

# New Technology for Highway Deck Plate Replacement

تكنولوجيا جديدة لاستبدال لوحة السطح للطرق السريعة

Hanshin Expressway has maintained 250-km long elevated highways in Osaka and Kobe Area, Japan for more than a half century. Consequently, 40% of entire network is older than 40 years under the heavy urban traffic. The introduction of a new technology to replace aging and damaged concrete bridge deck plates is a cutting-edge solution to realize longer-life expressway structures.

## Water-Jet Cutting for quick removal of deteriorated rigid concrete bridge deck plate

For shortening road closure, some parts of rigid concrete are preliminary removed to expose connection studs between bridge girder and deck plate.

### Advantage of Water-Jet Cutting Method

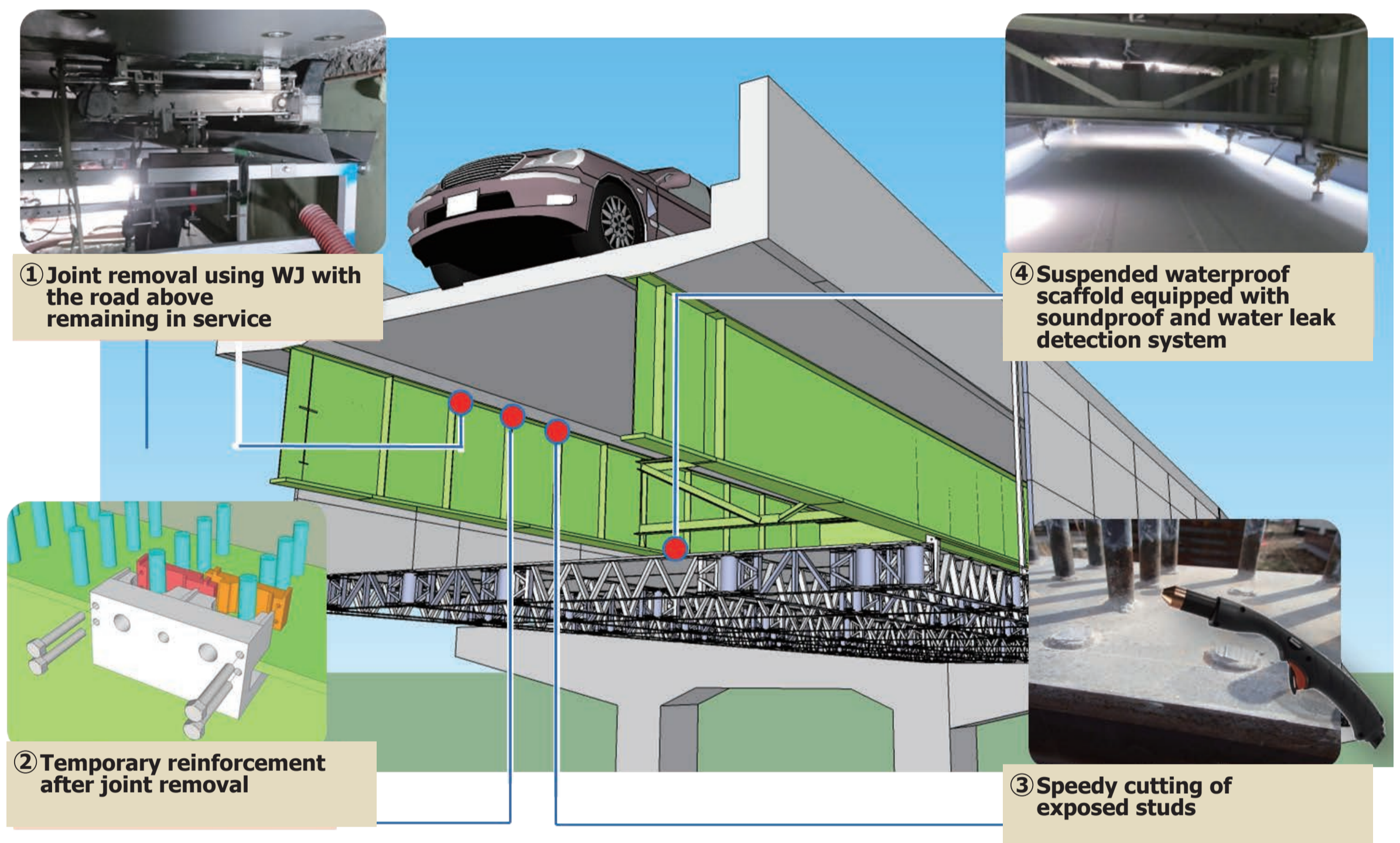
- During road closure, rigid concrete deck plate can be removed easily by simply removing remaining stiffener used during construction and cutting connection studs by plasma cutter.



