Bridge Management

Yoshihiko Ueno

Self-introduction

【Birthplace】 Koyama City, Tochigi Prefecture

【Career】 Bridge manufacturer ⇒ Construction consultant ⇒ National research institute⇒South Korea Daegu-Pusan Expressway PFI project manager ⇒ Non-destructive Testing Company executive 、 Foreign-affiliated consulting advisor⇒Toyama City manager⇒Toyama City Superintendent General, retired in 2019

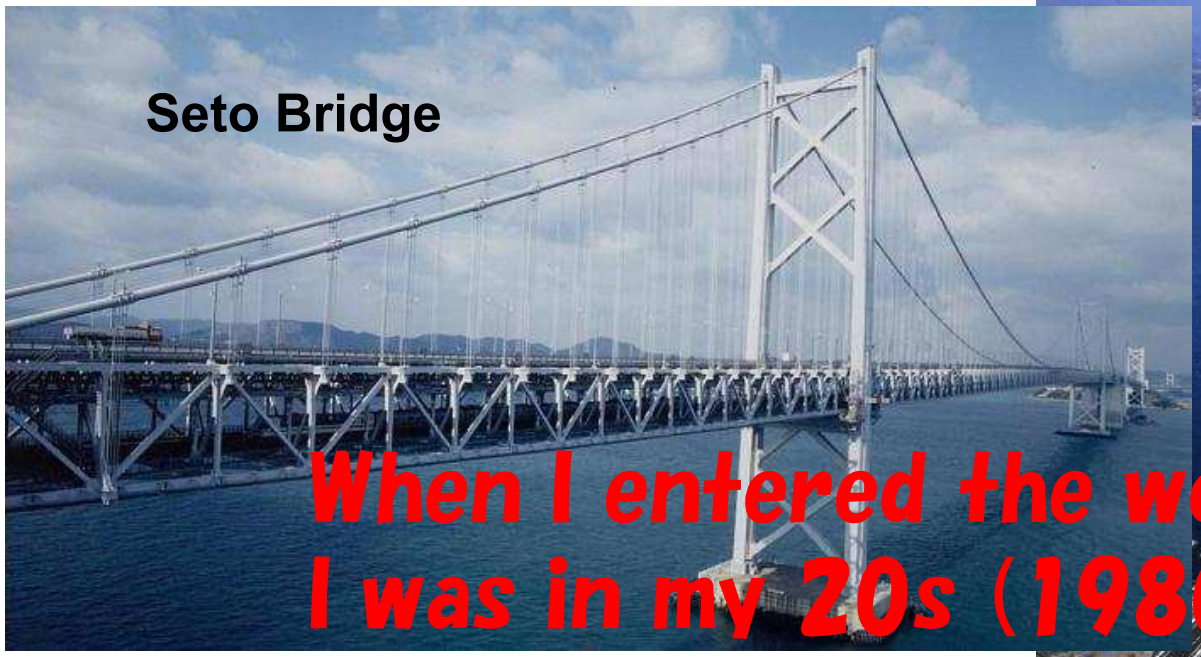
【Current position】 Policy Advisor for Toyama City, Representative of Ueno Infrastructure Management Office and Visiting Professor, Kanazawa Institute of Technology Ministry of Land, Infrastructure, Transport and Tourism

- Member of the Regional Infrastructure Regeneration Strategy Management Practice Methods Review Committee
- Member of the Hands-on Support Project Review Committee for the Introduction of New Technologies
- Observer of the Committee to Review Countermeasures in response to large-scale road collapses caused by sewerage systems, etc.

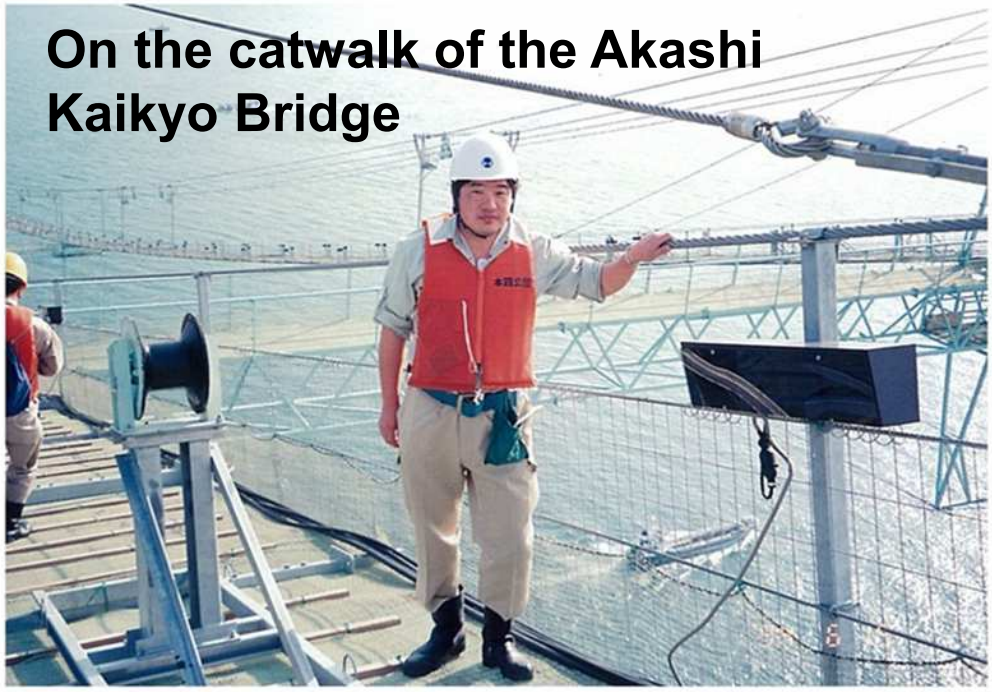
Self-introduction

Specialties: Structural management, standard formulation, structural standardization, PPP/PFI, new technology development (rationalization/automation)

Achievements: Great Seto Bridge, Akashi Kaikyo Bridge, etc.
Seismic resistance (Hyogo Prefecture Southern Earthquake Road Bridge Disaster Countermeasures Committee)
Road bridge specifications
Revision of steel bridge cost estimation system
Steel bridge design guidelines
Standard design for civil engineering structures
New construction technology comprehensive project,
Korea Daegu-Pusan Expressway PFI project



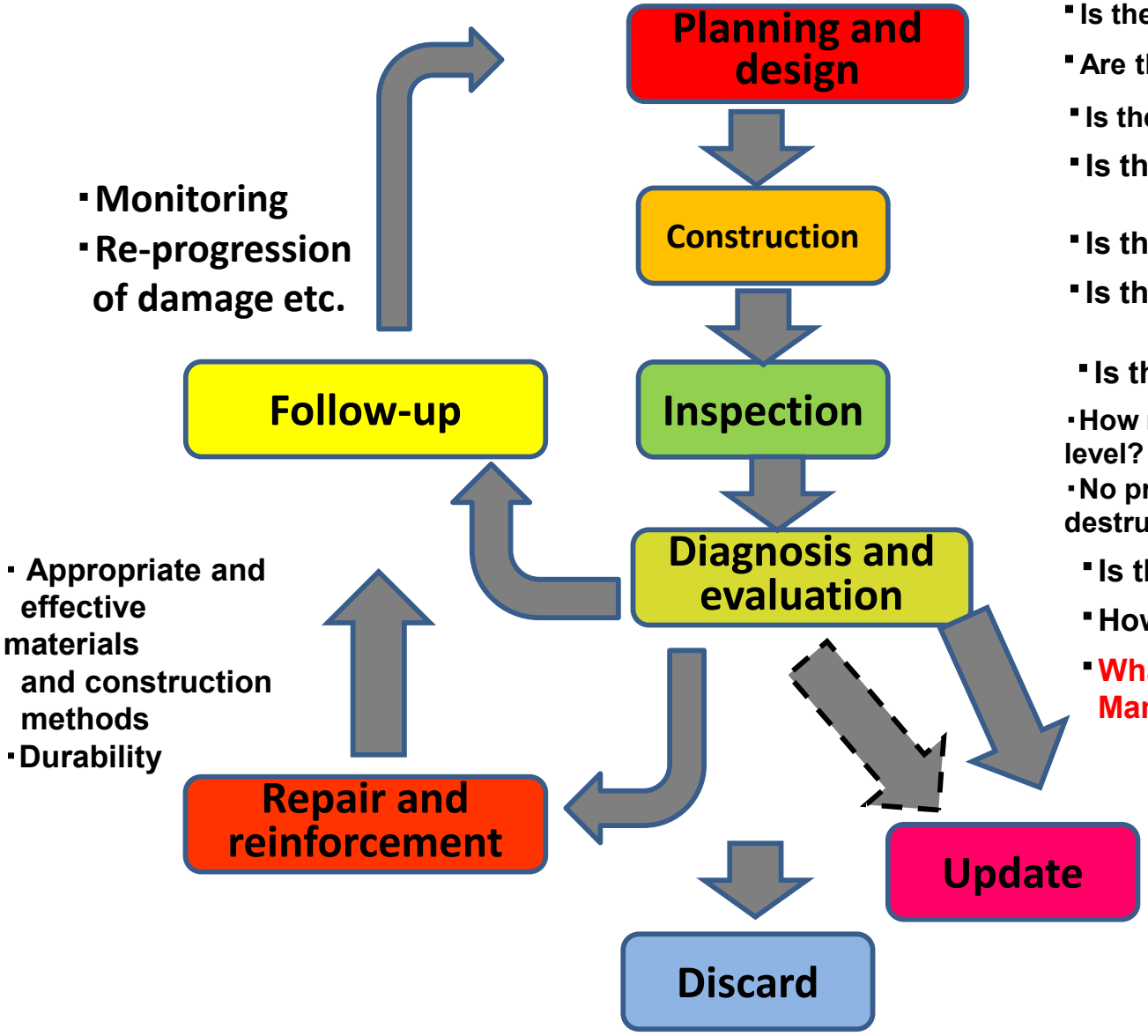
When I entered the workforce,
I was in my 20s (1980s),
which was the "age of building."



