

# Bridge Inspection and Bridge Deck Renewal Projects in Japanese Expressways

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# Company History

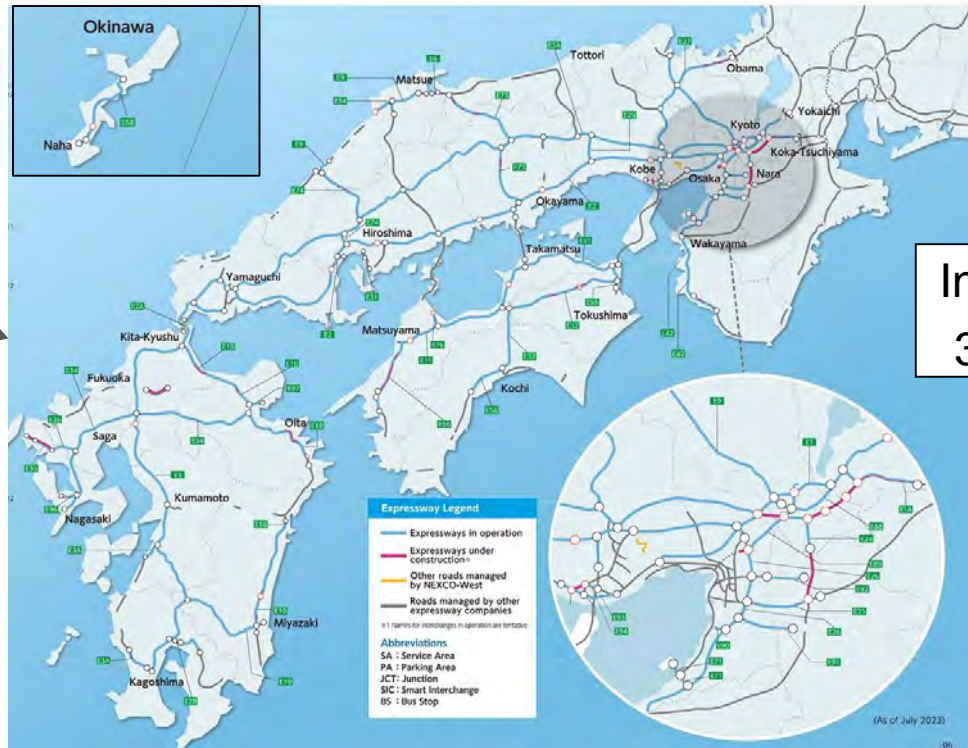


- Successor of JH (public corporation)
- JH had developed Japanese expressway network since 1956
- In Oct. 2005, JH was privatized and split into three private companies.