Apply WJ to remove the connecting concrete



Install temporary reinforcement (flange guard) between the girder and the floor base

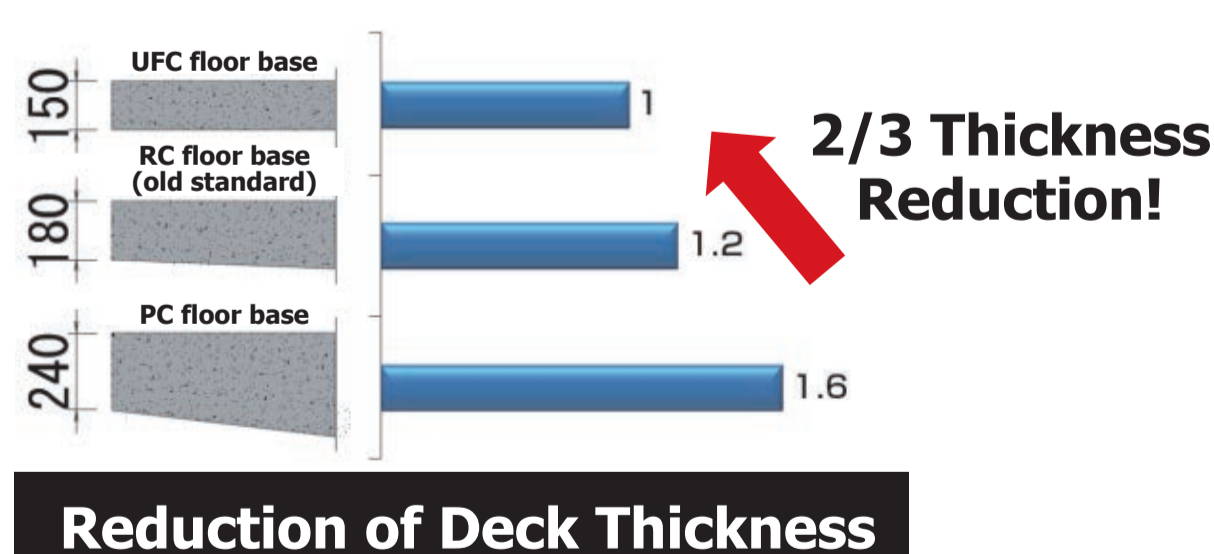
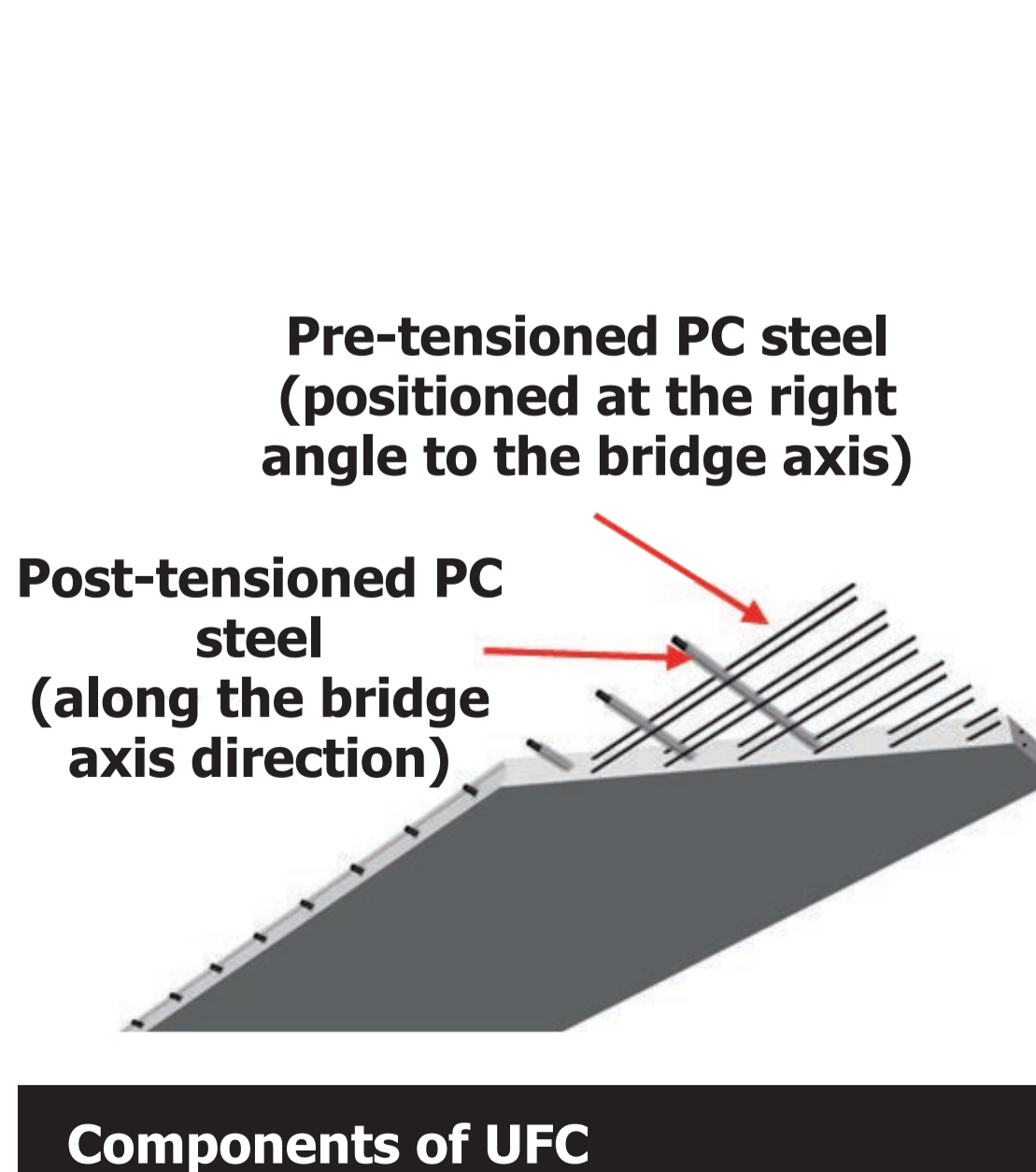