“Bridge Management”

Bridges must be planned, designed, and constructed to ensure people's safe and secure lives, and then operated safely while protecting them from disasters and deterioration.
It is also important to assess the current severe financial situation and carry out appropriate management, operation, and replacement.
It is not enough to just protect bridges and structures; we also need to give careful consideration to the sustainability of the country and local governments themselves.

Think about management cycle



- Is the plan and its research sufficient?
- Are the design methods and modeling accurate?
- Is the load-bearing capacity evaluation appropriate?
- Is the structure right?

- Is the construction plan safe?
- Is the construction complete?

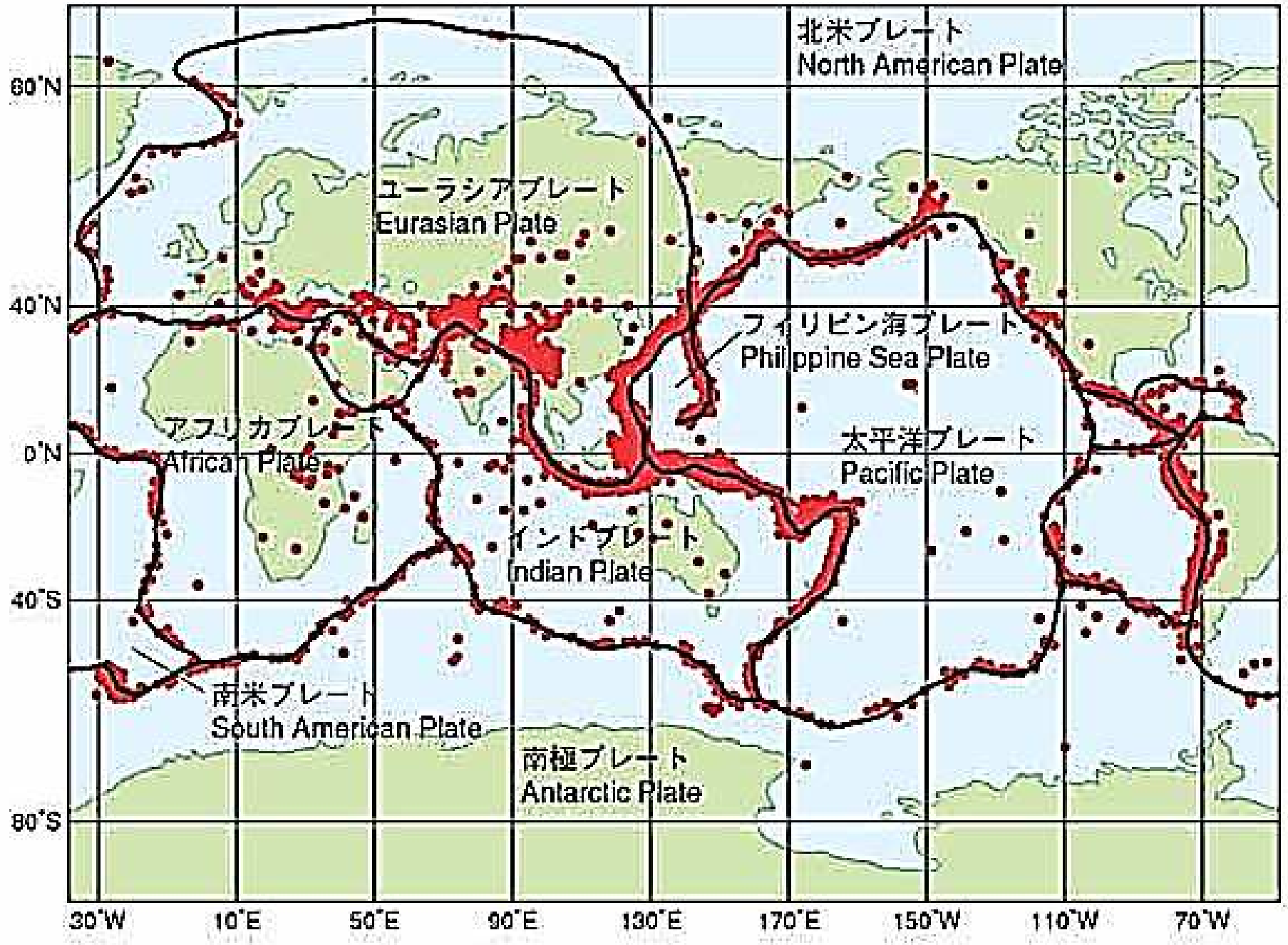
- Is the inspection method reliable?
- How much do you know at the periodic inspection level?
- No proposal for detailed inspection (non-destructive testing)

- Is the diagnosis appropriate?
- How to predict deterioration?
- What is the financial decision? Management

- Updates always occur.
- When should I update?
- Appropriate financial management is necessary.

The need to be aware of management

How will disasters affect you?



注）1991～2001年，マグニチュード5以上，100kmより浅い地震。
資料：アメリカ地質調査所の震源データをもとに気象庁において作成

Earthquake-prone areas

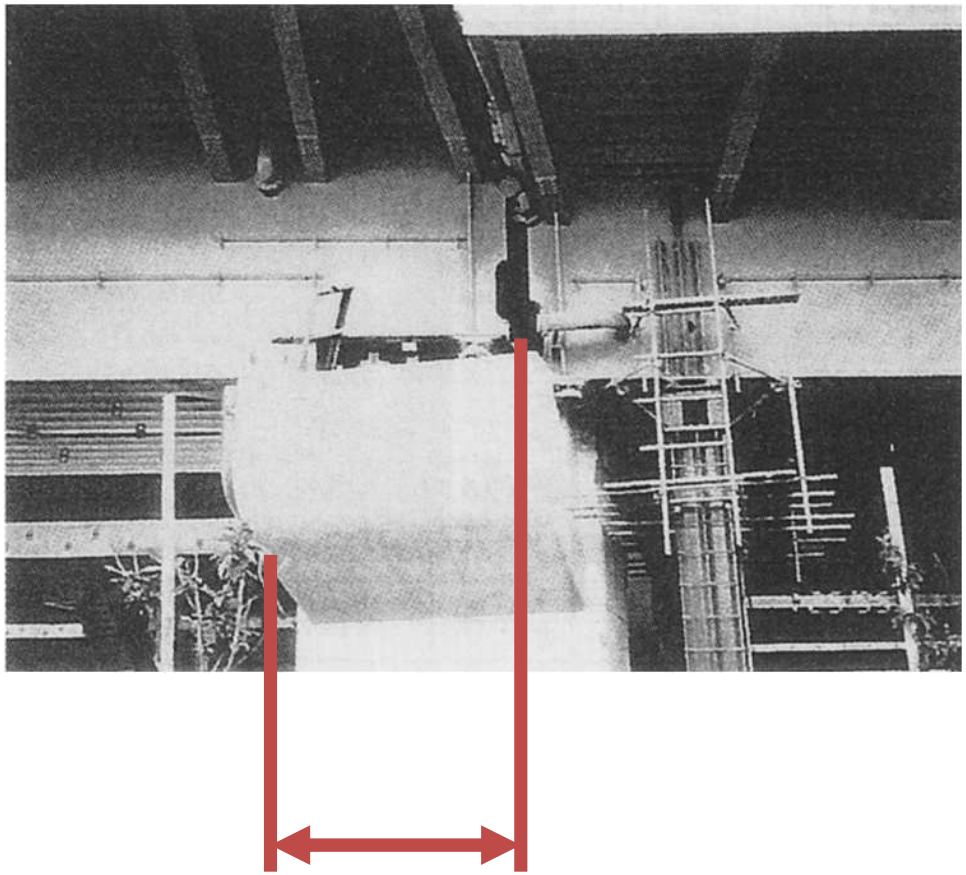
"Damage caused by earthquakes" (Japan)

