JICA Okinawa Training Course

Masahide Horita
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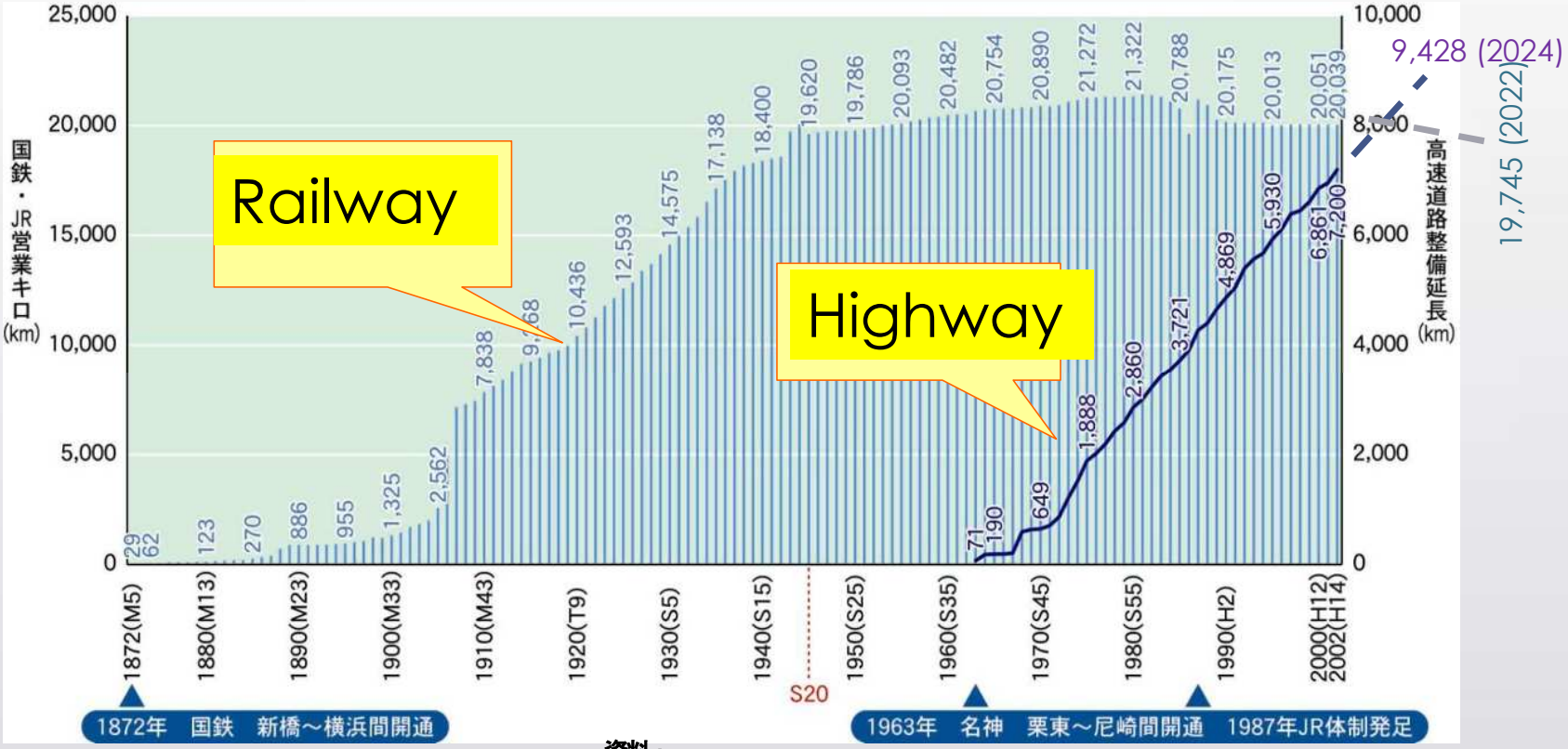
University of Tokyo

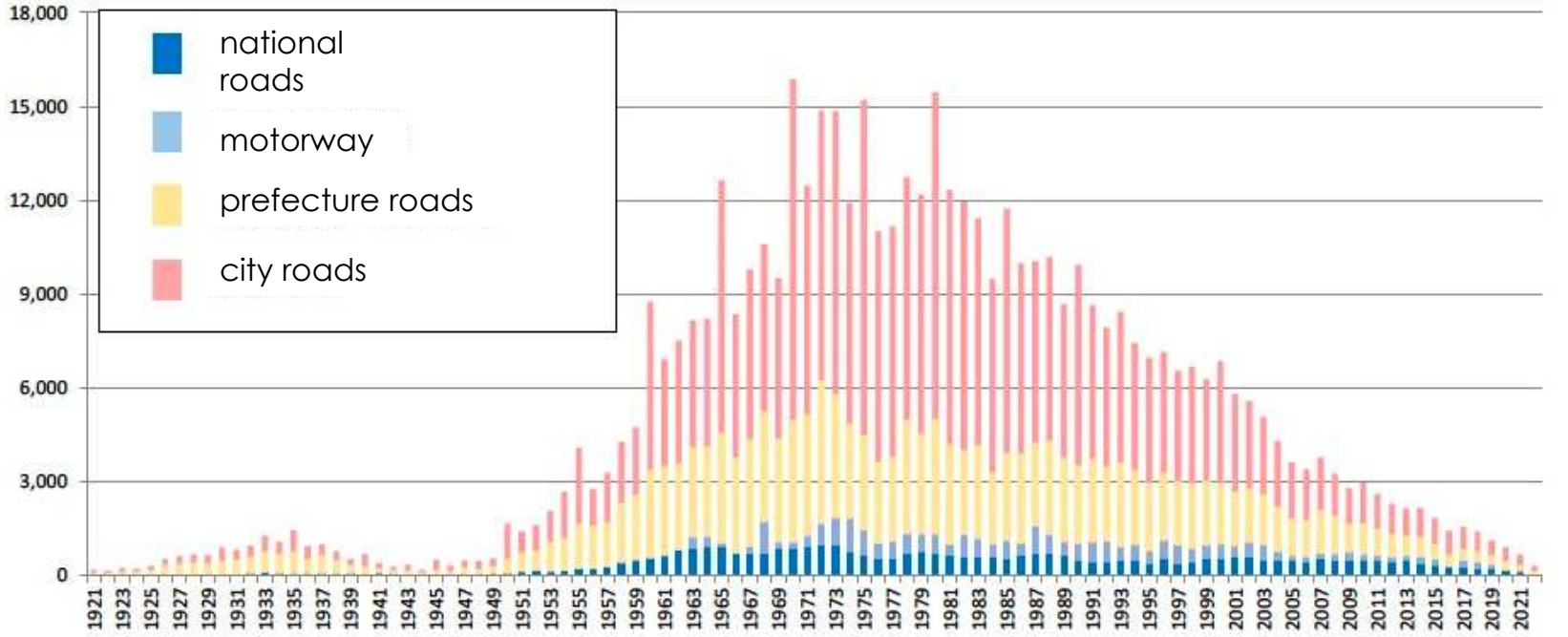
Total Lengths of Railway & Highway Networks (km)