Map showing NEXCO-West's business area



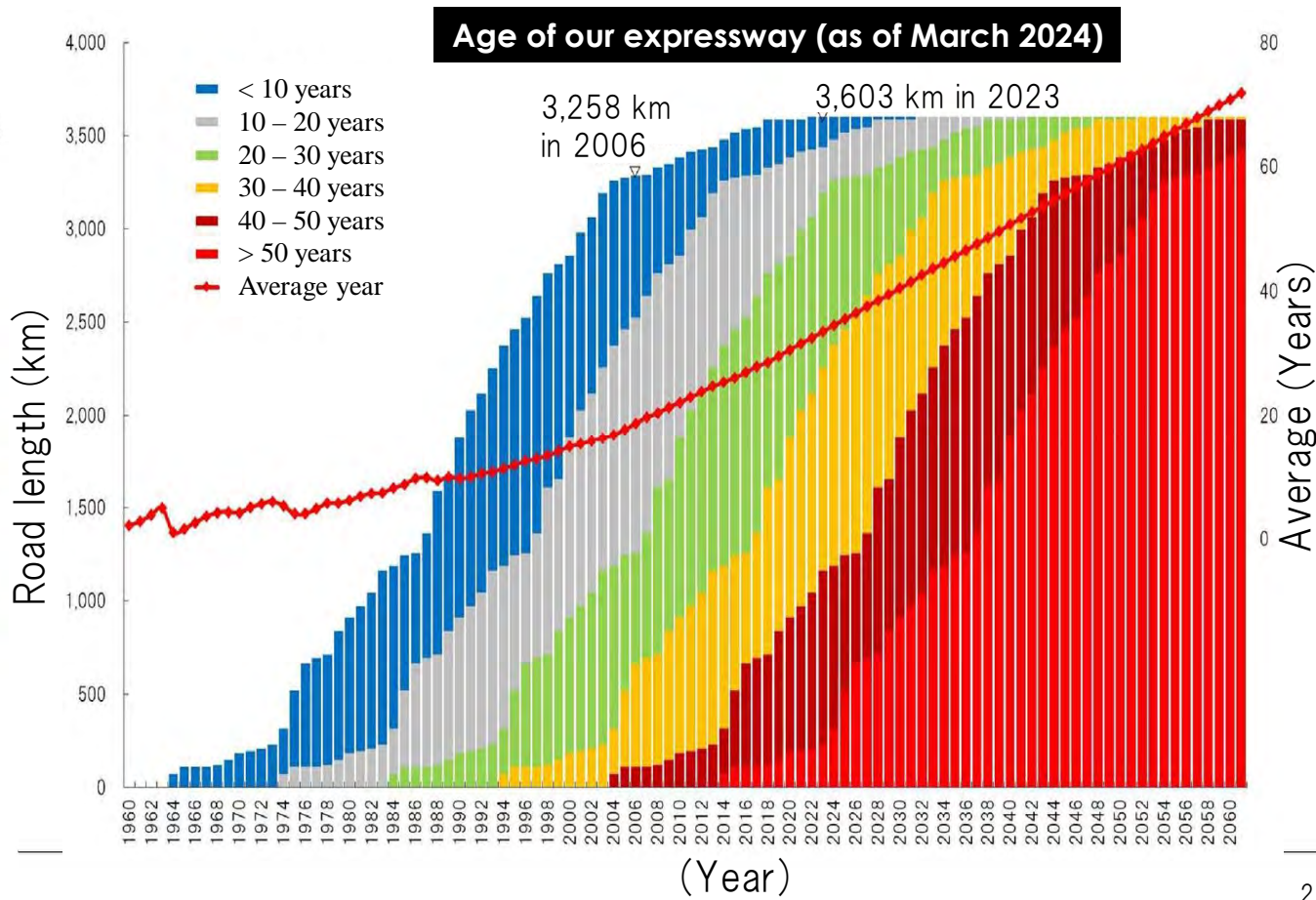
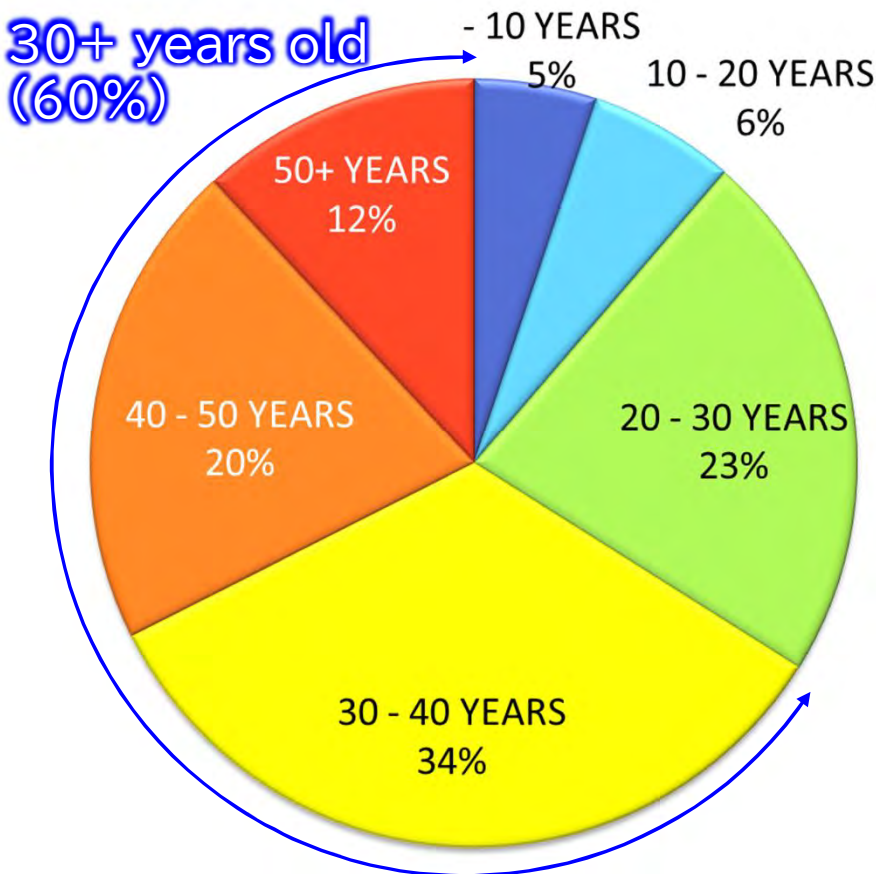
Japan Highway Public Corporation (JH)



In Service: 3,603 km

# Our Bridge Situation

- Maintaining approx. 670 km of bridges (Total length of outbound lane)
- About 60% of bridges are more than 30 years



# Our Bridge Inspection (Conventional Methods)



**Daily Inspection**



**Basic Inspection**

(Visually while driving, (getting off as needed)) (Annually: visual inspection from the ground)



**Detailed Inspection (every 5 years: Close-up Visual/ Sounding)**



# Bridge Inspection Technologies



- The Road Act mandates detailed close-up inspections every 5 years from 2014.
- The new regulations caused a significant increase in inspection costs (more than double)
- Inspections for hard-to-access locations and improving the efficiency became an urgent issue.
- NEXCO-West began to actively implement other techniques.