## Ultra strong Fiber reinforced Concrete for bridge deck plate -Lightweight, durable and easy installation-

Newly developed lightweight and durable rigid concrete bridge deck plate called "Ultra-strong Fiber-reinforced Concrete (UFC)". deck plate is lighter and more durable than conventional pre-stressed concrete deck plate. UFC deck can be flexibly applied to existing deck replacement projects and, therefore, is highly useful for bridge rehabilitation project especially in urban area.

### Advantage of UFC deck

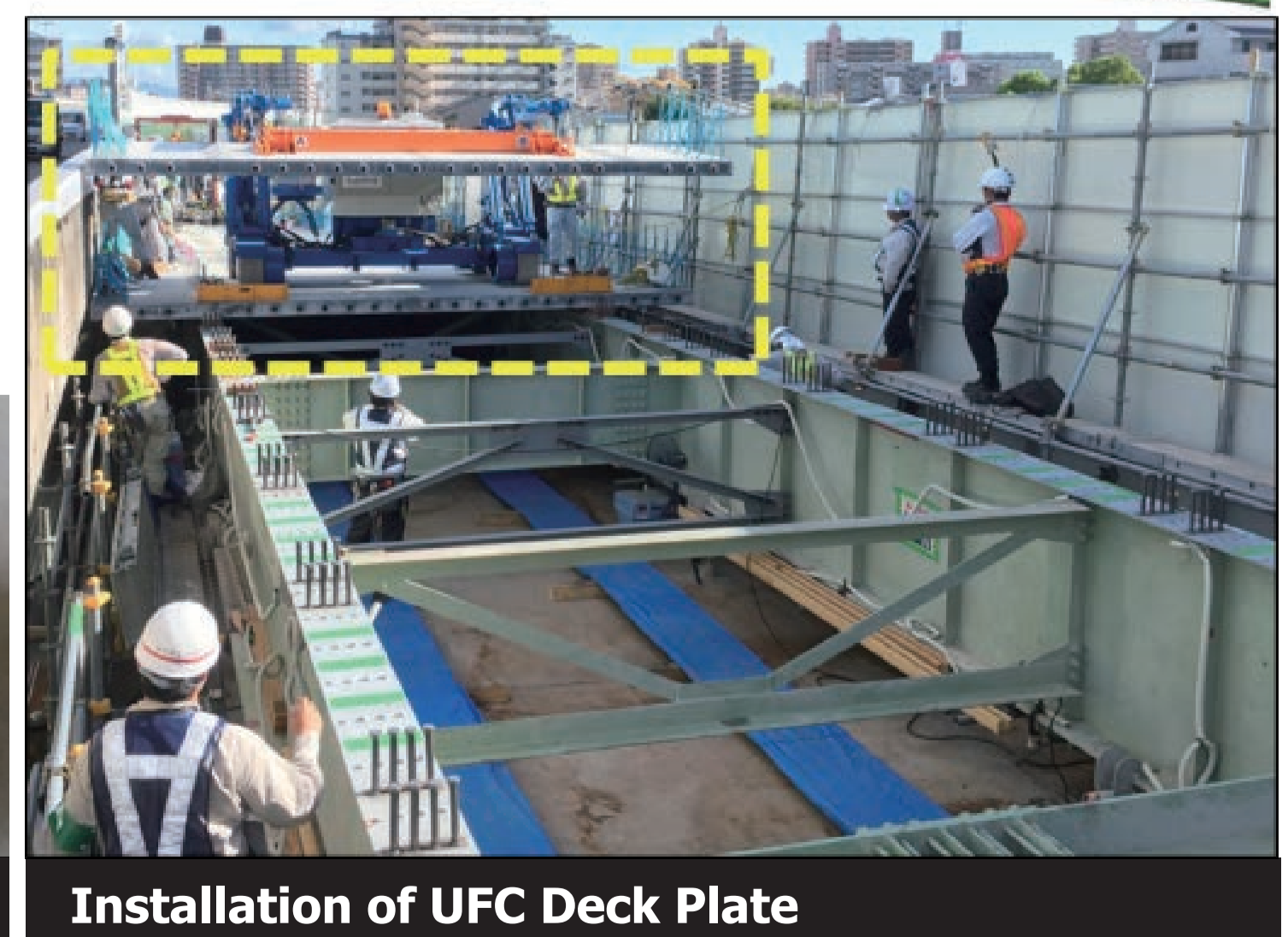
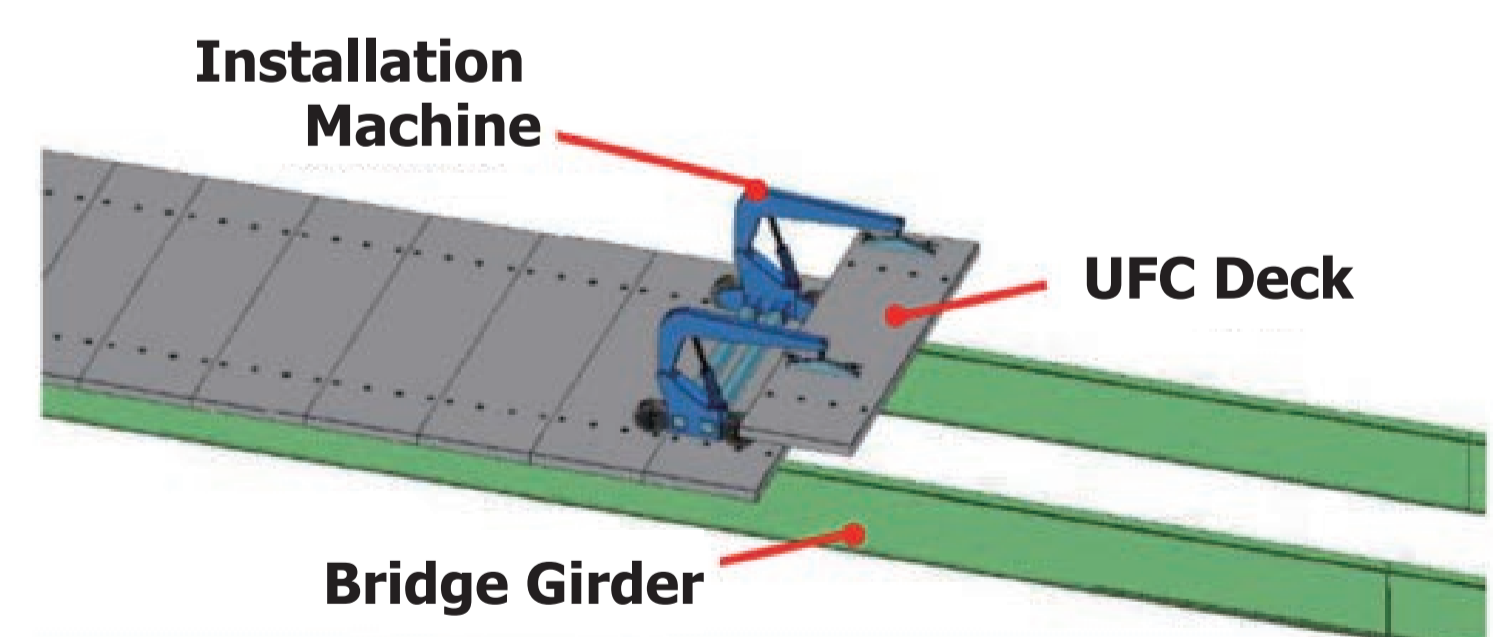
- High durability material and two-dimensional pre-stressing technology contributes weight reduction for two-third, thickness reduction by 17%.
- Less preliminary treatment needed to the main girders