資料：
「国有鉄道鉄道統計累年表」（S61まで）、「数字で見る鉄道2004」（S62以降）「高速道路便覧2002」

Aging Bridges

○ 建設年度別橋梁数 **Number of Bridges by Year of Construction**



※この他、古い橋梁など記録が確認できない建設年度不明橋梁が約 20.9 万橋ある。

Year Constructed

（出典）道路局調べ（2023.3 末時点）

MLIT, www.mlit.go.jp/sogoseisaku/maintenance/_pdf/research01_pdf01.pdf

Percentage of Infrastructure 50 Years or Older

	March 2018	March 2023	March 2033
Road bridges (Roughly 730,000 (bridges at least 2 m in length))	About 25%	About 39%	About 63%
Tunnels (Roughly 11,000)	About 20%	About 27%	About 42%
River control facilities (floodgates, etc.) (Roughly 10,000)	About 32%	About 42%	About 62%
Sewer lines (Total length: Roughly 470,000 km)	About 4%	About 8%	About 21%
Ports, harbors and seawalls (Roughly 5,000 facilities (depth of at least 4.5 m))	About 17%	About 32%	About 58%

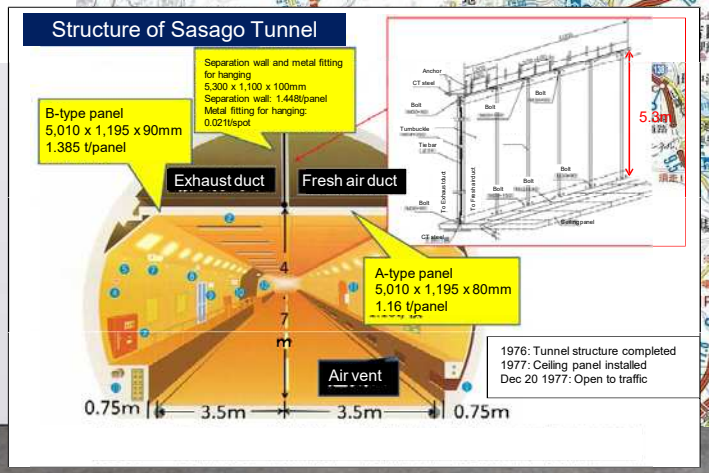
Source: MLIT White Paper, p.28, www.mlit.go.jp/en/statistics/white-paper-mlit-2017.html

(Nikkei Construction, 2013/01/28, p.25)

Sasago Tunnel Ceiling Collapse:

Incident Summary

- Date : Sunday, December 2, 2012 at 8:03am
- Location : Tokyo-bound Sasago Tunnel
- Incident : 130-meter-section of ceiling panels fell at 1.7km from the east portal of the 4.7km-long-tunnel, crushing three vehicles and catching two of those on fire. Nine people were killed and two others were injured.
- Road closure : Both the in-bound and out-bound roads were closed until the re-opening of the out-bound lanes for all traffic at 1pm on Dec.29th. All lanes in both directions were re-opened on Feb.8th.