## Traditional Method



Movable Staging



Snooper



Scaffold



Rappelling

## New Technologies



High-Definition Camera



Thermal Camera



Drone



# Bridge Inspection Technologies



## Auto-CIMA

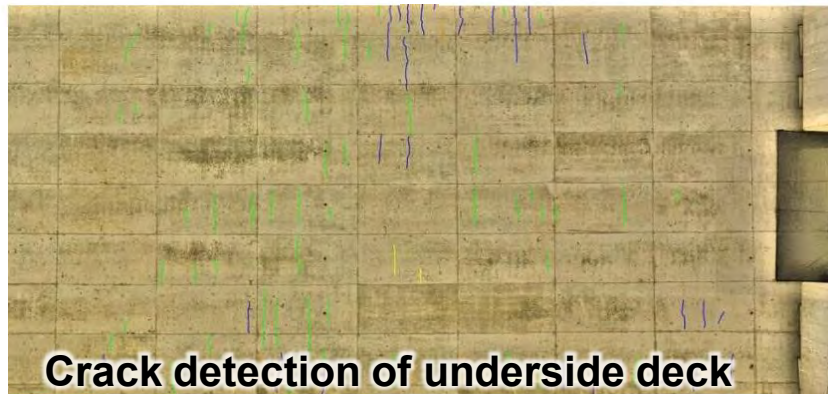
- ✓ Automatic photographing & stitching pictures
- ✓ Automatic crack & efflorescence detection
- ✓ Easy to make inspection record



(e.g.) Target defects



Photographing situation



Crack detection of underside deck

## Drone (UAV)

- ✓ Apply for bridges that difficult to approach
- ✓ Can reduce cost and improve safety.



Temporary Scaffolding



Snooper



UAV

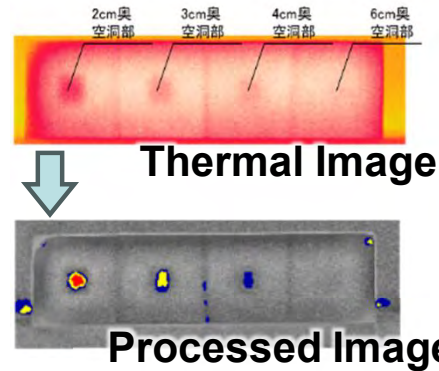


# Bridge Inspection Technologies



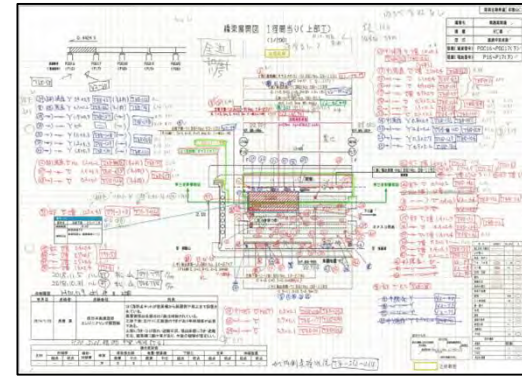
## Infrared Thermography

- ✓ Detect invisible delamination
- ✓ Prevent third party accident by fallen concrete



## Tablet

- ✓ Electronic tablets linking company's inspection data management system
- ✓ Eliminating time for manual data recording

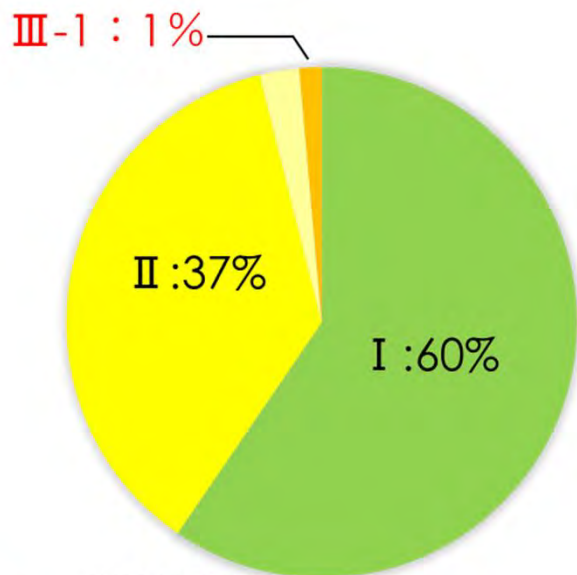


# Bridge Condition Rating



- ❑ Condition of the major bridge components (decks, girders, substructures, bearings) are evaluated every 5-year
- ❑ The entire bridge is evaluated based on the condition of each component.
- ❑ Bridge condition is evaluated in a six-step model. (National inspection standards: 4-step rating model)
- ❑ These ratings help classify which bridges are gradually deteriorating (CS-II) and which must be repaired within the current 5-year inspection cycle (CS-III).

## Bridge Condition (Inspected in 2019 - 2023)



IV	Severe
III-2	Poor -2
III-1	Poor -1
II-2	Fair -2
II-1	Fair -1
I	Good

- ❑ The percentage of bridges with CS-II and CS-III are steadily increasing.
- ❑ By individual element, the defects in girder ends are increasing due to exposure to water.