Upper part: Hanshin Earthquake Lower part: Kumamoto Earthquake

Examples of seismic reinforcement

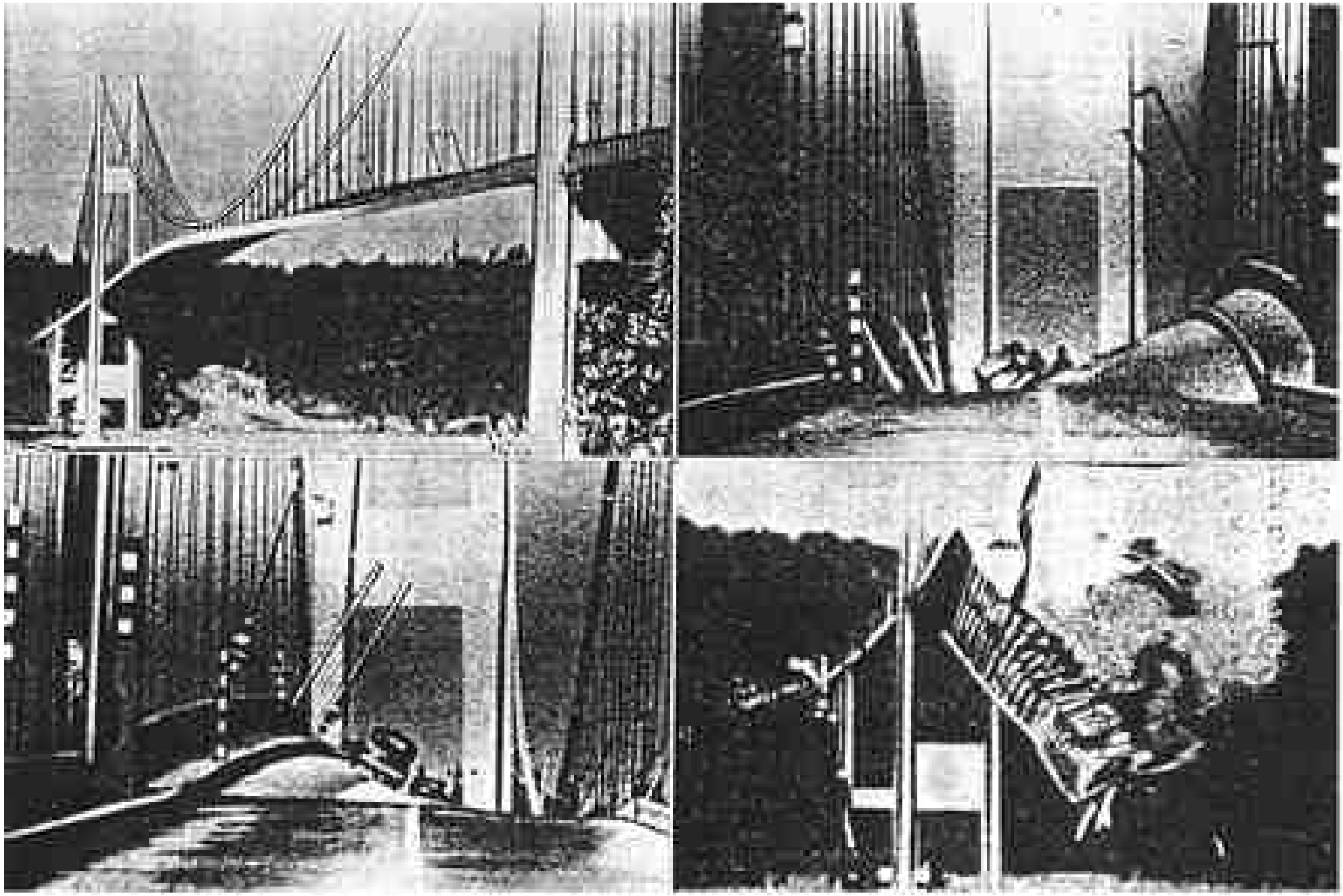
Installation of a fall prevention device

Bridge pier concrete reinforcement



Lengthening this area is the is the best way to prevent bridges from falling.

Wind, Tacoma Rose Bridge collapse, flutter phenomenon



Significant influence on later suspension bridge designs

Wind tunnel test of the Akashi Kaikyo Bridge

Flood disaster

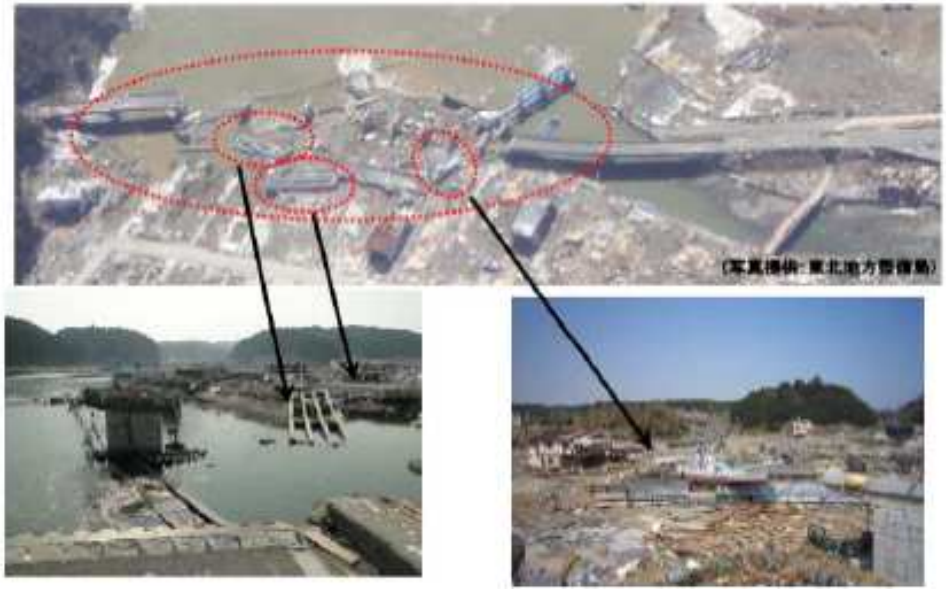
The rainfall has changed in recent years.

Flooded
Togetsukyo

Dropping of girders due to local scouring of piers

Tsunami

Great East Japan Earthquake
A bridge left by the tsunami



Jan. 1, 2024 After the Noto Peninsula earthquake

Toyama City situation

Bridge level difference
Next to City Hall

Liquefaction of road confirmed the next morning (in front of the prefectural office)


Expansion device failure

Inspection status of bridge substructure

Toyama has many waterways and canals, so inspections can be done by boat.

Cracks in the bridge abutment vertical wall

現在の一番の不安

高速道路上のオーバーブリッジ
⇒実は当時の設計ミスでは？(設計時の鉄筋量の不足は確認している)

※This bridge is scheduled to be removed within this fiscal year.

Aging problem

Current social issues: infrastructure management
What are we going to do with this bridge?