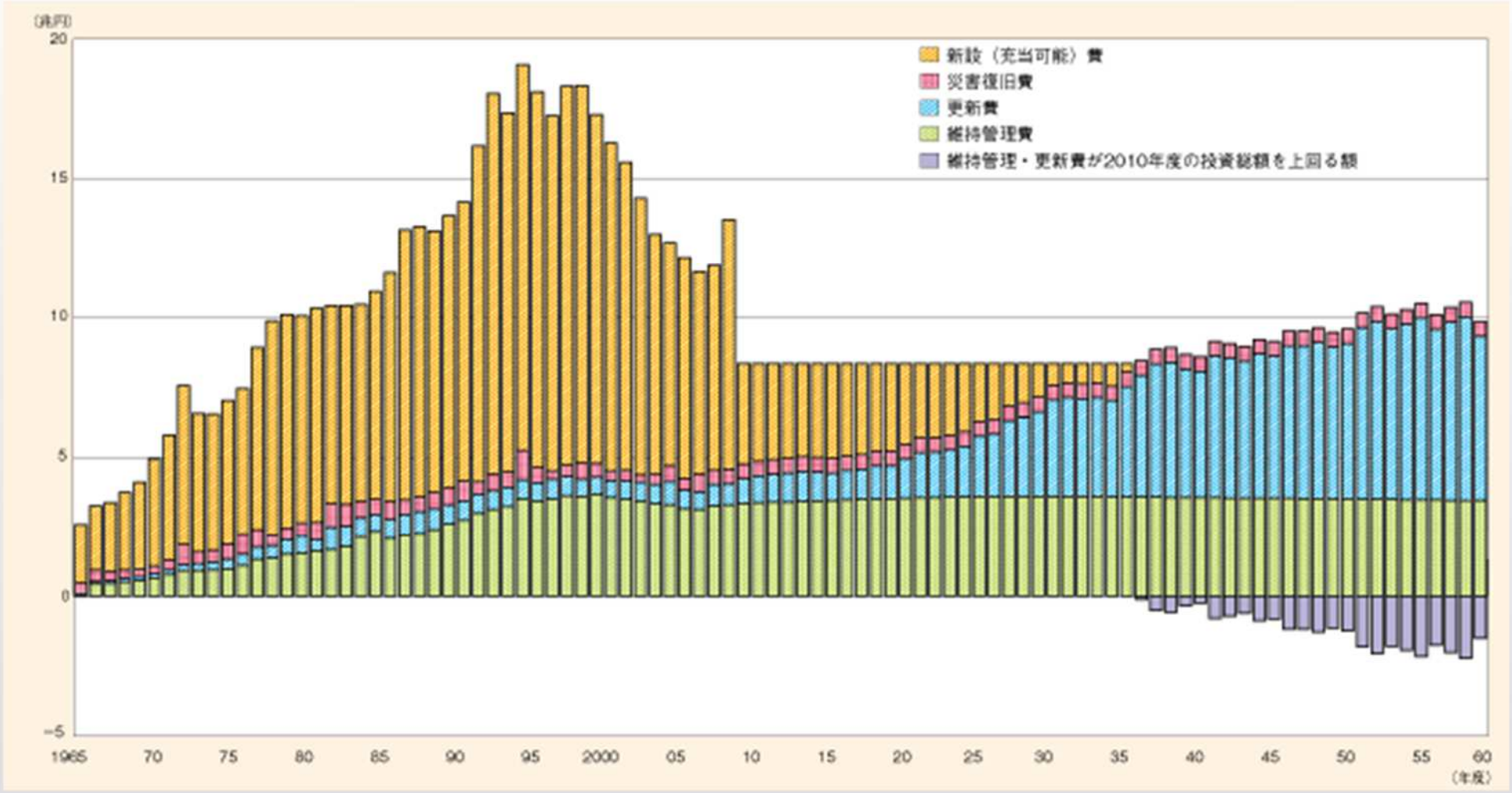


【mages of the Incident】


As of 12pm Dec. 2

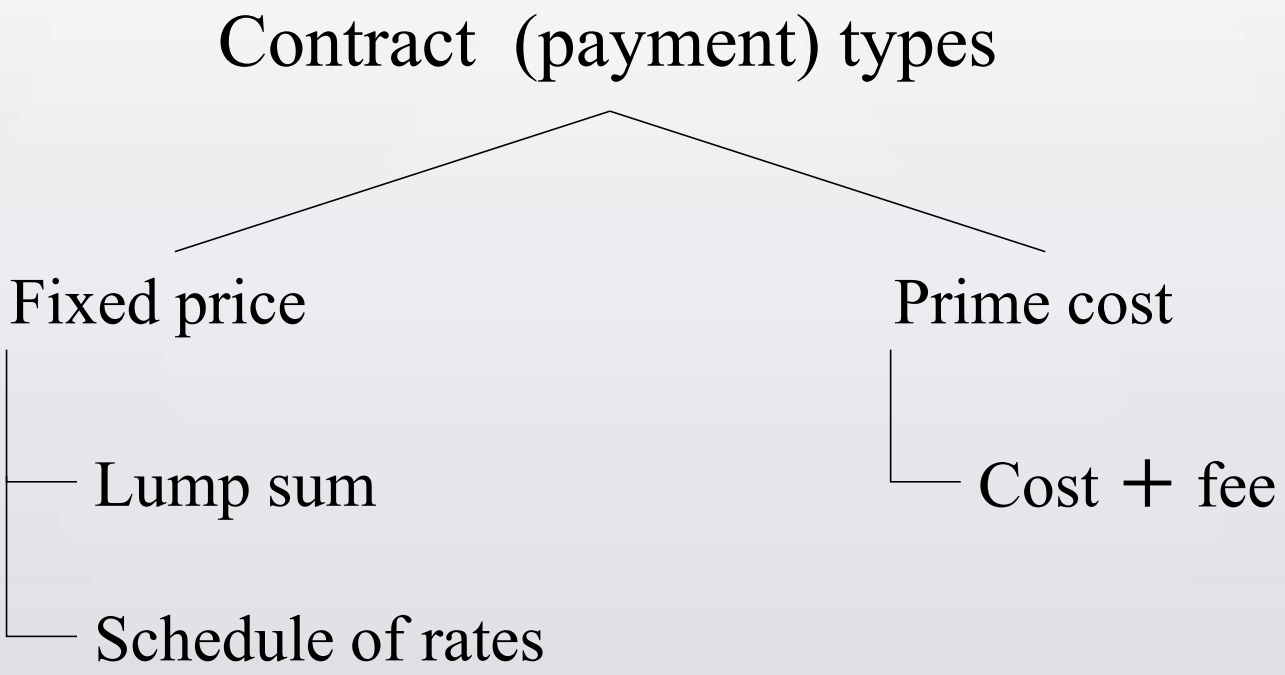

As of 3:30pm Dec. 3

Fallen panels are being removed



http://www.mlit.go.jp/hakusyo/mlit/h23/hakusho/h24/html/n1216000.html

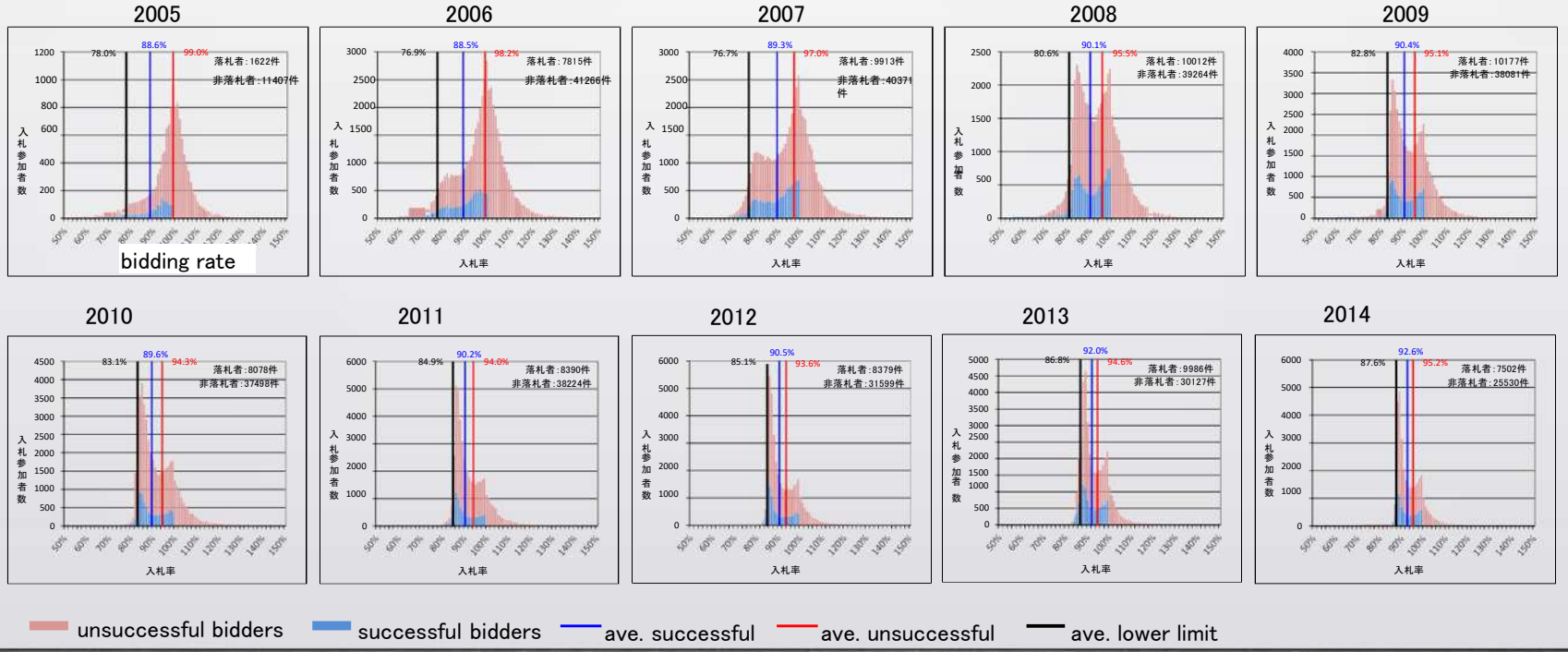
Contract (payment) types



Issues Unique to the Japan's Construction Industry

- Bidding prices with an upper limit, and, a lower-limit!
- 「総合評価方式」(weighted aggregation bidding procedures)
- Collusion (bid-rigging)（談合）vs over-competition

Trends in Bidding Rates



（出典：国土交通省, 2016, 直轄工事における総合評価落札方式の実施状況 (平成26年度)）

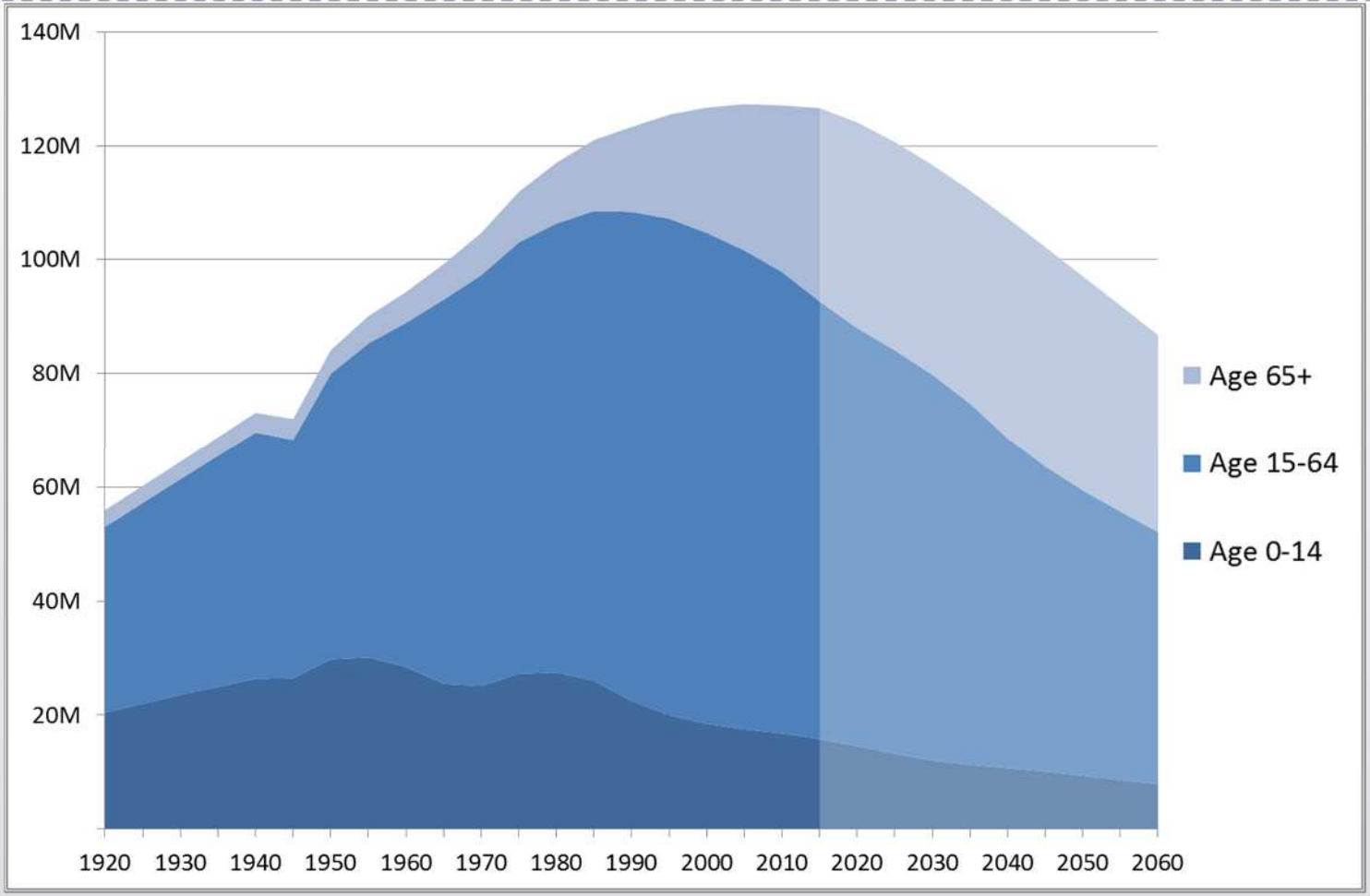
Recent Procurement Issues in Japan

1. Appropriate setting of ceiling prices
   - Eliminate so-called bugiri
   - the Implementation Manual for the Cost Estimation Method
2. Measures against dumping
   - the low bid price survey system or the lowest price limit system
3. Appropriate design changes
   - Guidelines on Design Changes
4. Leveling of construction work schedules, etc.
5. Review of varied tendering and contracting options, etc.
   - New additions to the Public Works Quality Assurance
   - technical proposal integrated negotiation systems

i-Construction

http://committees.jsce.or.jp/cmc/system/files/%E5%85%AC%E9%96%8B%E7%94%A8%E8%B3%87%E6%96%99.pdf

