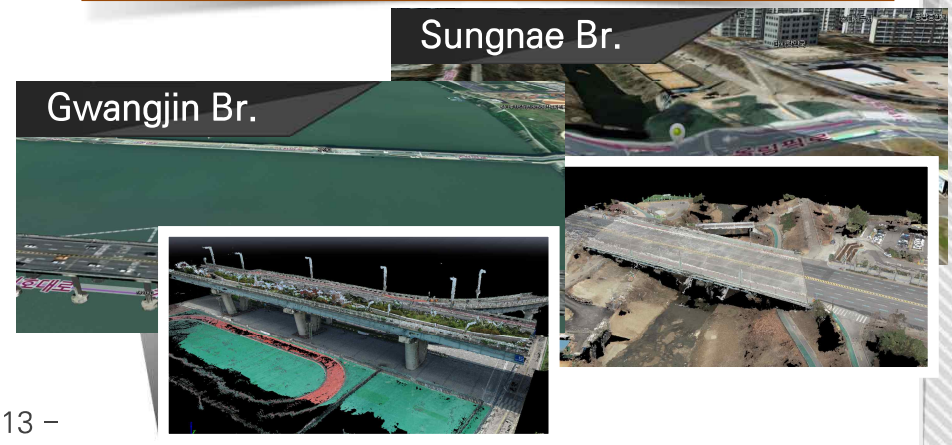
- Time consuming work
- Impossible without 2D drawing

Vision

Using UAV(Drone)

- Applicable for any structures
- Reflects real condition of structures

- 2D drawings have been lost
- Drones can be used for 3D Modeling



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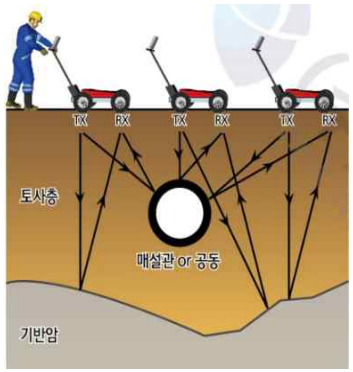
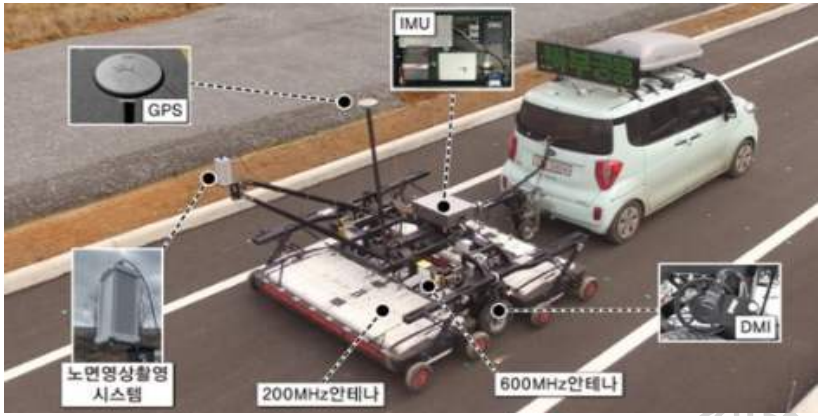
Water Management