Is it worth keeping?
Or is it should be removed?

Deterioration goes on forever.
Safety and security with limited financial resources!

America in ruins

1970～1980s

➢ Today's Japan

Periodic inspection

Basically close visual inspection and percussive checkup

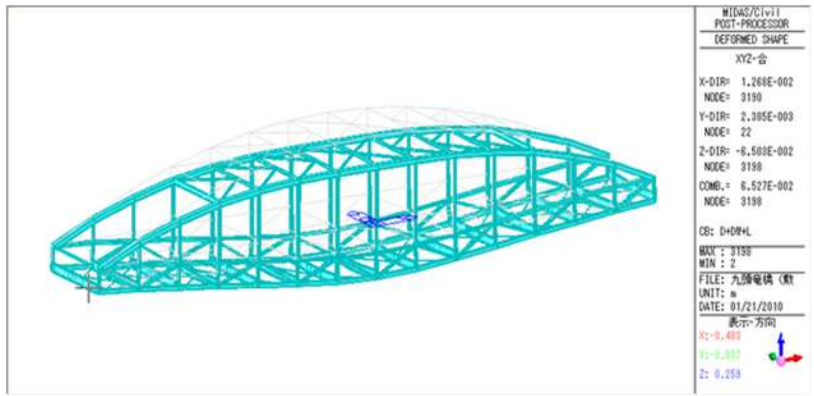
Use an inspection vehicle or install scaffolding because the underside of the building (the lower surface) is important.

The actual structural diagnosis is carried out as necessary.

Visual inspection, rough judgment and screening

Detailed inspection depending on the case

Photo shows ultrasonic plate thickness measurement



Diagnosis using analytical techniques

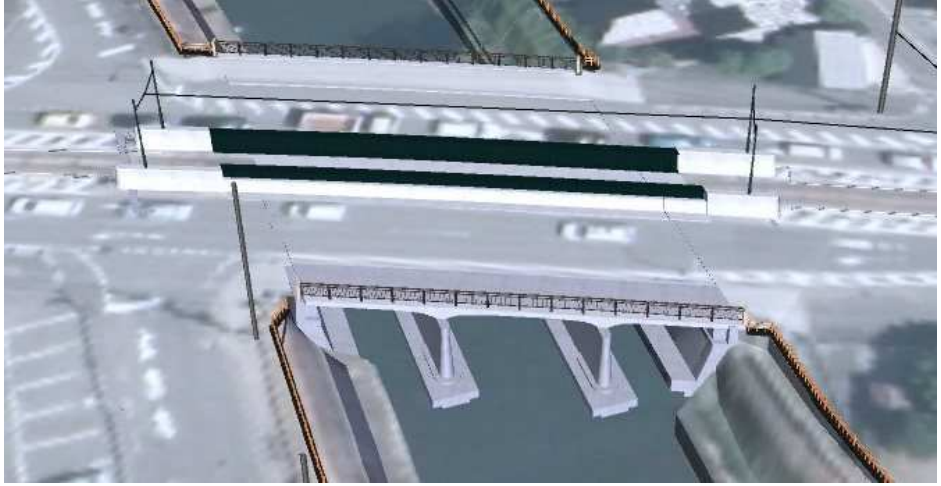
3D FEM analysis

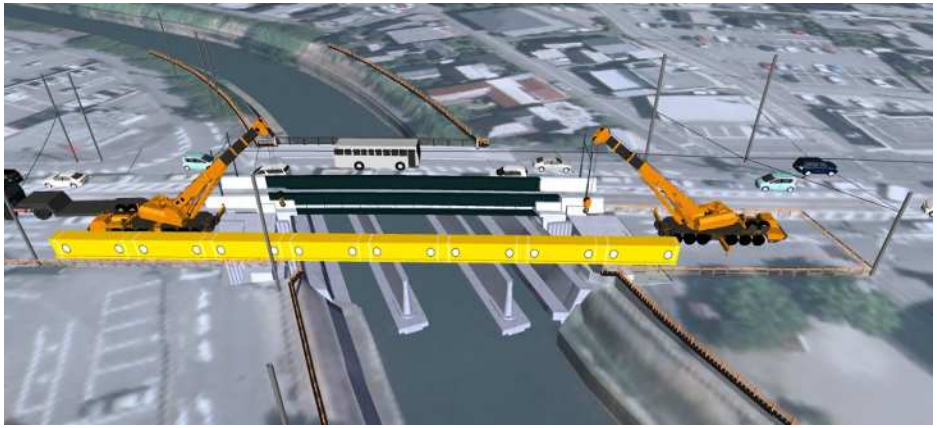
Decision to replace bridges ⇒Management of renewal

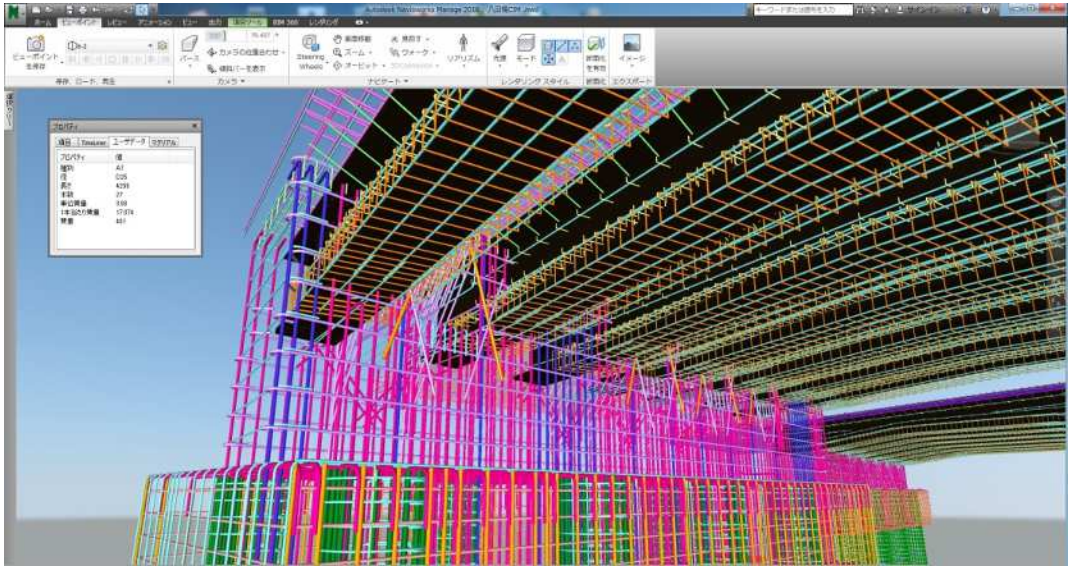
Management plans are developed and reviewed with renewal in mind!

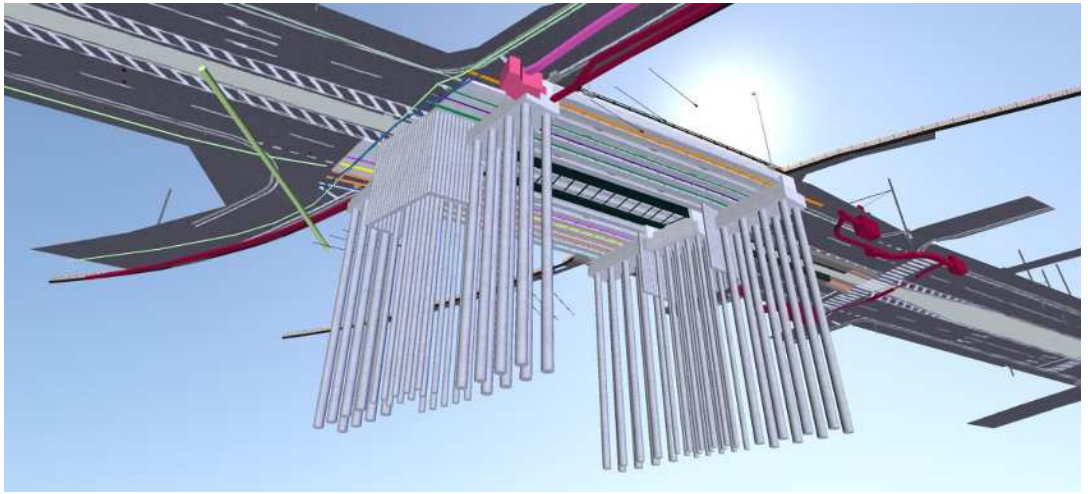
- **More than 50 years have passed since the bridge was built, and its function has deteriorated due to changes in traffic volume**
- **Delay in earthquake resistance ⇒ Revision of earthquake resistance standards, national land resilience**
- **Bridge replacement is an issue that always occurs.**
- **When we talked about earthquake resistance in the Diet, one member of the assembly said, "Toyama is protected by Mt. Tateyama."**