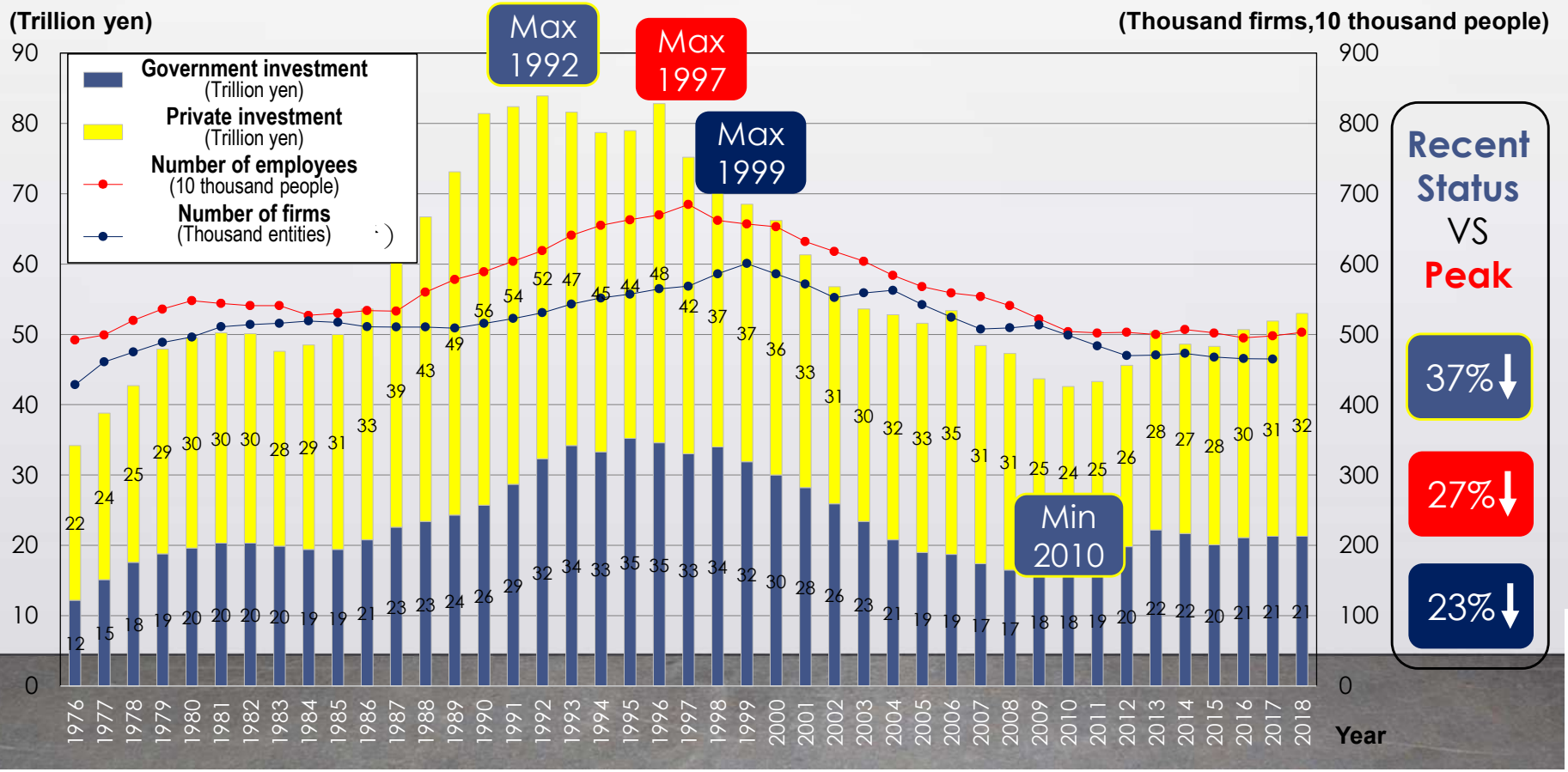
Population Decline & "Super-Aging" Society



Sources: Wikipedia

The transition of Japanese construction industry

- The climax of **construction investment** was in 1992 at 84 trillion. Then it reached the lowest point in 2010 at about 43 trillion. After the drastic retrench, the market started to revive slowly. In 2018, the investment was 53 trillion, 37% lesser than the peak.
- The **number of construction firms** were approximately 460 thousand (2017), which is around 23% less than the peak (1999).
- The **number of employees** were approximately 4.98 million (2017), went down by about 27% than the peak (1997).



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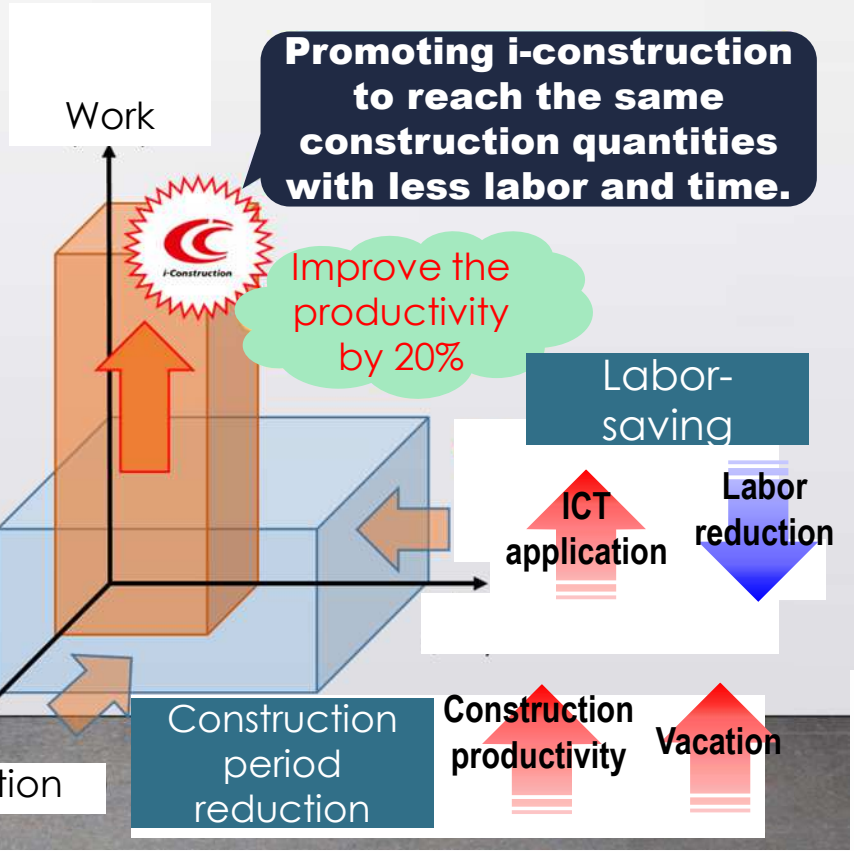
https://www.oecd.org/economy/continued-slowdown-in-productivity-growth-weighs-down-on-living-standards.htm

i-Construction：“Improving the productivity in construction industry”