Smart O&M Method for Buried Pipes

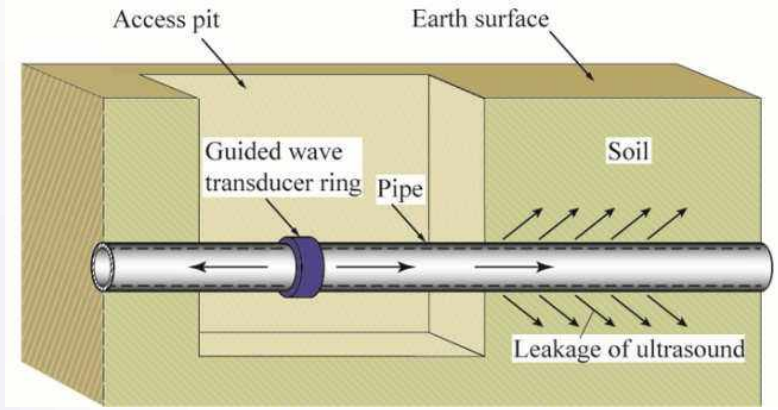
Leak Detection Technology

Ground Penetrating Rader; GPR





Guided Wave



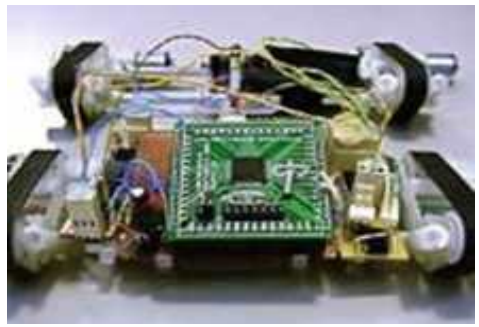
※ Imperial College London : http://www.imperial.ac.uk/non-destructive-evaluation/research/inspection-and-monitoring/improved-guided-wave-inspection-of-buried-and-coated-structures-/

Smart O&M Method for Buried Pipes

Leak Detection Technology

Inspection Robot

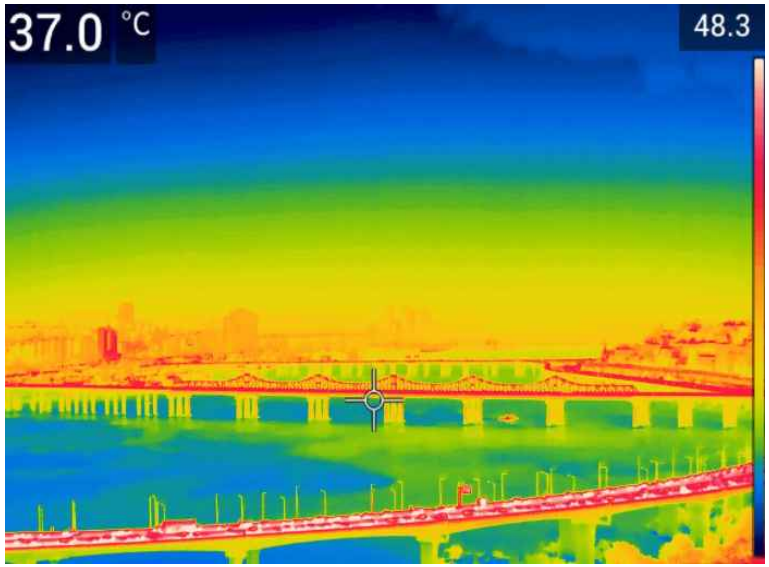
Youtube : Tracked mobile robot for pipeline inspection with and active adaptation system



Smart O&M Method for Buried Pipes

Leak Detection Technology

UAV(Drone) with Thermal Imaging Camera



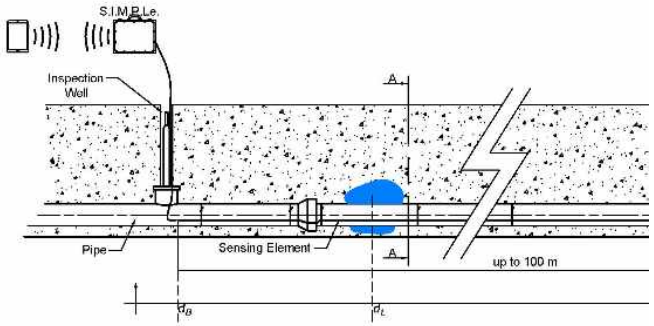
Youtube : Leak seeker: Anglian Water using drones to find broken pipes