DX Support: Utilizing BIM



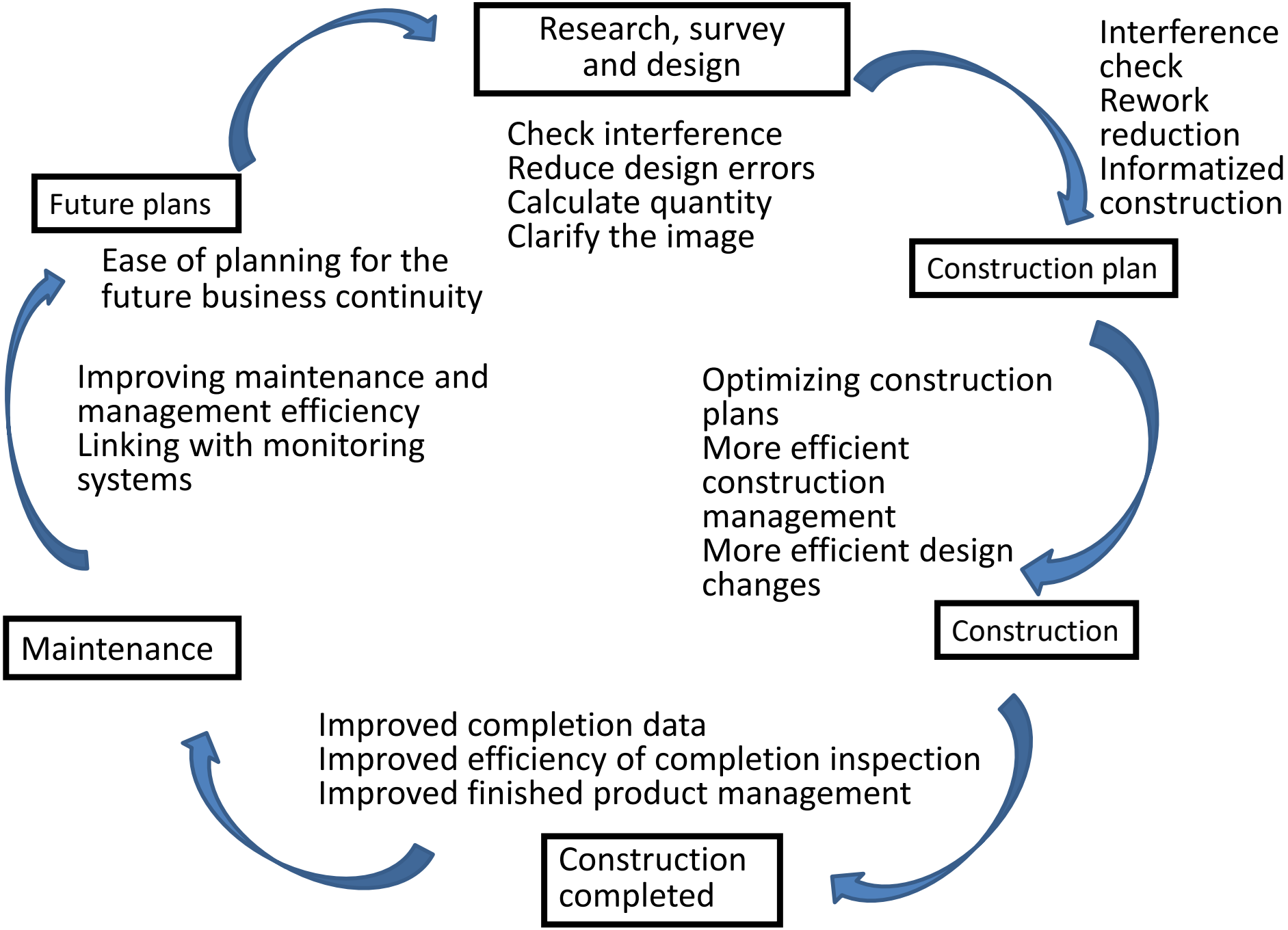






Creating 3D data
Centralization of data

Unification of 3D data ⇒ Construction DX



ASR（Alkali Silica Reaction）

- **Andesite crushed stone in the Hokuriku region contains highly reactive minerals**
- **Anti-freezing agent (NaCl) to be sprayed in winter**
- **Many bridges are experiencing combined deterioration of ASR and salt damage**

S bridge RC hollow floor plate bridge

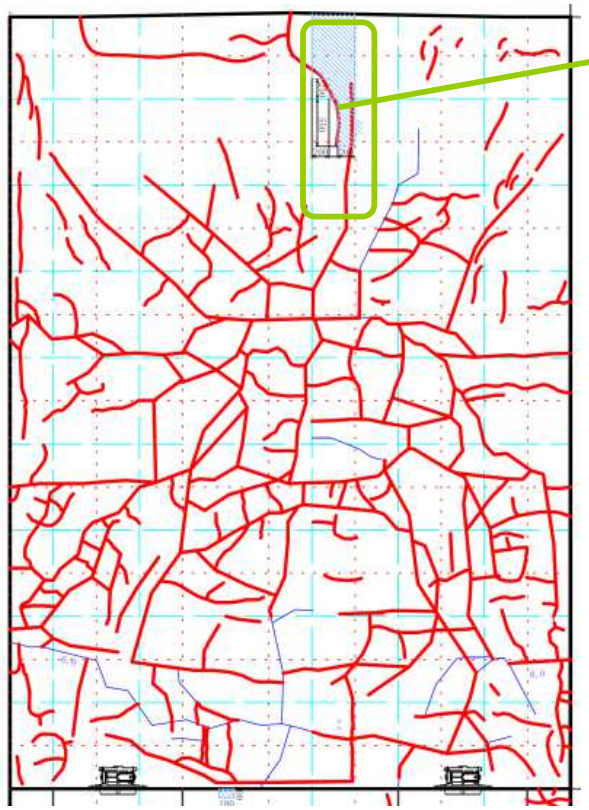
T bridge PCT girder bridge

M bridge PCT girder bridge

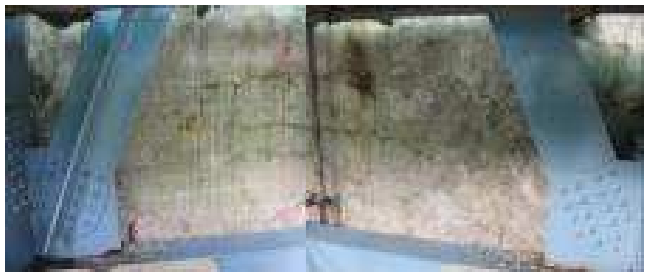
Damage caused by ASR

- **ASR progresses throughout the bridge abutment, causing many cracks**
- **Concrete cracks growing in the vertical direction on the parapet**
- **Confirm residual expansion property [Danish method]**

Crack development diagram of bridge abutment



Breakage of expansion device, crack in parapet



Tortoiseshell-shaped cracks

Damage to bearings ⇒ We seldom see it.

- Bearings corrode due to aging
- The mounting bolt broke, the roller came off, the girder tilted, and a step occurred at the expansion/contraction part.