○During the Future Investment Meeting held in Sep 12, 2016, Prime minister Abe proposed that for realizing the evolution in construction field, the **productivity should be improved by 20% by 2025.**
○Aiming at this objective, in the past three years, the innovative technological applications such as **drone inspection** in bridge, tunnel and dam and **3D digitizing of construction process** has been adopted.
○In the meantime, the Japanese construction industry is committed to create better working environment with **higher salaries, available holidays and promising future** to attract various talents.

Future Investment Meeting in Sep12, 2016



Labor + Productivity → Economy

The improvement of productivity is indispensable to maintain economic growth when the labor force is declining.

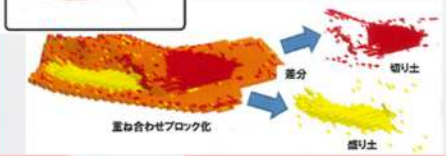
Overall application of ICT in earthwork

① 3D measurement by unmanned aerial vehicles

3D measurement by drones in short time with high density

② Design and construction planning by 3D measurement

By comparing the 3D model and design drawings, the filling and excavation (earthwork) can be calculated automatically.

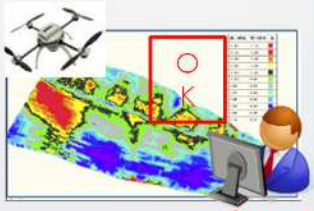


③ Auto machinery construction by ICT

ICT construction machinery are automatically controlled by 3D design data and IoT

④ Labor-saving verification

By the 3D inspection using drones, the work of verification reduced drastically.



Owner

i-Construction	Measurement	Design and planning	Construction	Verification
	①	②	③	④
Traditional method	Measurement	Design and planning	Construction	Verification

Implementation of measurement

Calculation of earthwork from design

Setting finish stakes by design

Earthwork following the finish stakes

Repetitive measurement and working

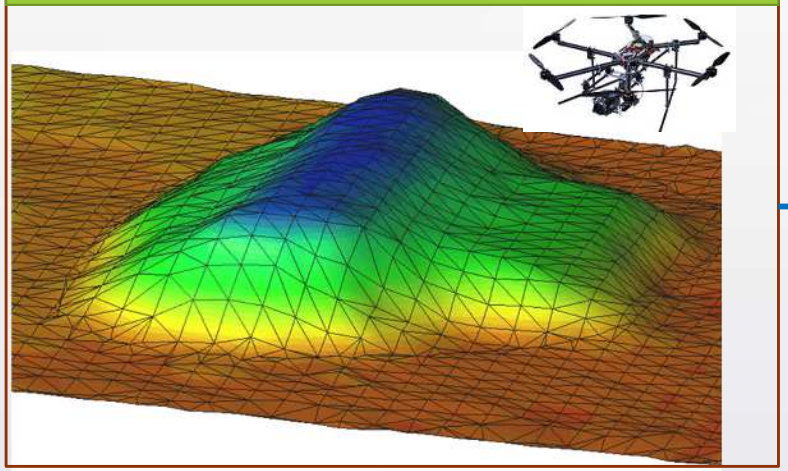
Verification of documents

i-Construction

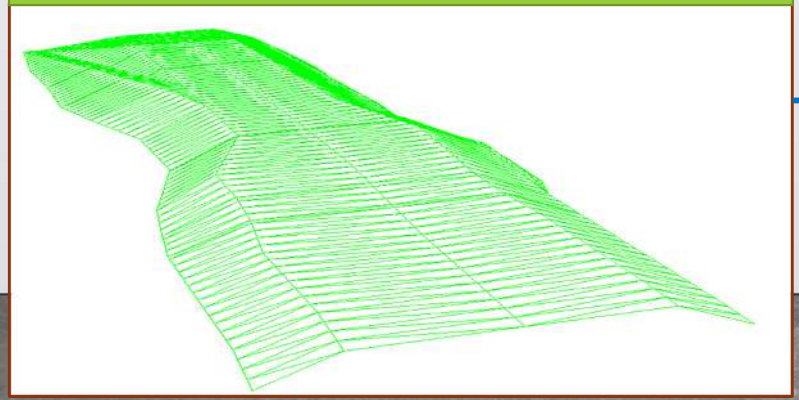
The procedure of ICT earthwork (measurement)

Initial measurement and finishing measurement

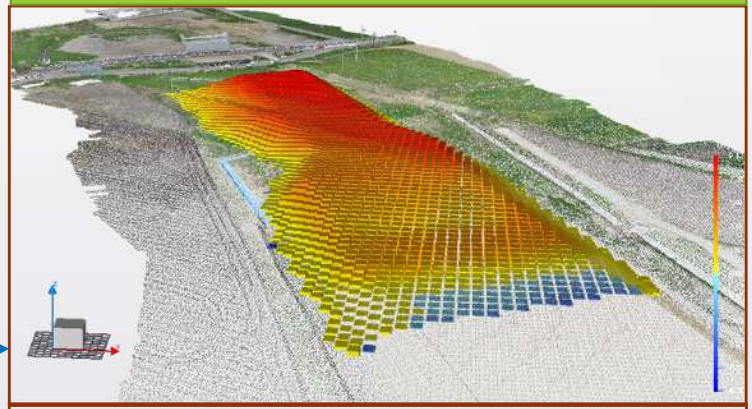
3D measurement by drone



Making 3D design data



3D construction management of finished shape



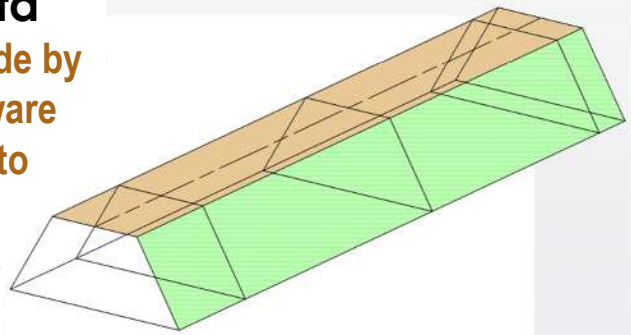
Comparing the topography data before and after the construction by unmanned aerial vehicle measurement（UAV）, the progress of earthwork can be monitored. In the same way, the comparison of design data and the finishing data could verify the level of completion.