Reduction of Deck Thickness



Use of Fibers inside Concrete



Installation of UFC Deck Plate

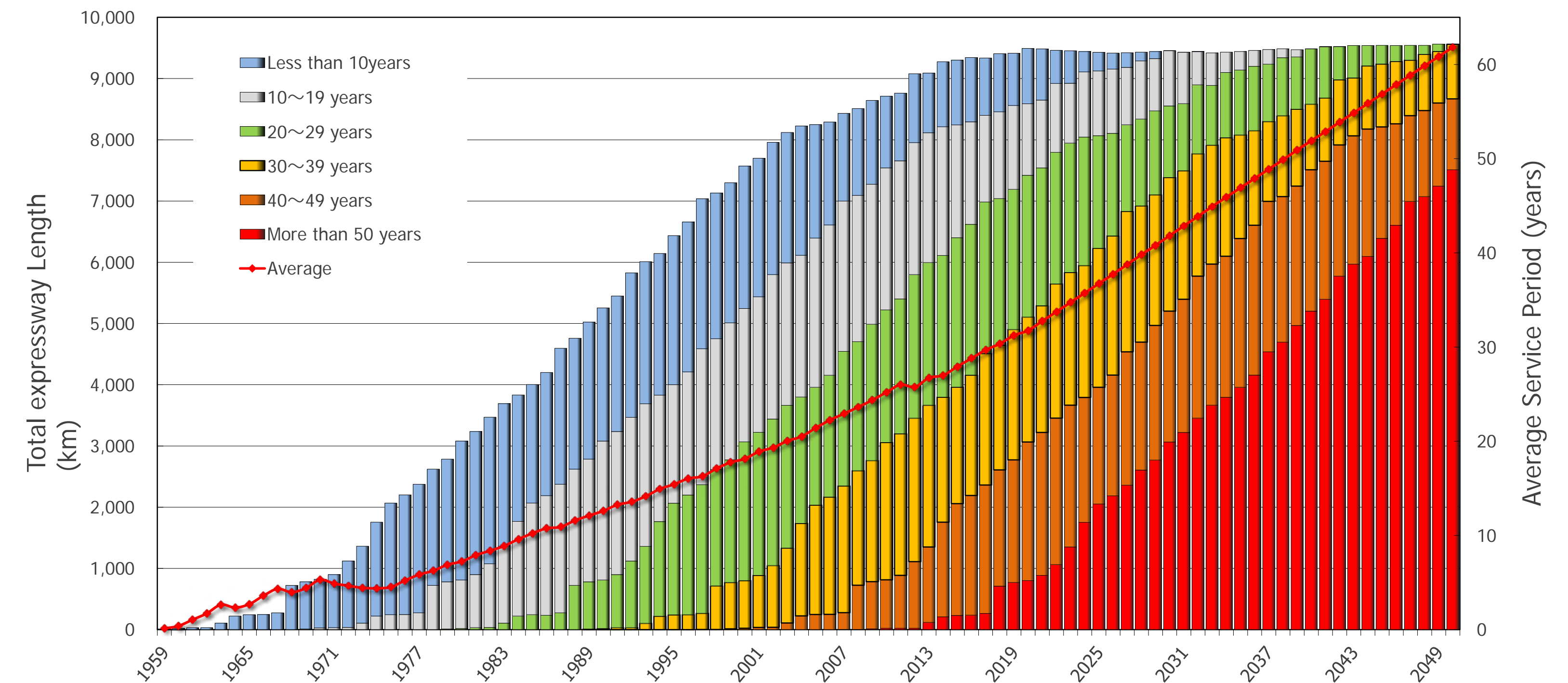


# Ageing Road Assets

## متقادم

### Current situation and problem of expressways

- ◆ At least 40% of the total expressways-length has been operated for more than 30 years and because of this, the expressways are seriously deteriorated.
- ◆ At least 40% of the total bridge-length and 20% of total tunnel-length were also constructed more than 30 years ago and they are facing increased risk by the aged deterioration.
- ◆ The total vehicle weight is increasing with the increase in the number of large-scale vehicle on the expressways. The expressways are under severe conditions such as increasing in the usage of anti-freezing agent (NaCl) and the increase in the amount of extreme rainfall for a short time.