Smart O&M Method for Buried Pipes

Leak Detection Technology

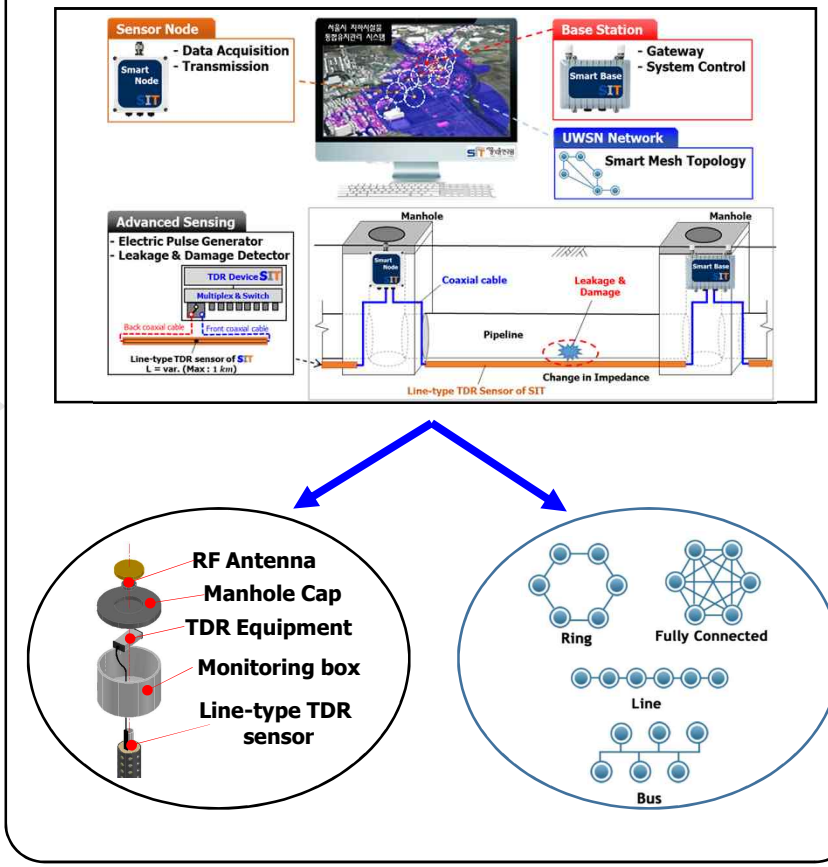
Time Domain Reflectometer; TDR

Inspection by TDR



※ MoniTech : http://www.monitechsrl.it/eng-ENG/?p=55

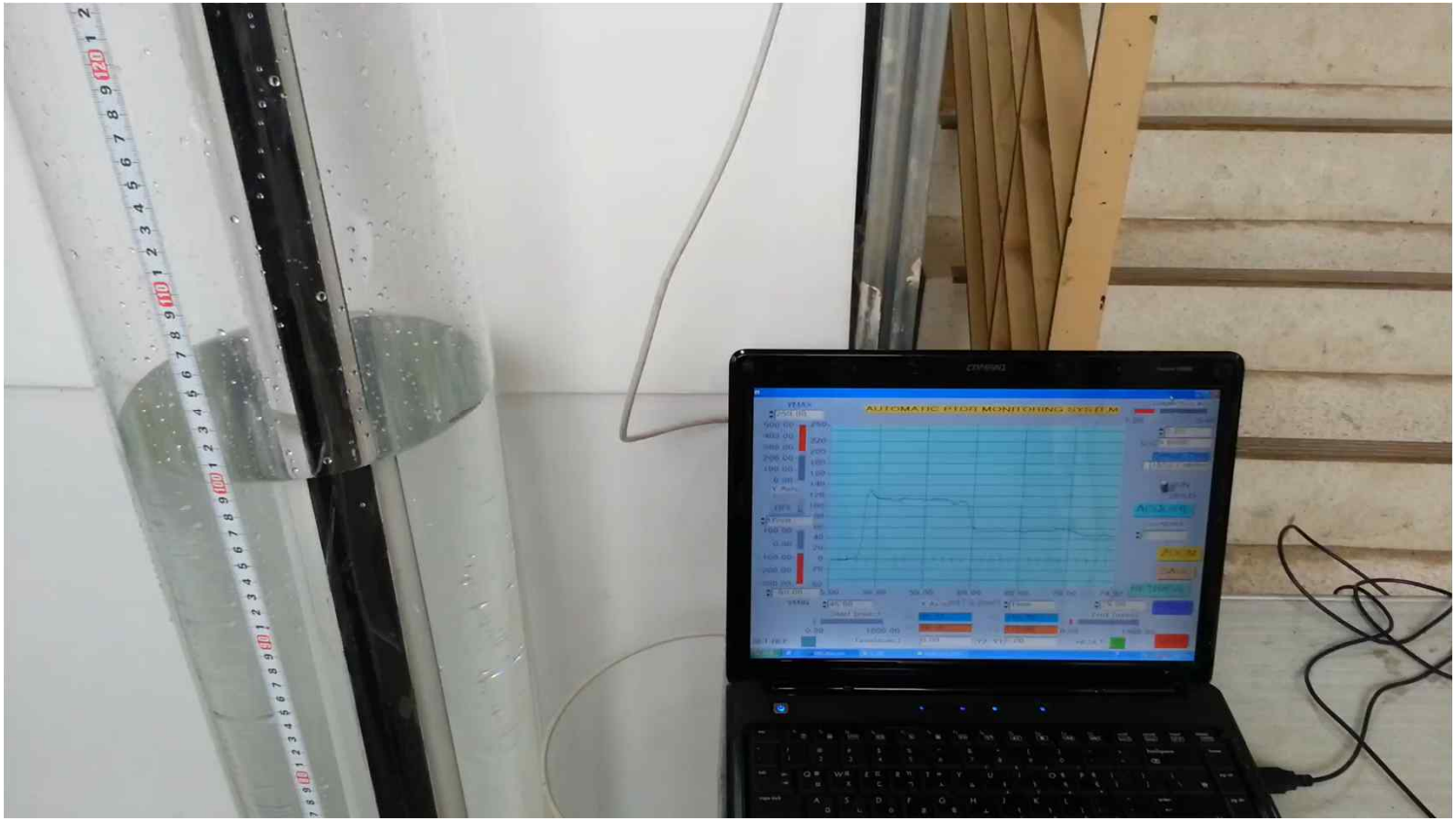
Smart Monitoring System



Smart O&M Method for Buried Pipes

Leak Detection Technology

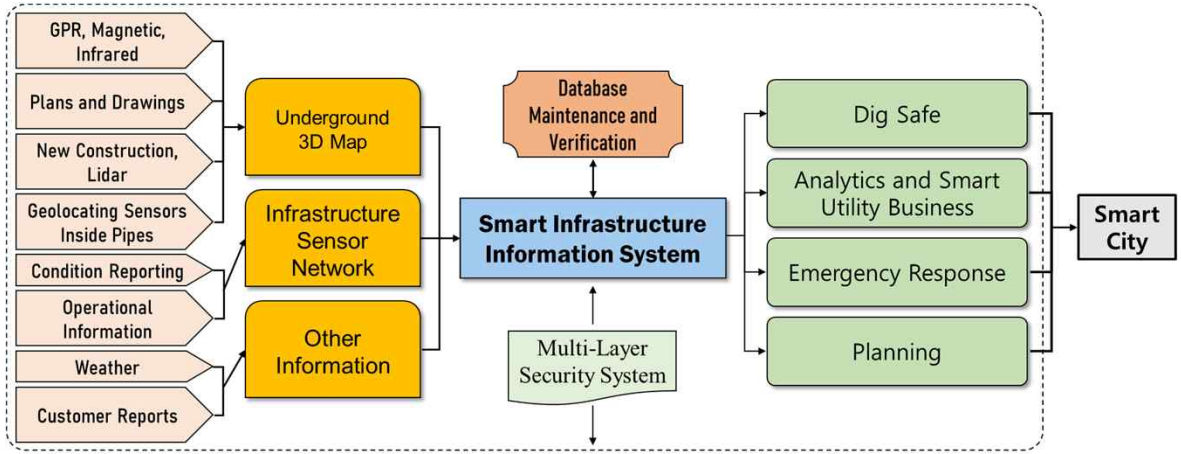
Time Domain Reflectometer; TDR



Smart O&M Method for Buried Pipes

Smart Management System

Integrated Management System



3D Map of buried pipes

Augmented Reality

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Water Managment

Water Managment

Smart Technology for Water Management

Flow Rate Measurement

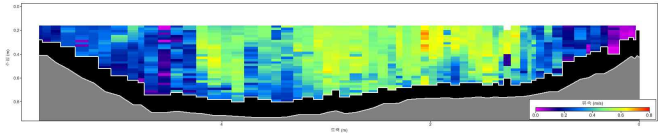
- Seoul suffer form frequent flood
- In order to control the water flow, outflow should be measured accurately.
- It's not easy to obtain accurate data because of climate change these days.
- Need to develop smart, safe and accurate measurement methods.