i-Construction

The use of 3D DATA

3D design data

The 3D design made by construction software can be passed on to different agencies, facilitating various applications.



3DMC and 3DMG

Applying 3D database in machine controlling and guidance, improving the productivity and lowering down the skill requirement.

Quantity survey

Comparing 3D design data and updated construction data for accurate quantity survey and design changes.

3D management

The design database can be compared for completion checking with the 3D models from unmanned aerial vehicle and laser scanner.

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Productive construction based on 3D design data

The earthwork is automated by planting 3D design data into the ICT machines such as bulldozers and backhoes. The design data will guide the machine for implementation so there is no need for finish stakes (by machine control or machine guidance functions).

The monitor in ICT bulldozer
- The work objective and current status are shown on the screen
- The elevation of the blade can be controlled by itself (machine control)

Construction by ICT bulldozer and backhoe
June 7, 2016

The monitor in ICT backhoe
The work objective and current status are shown on the screen

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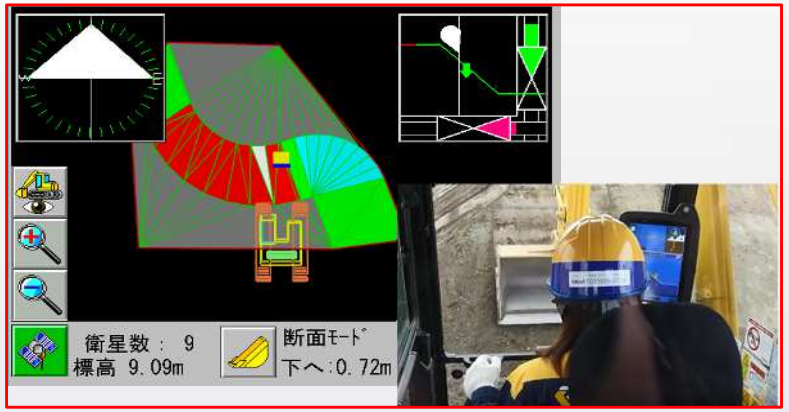
Comparison of ICT earthwork and previous earthwork

In the past, **finish stakes** are indispensable

No need for finish stakes in **ICT earthwork**



Automatic control by 3D design data

i-Construction

Expanding the application of BIM/CIM

S T E P 1 **The application of CIM facilitates design frontloading/stakeholders negotiation**

● Design frontloading ● Negotiation between stakeholders

Design considering inspection conducting

Discussion of transportation rules

BIM application in local hearing

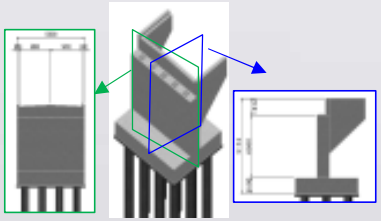
S T E P 3 ・Prompting unified specifications
・Building new contractual structure led by CIM
・Standardizing information for maintenance
・Openness of 3D database

The date base coupling CIM model and the geographic information

2017, initiating → **1～2 years** **Applying in large scale structures in principle** → **About 3 years** **Expanding the use sequentially**

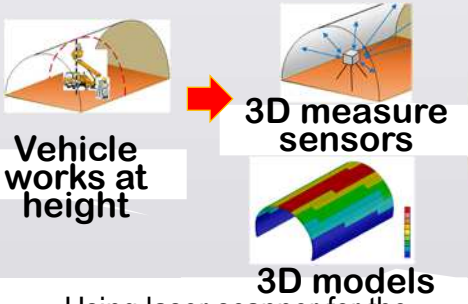
S T E P 2 **Directing affluent BIM/CIM application, setting up standards and systems respectively**

● Planting attributes



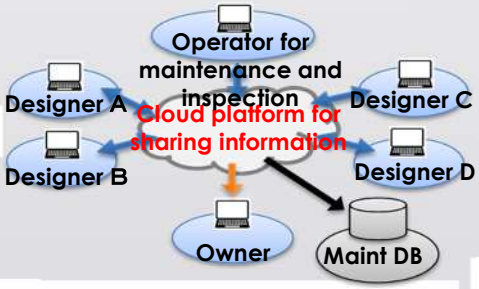
Displaying geometrical and other characteristic information by CIM

● Highly efficient inspection and monitoring



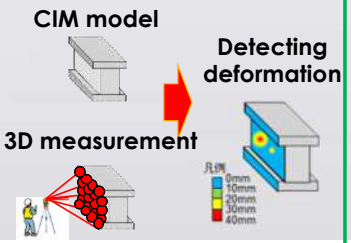
Using laser scanner for the ınagement with the entire surface

● Sharing data with all stakeholders



Building integrated data sharing system

● Highly efficient maintenance management



Detecting structure deformation by 3D measurement and CIM

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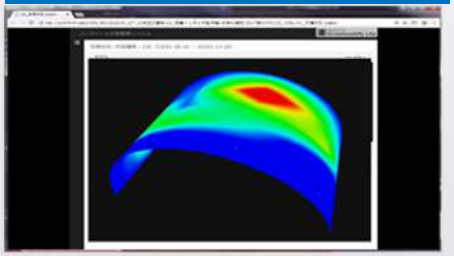
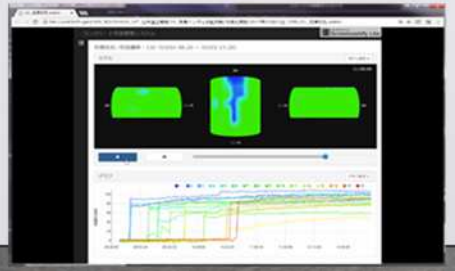
Effective utilization of data in quality management