# Impact of the Winter Maintenance



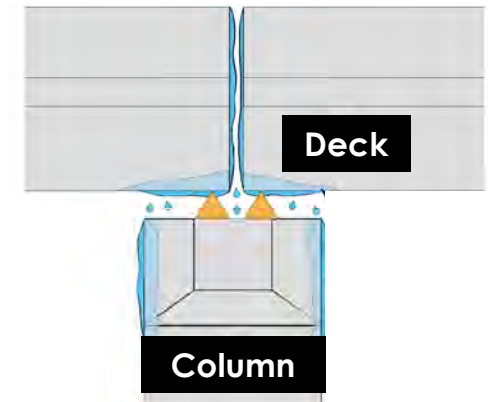
- ❑ de-icing salts for winter maintenance are highly influential to the bridge deterioration.
- ❑ Distributed de-icing salts goes through the expansion joints onto girder ends and bearing



Winter maintenance



Girder ends and Bearings (46% of CS-III)



# Repair and Rehabilitation

## ❑ Issues on the Deck Top



❑ Partial Replacement



## ❑ Fatigue of the Deck



❑ Deck Overlay



## ❑ Girder Edge



❑ Patch



# Repair and Rehabilitation

## ❑ Corrosion in Steel Beam



## ❑ Steel Plate Attachment



## ❑ Paint Deterioration



## ❑ Re-Painting



## ❑ Bearing Issue due to Water



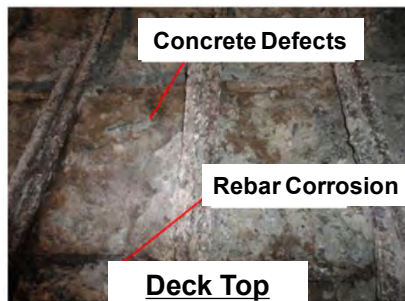
- ❑ Rep the Bearing
- ❑ Coating on Concrete Surface



# Deterioration of Concrete Decks

- ❑ Serious issues due to aging, application of de-icing salts, increased volume of traffic including over-loaded trucks.
- ❑ Older bridges were constructed with outdated design and construction standards, and these caused significant deterioration.

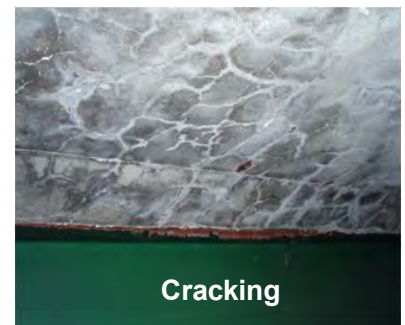
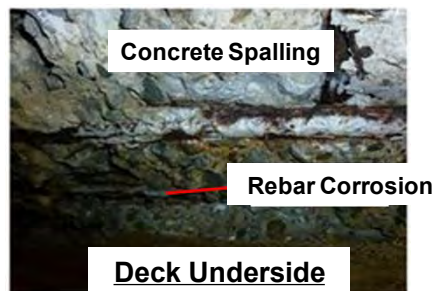
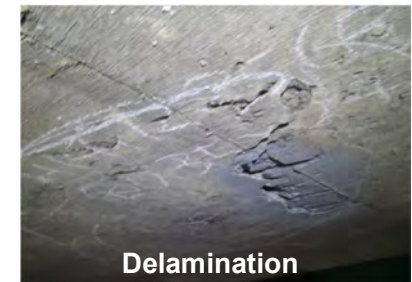
Example 1