Elapsed years of the expressway transition



Severe environment in snow region



Concrete cracks and float



Concrete free lime

Damaged Condition

# Expressway Renewal Project

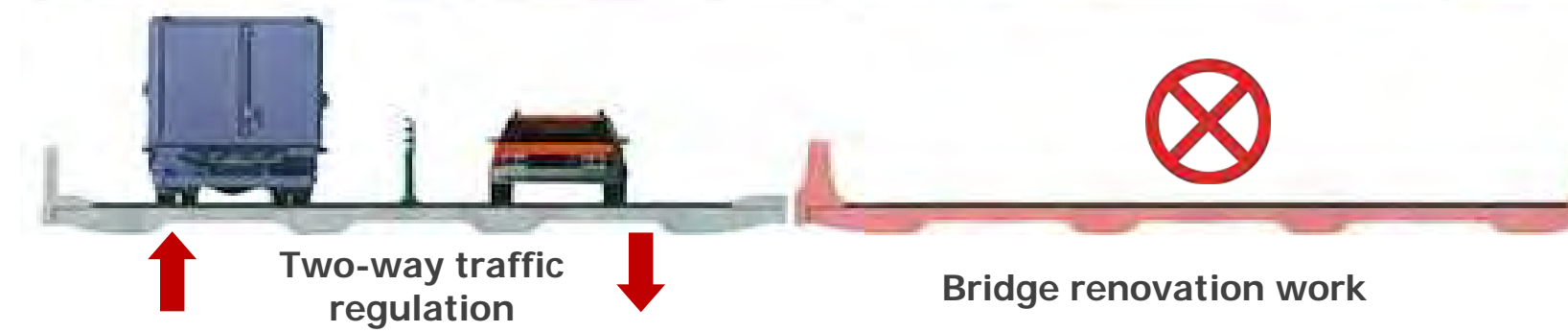
التجديد

## Severe deterioration on slab lower surface



## Large-scale renovation for bridges

e.g. Replacement of RC concrete slab with PC precast slab



Open to Traffic (1963)



Deteriorated Structure (2014)



Undergoing Renewal Works (2019)



Renewed Segment (planned in 2026)

# Expressway Inspection & Diagnosis

## التفتيش والتشخيص

### Road Surface

One of unique road surface inspection vehicles, not only can measure rutting, cracking, and flatness ( $\sigma_{10ft}$ , IRI) but also longitudinal and transverse pavement measurements without making contact with the pavement.