・**Smart formwork** equipped with various sensors (electrostatic capacitance, temperature, acceleration) monitors the concrete placing status, improving the construction management
・**AI analysis** and evaluation of **concrete cover quality** by concrete surface photographs
・**Mobile Mapping System** can efficiently record the shape of the tunnel by taking the data of vast spatial points, replacing the onerous traditional inspection procedure

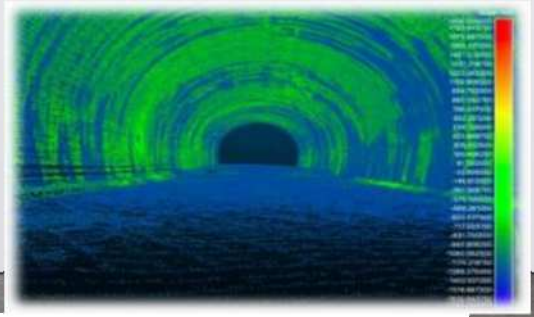
Visualizing the concrete placing status by smart sensor formwork





AI graphical diagnose of concrete surface quality

Finishing management by Mobile Mapping System



Test location: West Tottori Road, Kazaneyama tunnel

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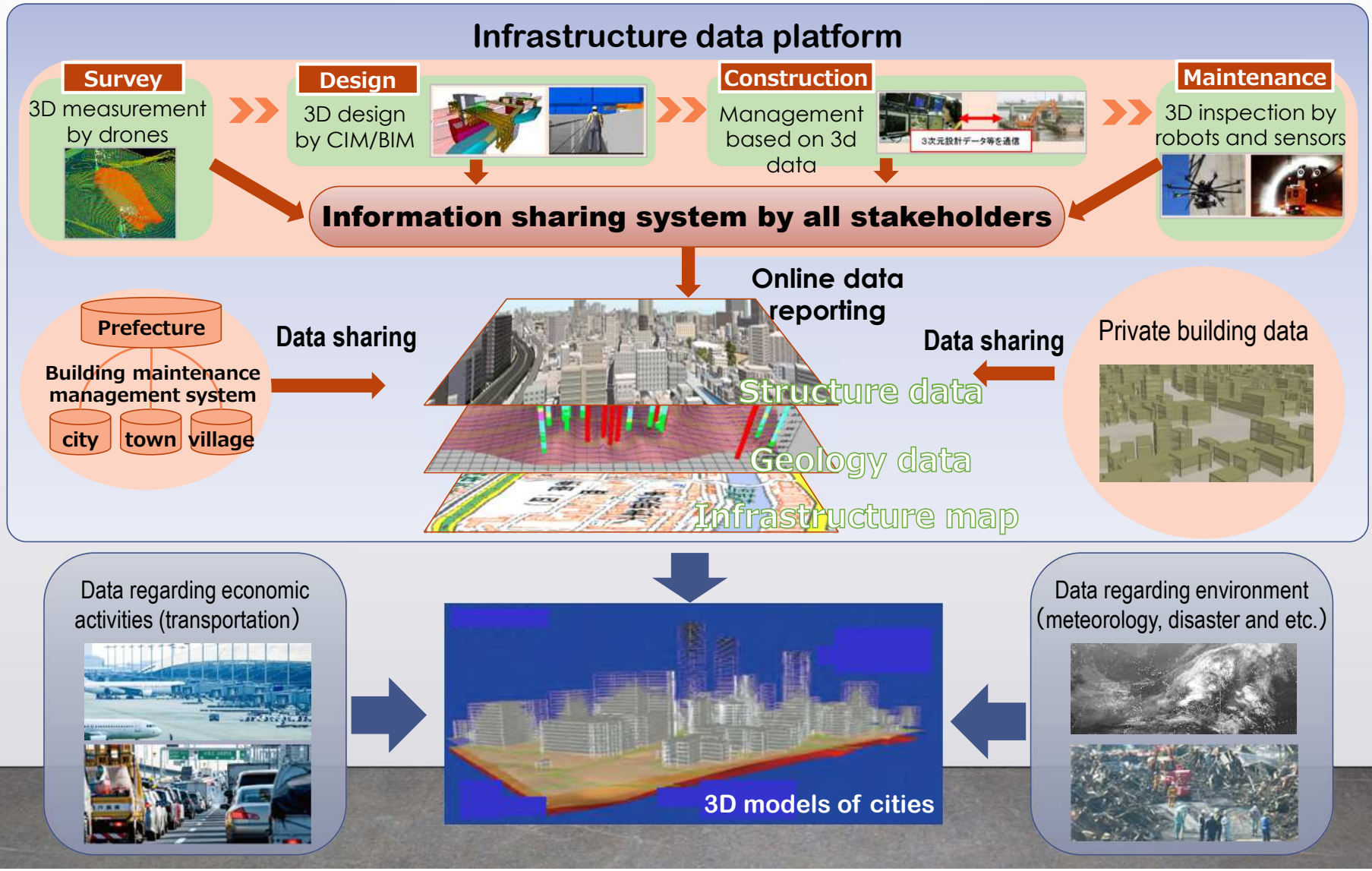
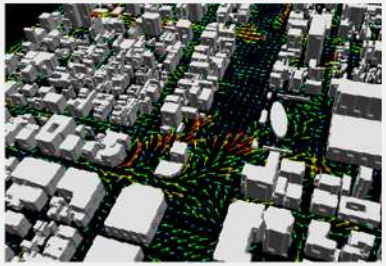
MLIT data platform

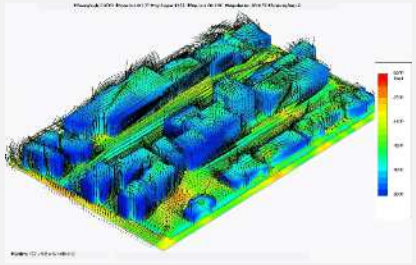


Future works

○ Urban planning

Analyzing sunlight and winder, forming the optimal solution for heat island effect





○ Efficient logistics

Goods delivered by drones

○ Disaster prevention plan

Applying the analysis of people flow for the evacuation simulation.

○ Prospering tourism

Effective use of VR/AR to improve the charm of sight seeing spots

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