Example 2



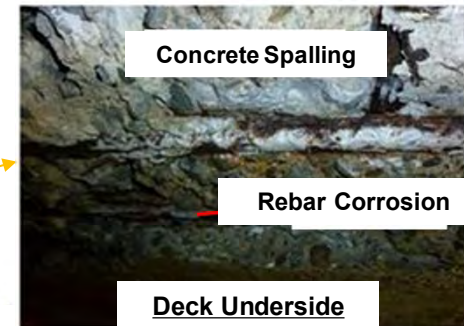
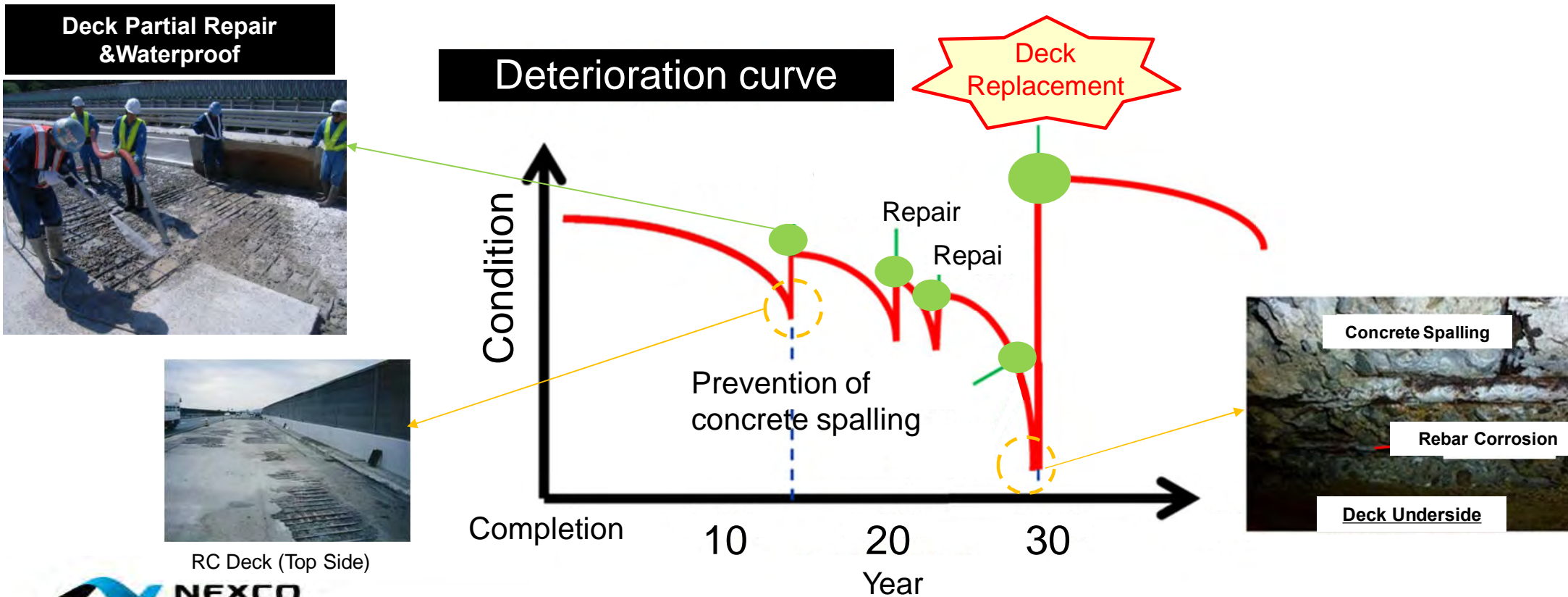
Example 3



# Highway Structure Renewal Project



- ❑ Our bridges have not been restored to a desirable condition even after repeated repairs.
- ❑ For such bridges, renewal projects, such as deck replacements, were initiated in 2015.



# Highway Structure Renewal Project

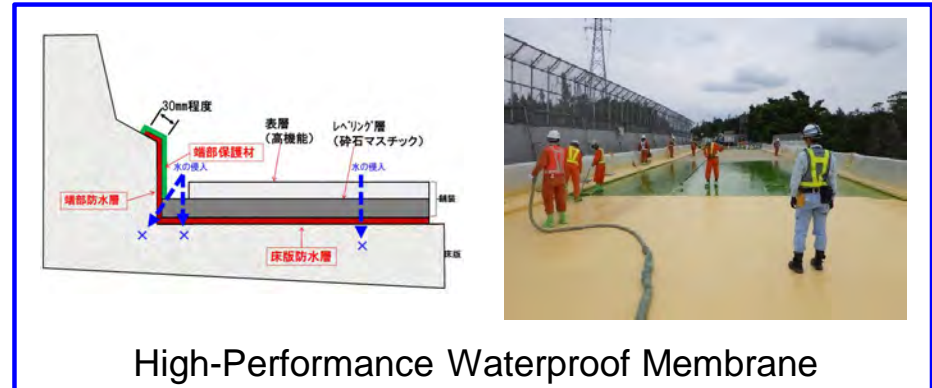


- ❑ Renewal projects included tunnels and slope protection structures, as well as bridges.
- ❑ 70% of the total budget of \$27 billion is allocated for bridges.
- ❑ Deck replacement alone accounted for 60% of the total budget.

	Item	Qty	Budget
Major Replacement	Bridge Deck Replacement	233km	\$16,016M
	Bridge Deck Rehab	615km	\$3,161M
Major Rehab	Slope Rehab	26,556 slopes	\$3,420M
	Tunnel Rehab	141km	\$4,859M
<b>Total</b>			<b>\$27,455M</b>

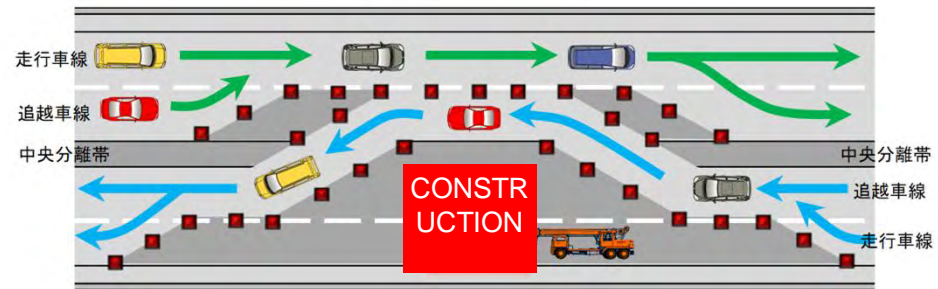
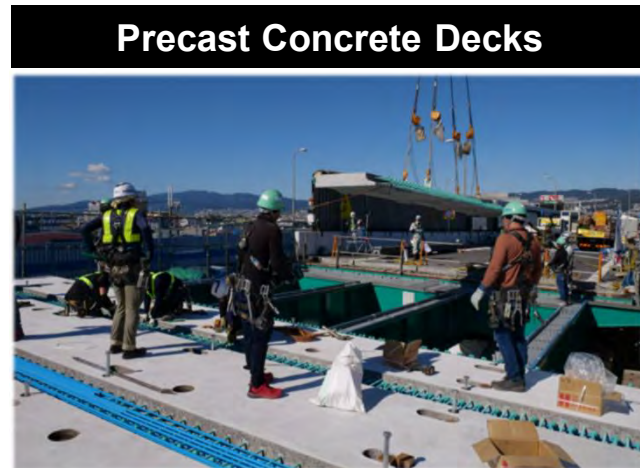
← (60%)