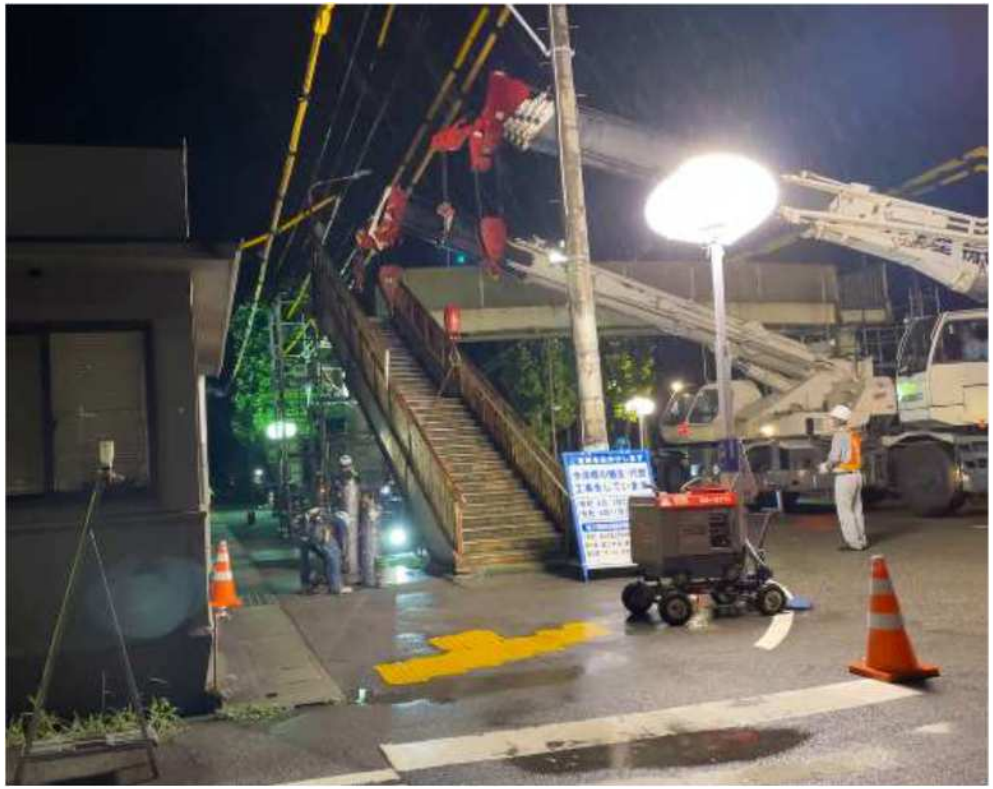
Corrosion also progresses on downstream bearings


Panasonic
Panasonic

What to do with bridges that cannot be repaired? ⇒Monitoring

Monitoring system

Above: Field demonstration test situation
Upper right: Sensor installation status
Bottom right: Destructive test after dismantling



Choice of removal

Also for passing on technology! Need for new business

Important things in design

- Recognize that design is fiction.
- Think about how things (bridges) break and why.
- ⇒How to deal with it
- Always devise details from your own experience.
- Doubt consultants.
- Think until you are satisfied.
- Design with operation and maintenance in mind.
- Excessive design changes can lead to mistakes and accidents.

What is important when planning?

- Survey Plan
- Is there any data missing in the design?
- Check topography, borings, geological surveys, past disasters, etc.
- Check the site carefully
- Selection of route, bridge location, structural system

Important things in construction

- Construction is the act of realizing the design.
- During construction, the structural system becomes unstable.
- Accidents are likely to occur during construction.
- ⇒Beware of human error.
- Greatly affected by weather conditions.
- It is necessary to consider how to deal with cases where things do not go according to the design.
- Need to consider what to do if things don't go as designed.

Important things in operation and management

- Be careful of disasters and accidents during operation.
- Be careful of overloading.
- Operation will continue for a long time. ⇒Coping methods, maintenance and management
- Be creative with details to create a long-lasting structure.
- Choice of monitoring
- Renewal (replacement) will surely occur.
- The responsibility of the administrator is significant.

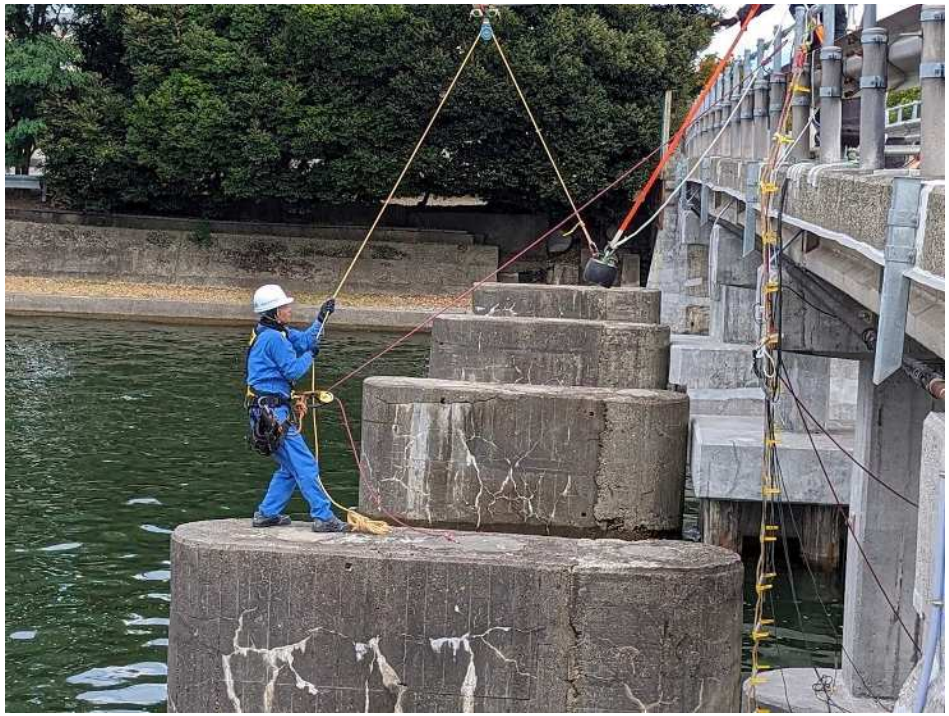
Impact vibration test

Check the safety of the bridge as a whole structure

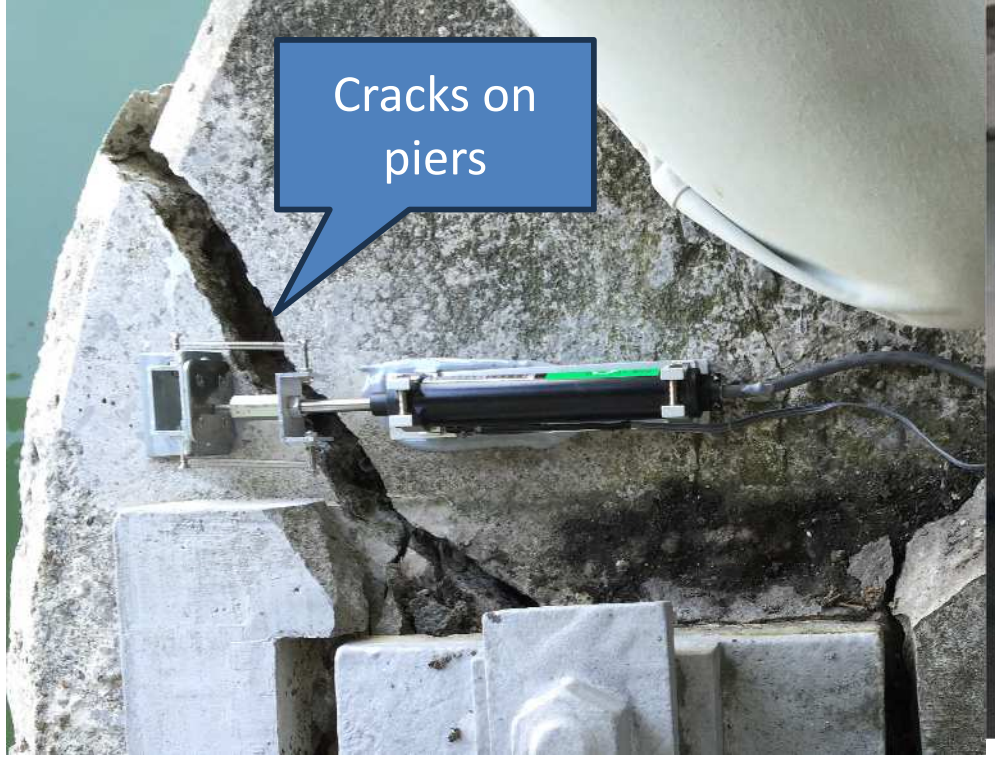
Detect natural vibration frequency using impact elastic waves