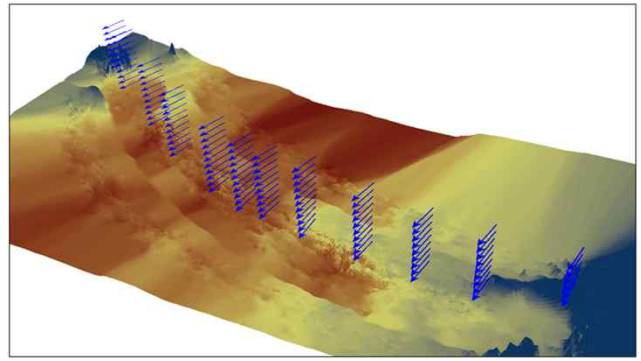
Water Managment

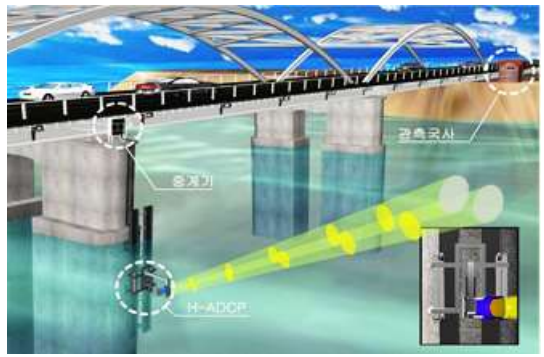
Smart Technology for Water Management

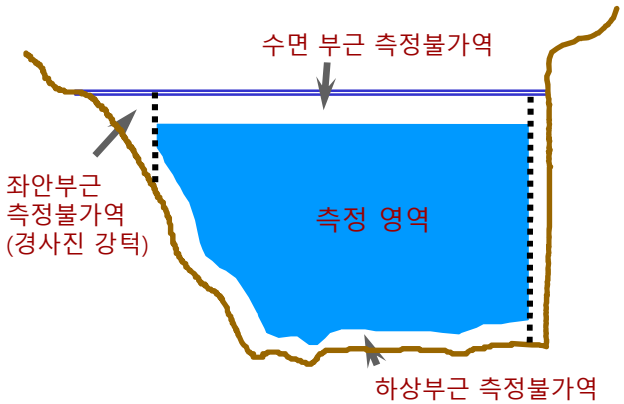
Flow Rate Measurement

- Ultrasonic is used
- Unmanned ship is applicable
- Velocity and flow can be simultaneously obtained.
- Cannot be applied to shallow water
- River bed cannot be obtained because of interference.