← (10%)



# Typical Method to Replace RC decks

- ❑ To reduce construction time onsite, Precast Concrete Decks are being used instead of cast-in-place.
- ❑ 4-lane roads are consolidated to 2-lanes on each side of the expressway with a two-way traffic operation. (In lower traffic volume areas)
- ❑ In the secured work zone, the existing deck is removed and replaced with the precast decks.

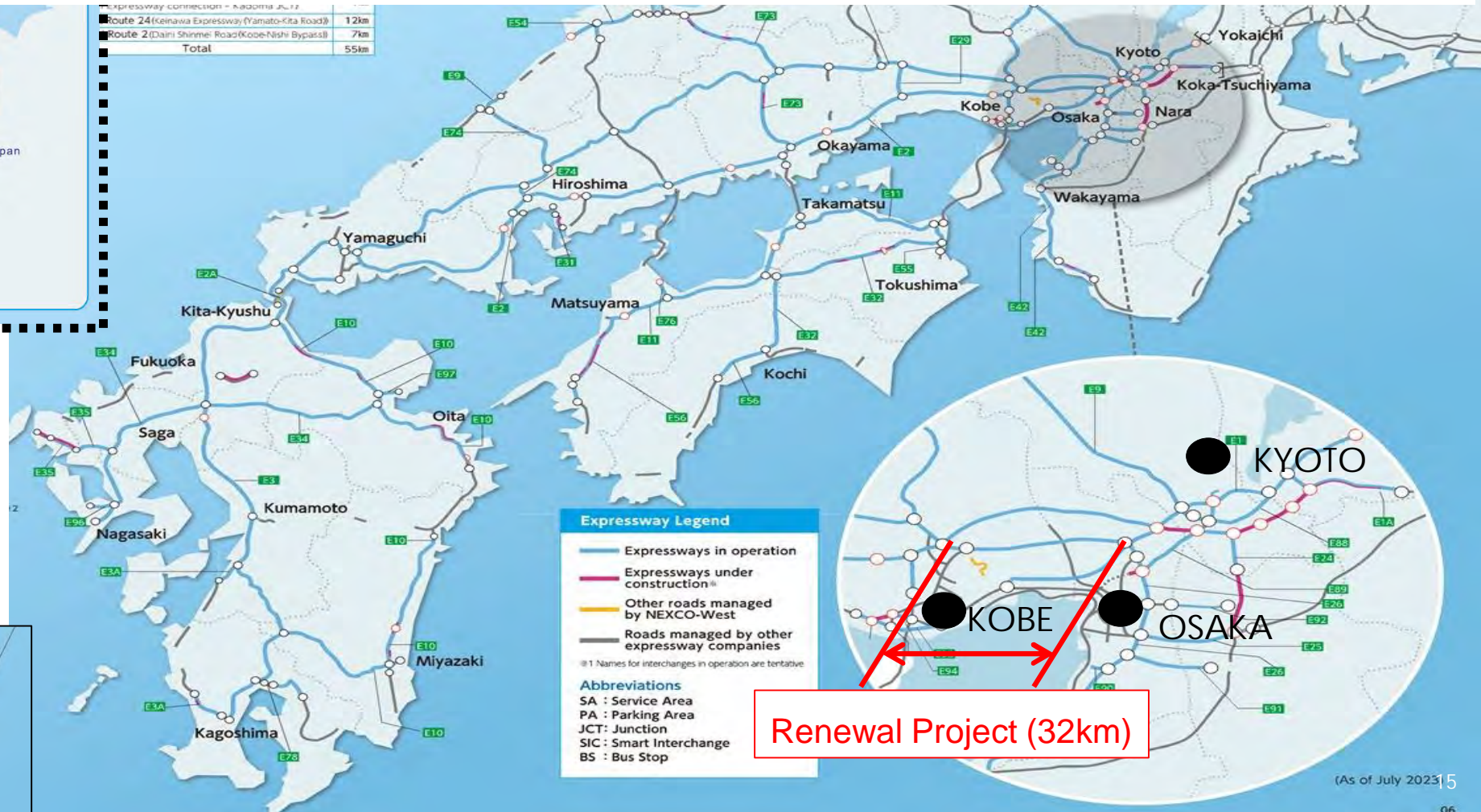


# Bridge Deck Renewal Project at Chugoku Expwy

Bridge deck renewal project currently underway at Chugoku Expressway (510km in length) in the urban area between Osaka and Kobe (32km).