It can smoothly and safely perform all 6 functions at 100km/h without impacting the flow of other traffic.



High-Speed Road Surface Measuring Vehicle (Road Tiger)

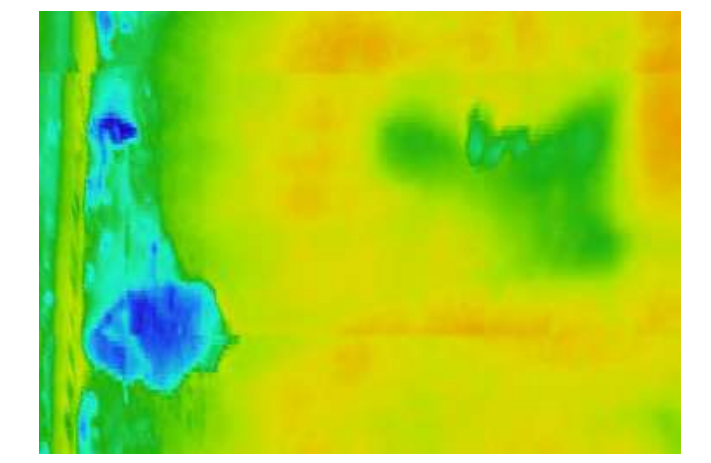
### Bridge

#### Digital camera/video camera system - Crack inspection:

High definition images taken by digital camera or video camera makes it possible to inspect the surface of a structure in the same way as the close visual inspection. Through a computer analysis of the images, the cracks are automatically detected.

#### Infrared Camera System – Delaminations /spill inspection:

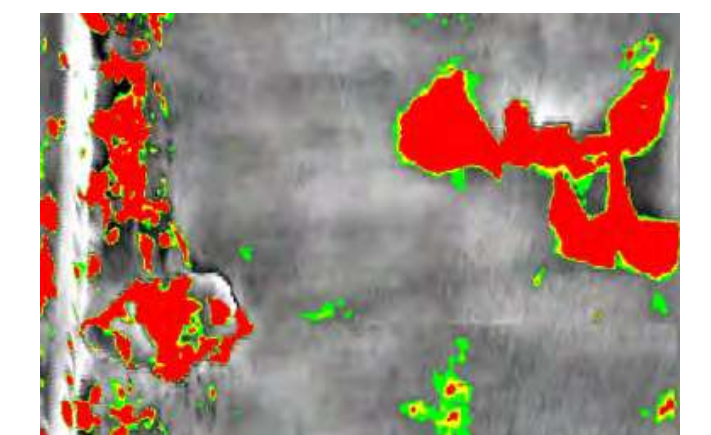
The infrared camera system takes images which is analyzed automatically and displays the damage level in three stages. Because damages are objectively analyzed by software, bias or oversight in measuring caused by skill difference can be prevented. In addition, this system helps to create a research report since the detected results are easily captured on spreadsheets or word processing software. This system has gotten track records in the U.S.