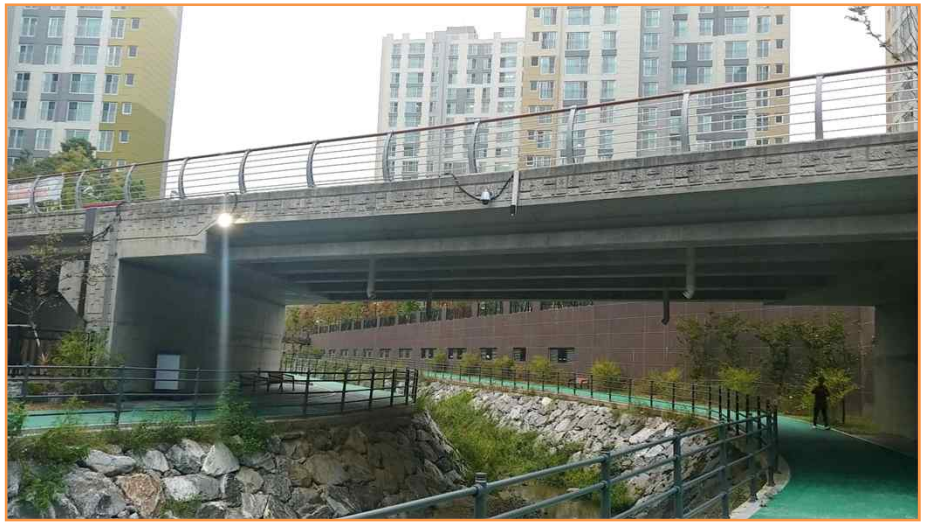




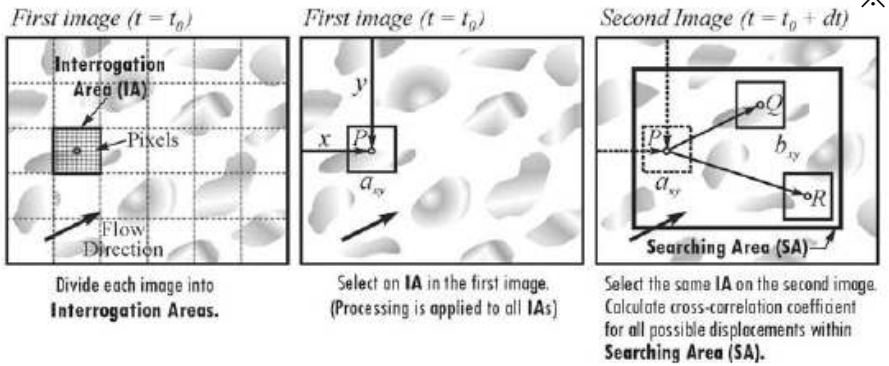
Water Managment

Smart Technology for Water Management

Flow Rate Measurement



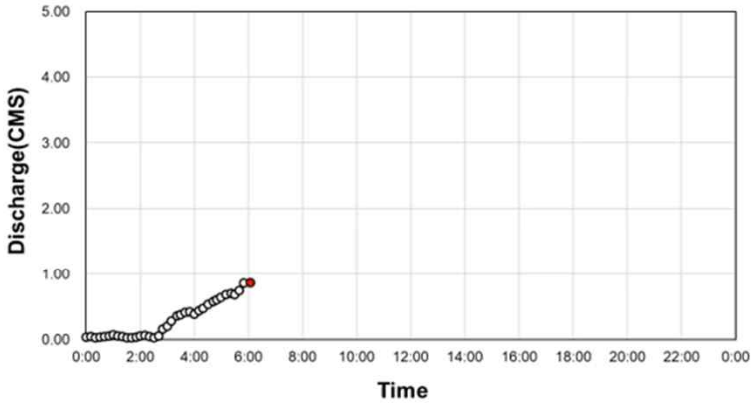
※ Neokmak River, Yongin, Gyeonggido, Korea.