Expressway connection - Kadoma JCT	
Route 24 (Seinawa Expressway (Yamato-Kita Road))	12km
Route 2 (Daimi Shimmei Road (Kobe-Nishi Bypass))	7km
<b>Total</b>	<b>55km</b>





# Bridge Deck Renewal Project at Chugoku Expwy

- ❑ This section of highway was constructed just before the 1970 Osaka Expo (about 50 years old)
- ❑ This area has been urbanized in 50 years, and our bridges became deteriorated.

**< Osaka Expo >**  
**1970/3/15 –**  
**1970/9/13**



(Source) Expo '70 Commemorative Park website: <https://www.expo70-park.jp/cause/expo/#caption2>

**Chugoku EXPWY (Current)**



**Bridge Deterioration**

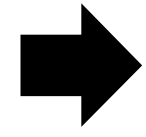


**< Chugoku EXPWY >**  
**Opened on 1970/3/1**



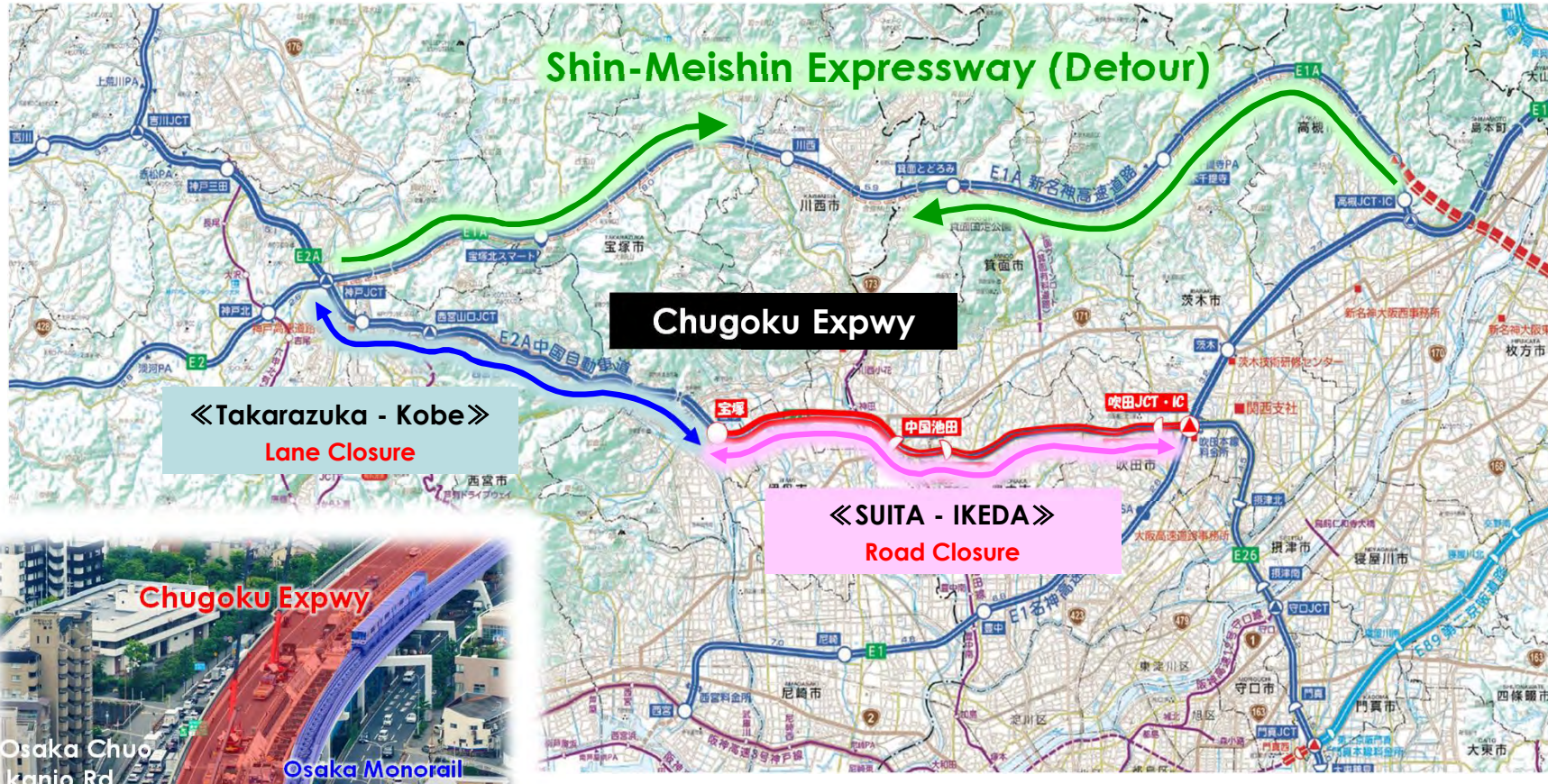
**Less toller buildings**

**50 years**



(Source) Geospatial Information Authority of Japan website: <https://mapps.gsi.go.jp/contents/ImageDisplay.do?specificationId=418437&isDetail=true>