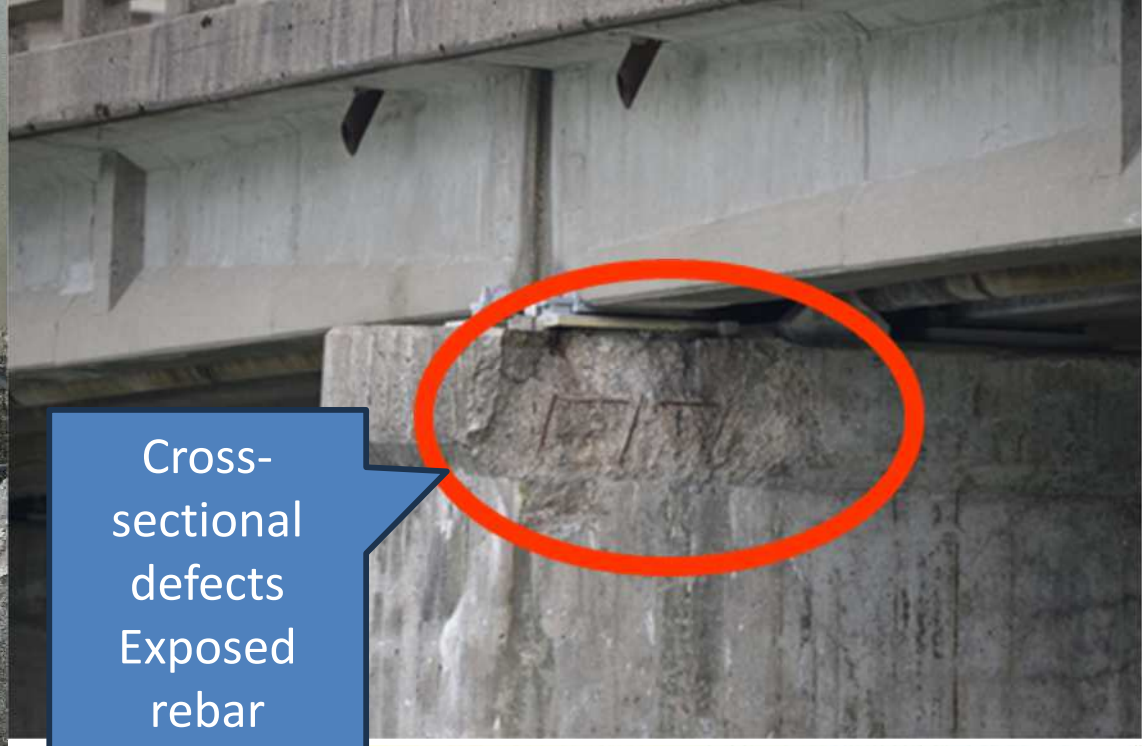
Aim to evaluate the soundness of the bridge

Panoramic view of Senbarzaki Bridge (downstream)



Impact of the bridge pier





Monitoring as a response

Steel headbands installed

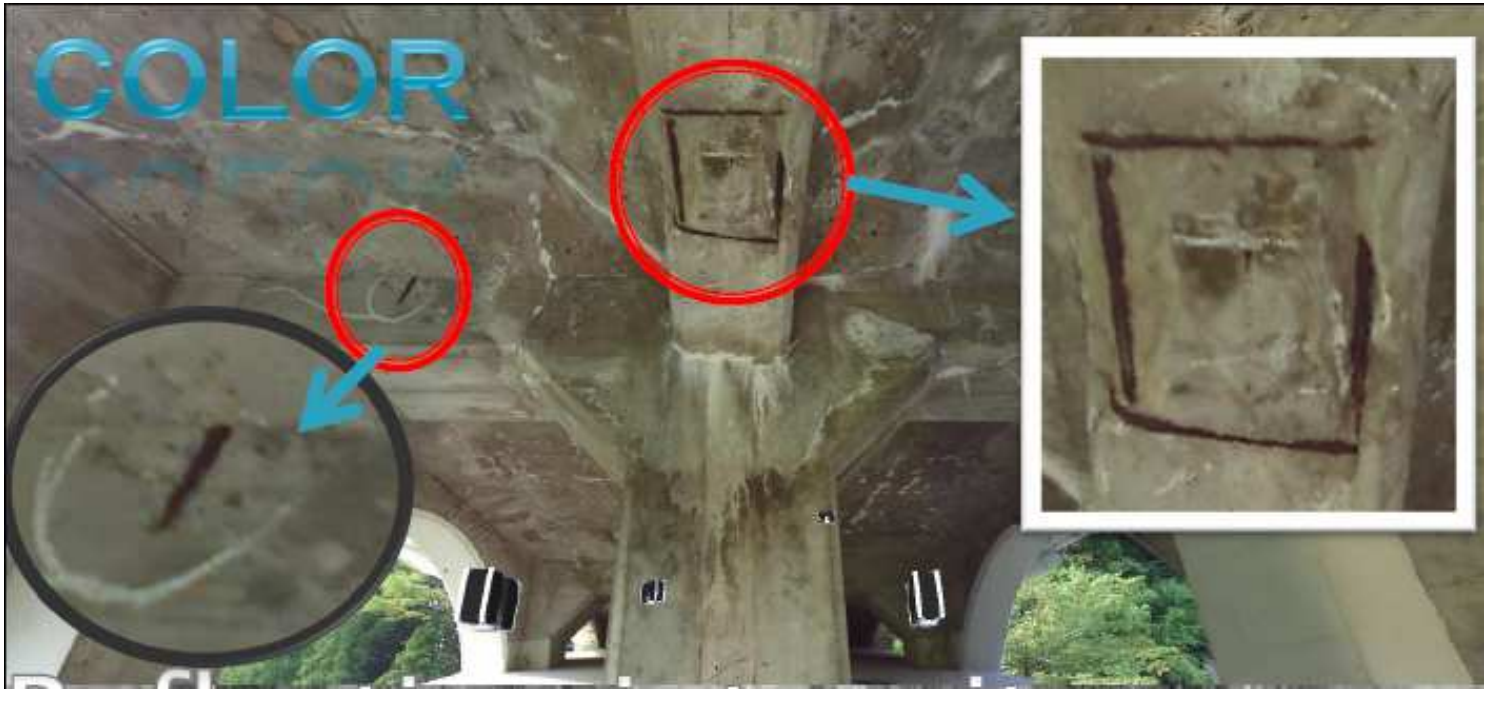
Insufficient amount of rebar during construction Headbands to ensure rigidity

Initial defects result in huge maintenance costs.

Use of 3D scanners

Use of image data

Recording on-site facts with image data



How much do the managers and consultants know about bridges?

- **Do you understand bridge standards?**
- **Have you ever planned and designed bridges?**
- **Have you ever built a bridge?**
- **Do you have ever operated and managed a bridge?**
- **Do you know about non-destructive testing?**
- **Have you ever destroyed a bridge or seen one destroyed?**
- **Have you ever repaired and repair design and repair?**
  In terms of materials and construction methods?
- **Do you have experience in monitoring?**
- **Have you ever replaced a bridge?**

・・・・・・

Many engineers don't even understand this.

For the future, both wheels necessary for infrastructure engineers!

Technology (Tool)

- Knowledge, experience, and technology required to understand bridges and other structures
- New technologies, new materials, new methods, etc. that should be introduced
- DX technology, DB, BIM/CIM, analysis technology, non-destructive testing
- AI, drones, robots, monitoring systems
- Technology to ensure the safety of the entire structure
- Technology to see the invisible

- Technology development and its certification system at public research institutes
- Reforming the thinking of government agencies, etc.

It is we, civil engineers, who are responsible for protecting this infrastructure!

Management (Mechanism: how does it work?)

- Technology and thinking for managing multiple/large numbers of things
- New "systems", management methods and thinking

- Human resources, understanding of citizens
- PPP/PFI, comprehensive management ⇒ We need help from the private sector!

Infrastructure problems cannot be solved by "technology" alone.
Progress won't be made with just "software" and "critics!“ We need people who can do it!