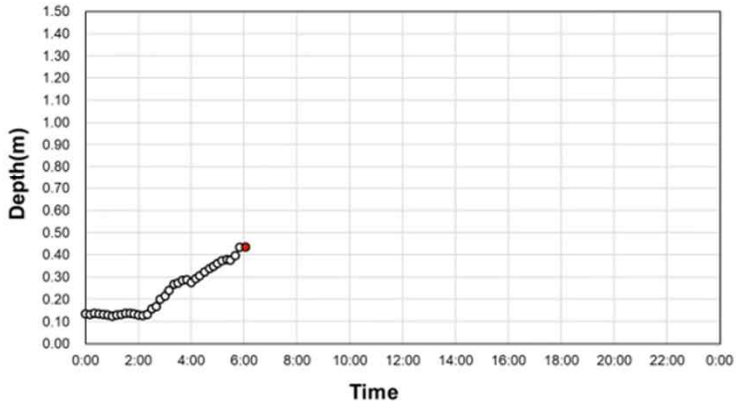


Water Managment

Smart Technology for Water Management

Flow Rate Measurement





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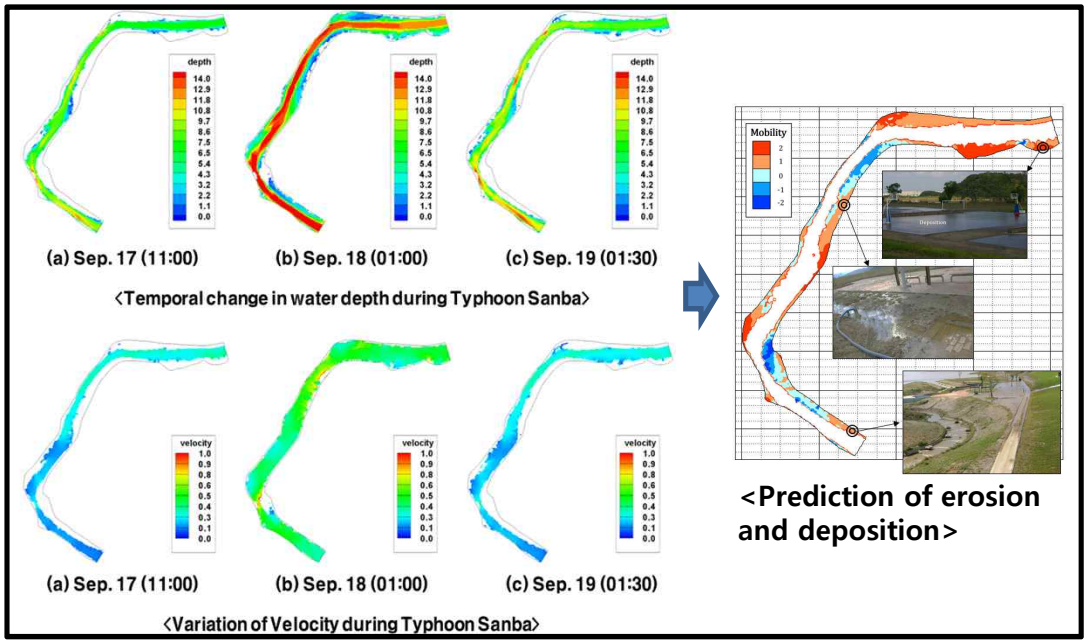
국립재난안전연구원

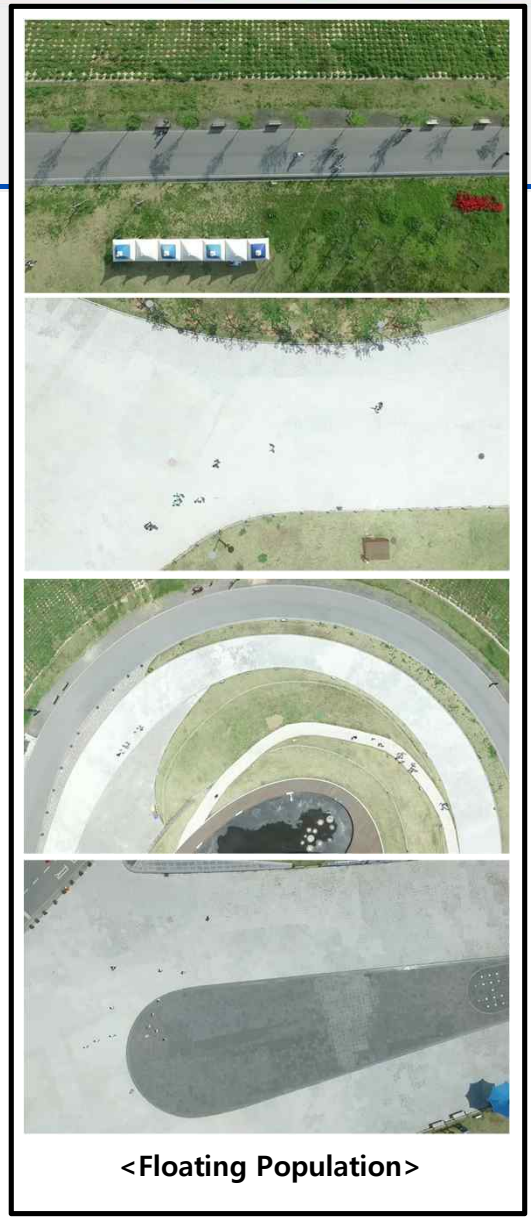
Water Managment

» Smart Technology for Water Management

Riverfront Facility Stability



※ Y.D.Kim et al., Seoul National University, Advanced Research for River Operation and Management



Conclusion Remarks

Summary

- Seoul has been (rapidly) developed during last 50 years, and infrastructures have played much of a role
- Major cities in the world are saturated with buildings, roads, bridges and other facilities.
- Almost structures were designed and constructed with (approximately) 50 years of expected service life, and have became superannuated.
- O&M is more important than construction in these days.
- In order to develop efficient (and accurate) management system, more than 2 major techniques are necessary
- (Integrated) Management system seldom give us visible benefits such as construction or remodeling. However, it give us a great advantage in the view point of asset management.
- The benefit of well-organized infrastructure management system will be recognized after 3~5 years.