# Bridge Deck Renewal Project at Chugoku Expwy

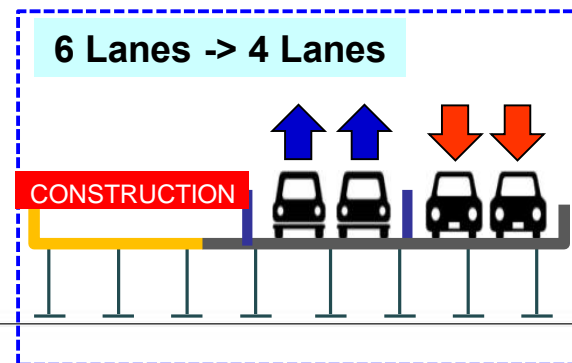
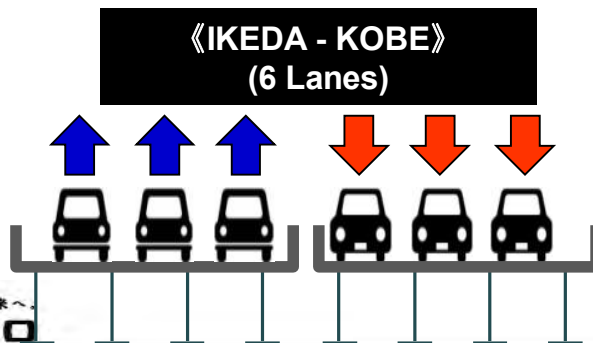
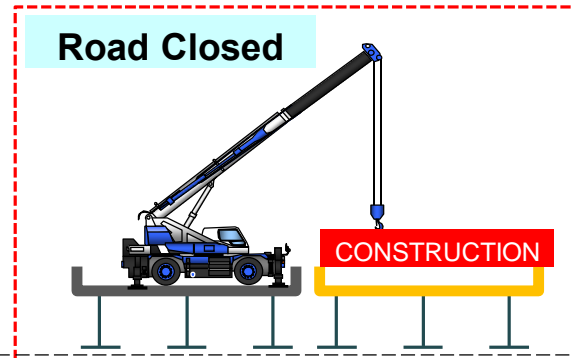
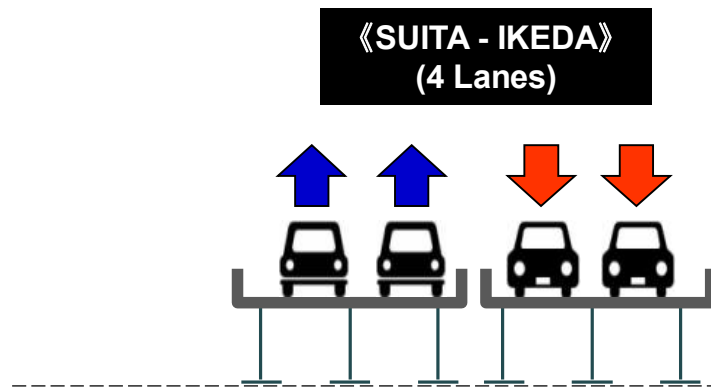


- ❑ Waited completion of the parallel Shin-Meishin Expressway before proceeding with the Chugoku Expressway Renewal project to secure the alternate route.

# Bridge Deck Renewal Work Zone Management



- ❑ If we were to implement conventional deck replacement methods, it would cause serious traffic congestion.
- ❑ 100-day road closures between Suita and Ikeda were performed for 2 years, while the Shin-Meishin Expressway and local road parallel to Chugoku Expressway served as detour routes.
- ❑ For a 6-lane section between Ikeda and Kobe cities, 2-lanes for each direction was secured during the construction.



# Design Features for Bridges in Chugoku Expwy



❑ Construction before the Osaka Expo took place over a very short period: within 3 years.

- ❑ A **uniform standard cross-section design** was used for mass-production.
- ❑ Composite girders with large rolled H-beams and welded H-beams

- ❑ To **reduce overall girder weight**, High-strength materials and cut composite girders were used.

➔ **Smaller beam height** and **cross-section** than usual, resulting in **less fatigue durability**.

The tight construction timeframe prioritized delivery over performance.

	Toyonaka Viaduct	Typical Design
Cross-Section View		
Beam spacing	<b>4.0m</b>	2.6m
Tensile Strength	<b>570N/mm2</b>	490N/mm2
Weight of Steel	<b>150t</b>	210t

**Steel beams were also replaced in addition to the concrete decks.**

# Bridge Jack-Up for Accelerated Bridge Construction



- ❑ Before upcoming 30-day closures, newly fabricated girders were assembled in the work zone under the bridge, then are jacked-up near the existing girders.
- ❑ Once road closure is initiated, the existing decks and girders were removed, the new girders jacked further up to final height, and the precast decks were placed on top of the girder.
- ❑ This method reduced the time needed for placing new girders and scaffolding, leading to an efficient, safe, and short construction effort.



Thank you for your attention