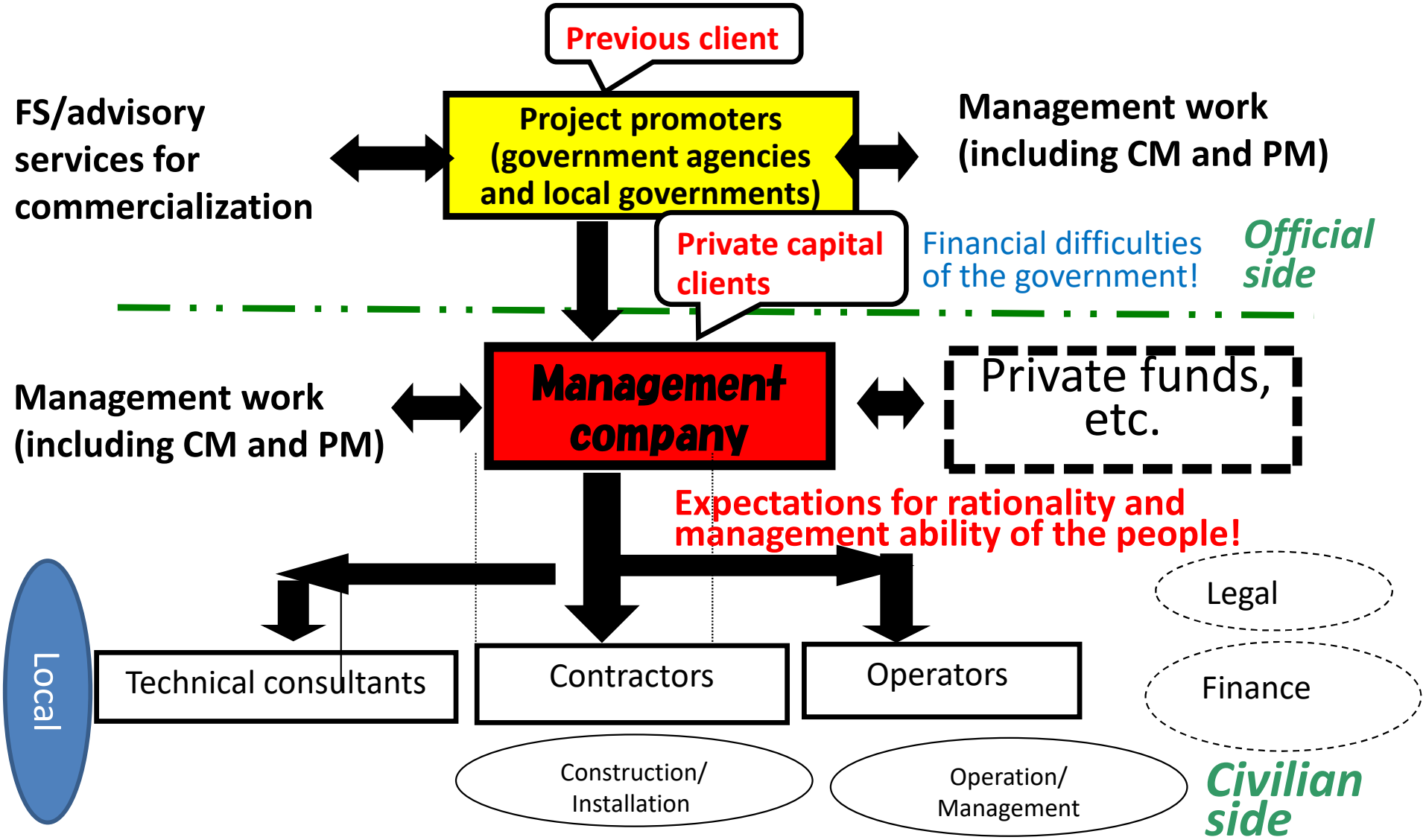
Awakening to management

South Korea, Daegu-Busan Expressway PFI Project:
Assigned as manager. 105 bridges, 13 tunnels, 85km long, constructed all at once. 1 year design review and 4 years construction management (CM) and monitoring.

PFI infrastructure projects have been implemented in South Korea since 2000, and in Europe and the United States since the 1980s.
They have yet to be implemented in Japan.

Through this experience, my "management thinking" has been strengthened!

Possibility of introducing new "systems" (examples): Private sector technological capabilities, financial strength, efficiency, etc.



The ordering system also needs to change.
We need to consider each company's position.

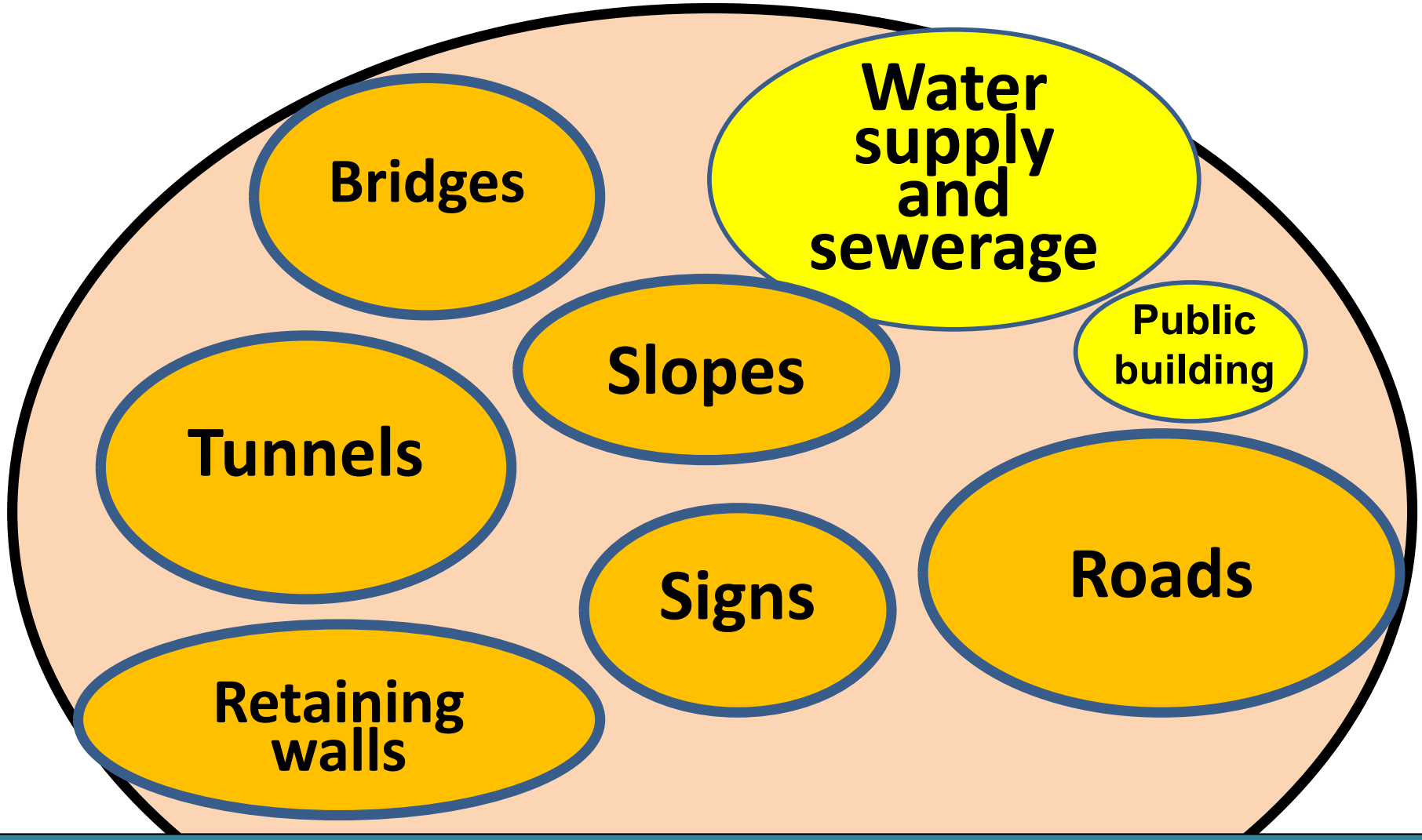
Aging bridges

Aging tunnel

Aging retaining wall

Structures

Centralized management of infrastructure "groups"



Currently, Japan is considering moving to a "swarm" system. In other words, it is about managing the management infrastructure collectively.

Thank you very much for your attention!

Finally, to those in infrastructure management,
"There's no better way to learn something than to experience it yourself. (Einstein)

Yoshihiko Ueno