Infrared thermal image



Bridge inspection using Infrared Camera System



Damage is detected by computer analysis

### Tunnel Liner



Inspection vehicle

Filming in a tunnel



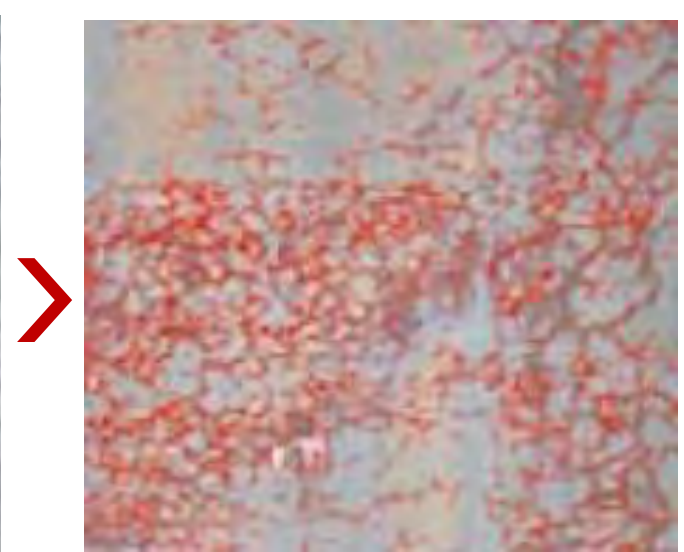
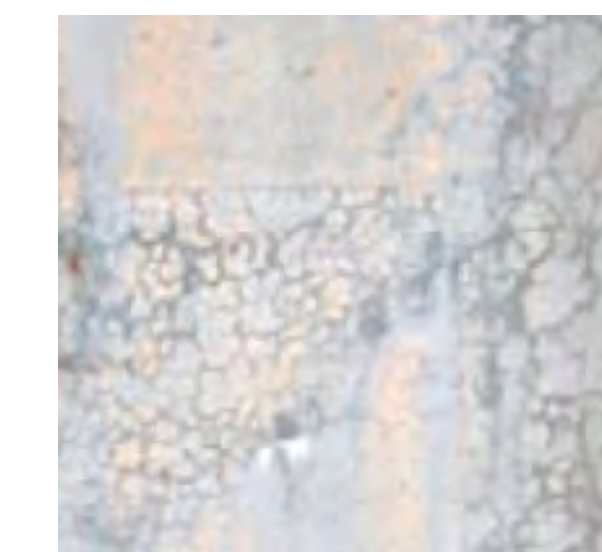
Crack analysis (minimum 0.2mm in width)

#### Tunnel liner inspection vehicle:

It is now possible to obtain a clearer image at a speed of 100km/h by adopting the line sensor camera instead of the conventional video camera. In addition, because the photographing illumination using LED infrared illumination is not visible to the naked eye, it no longer influences on the passing vehicles on the opposite direction. Moreover, this vehicle automatically identifies the cracks by the captured image.



Bridge inspection using Digital Camera System



Automatic crack-analysis by computer



Video Camera System

# Disaster Management

## الوقاية من الكوارث

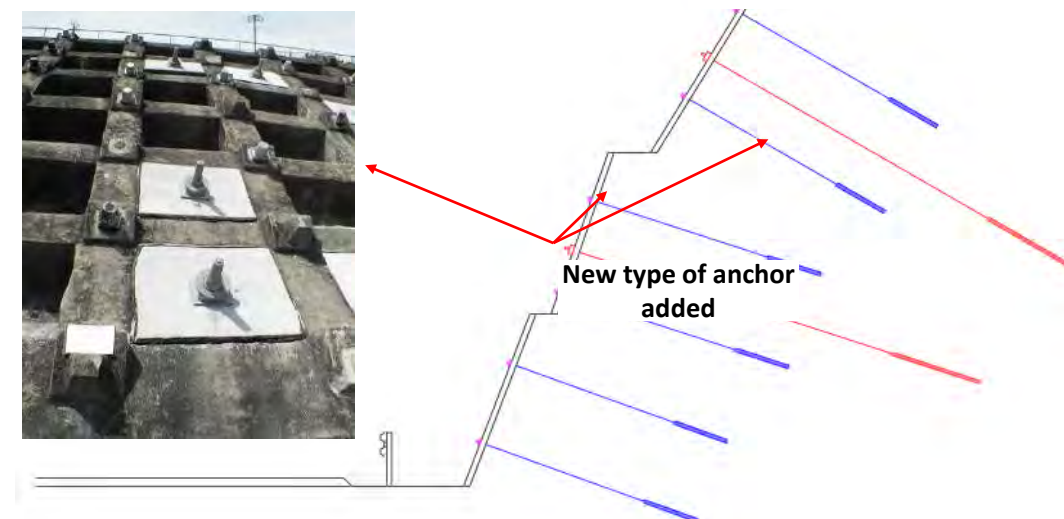
### Disaster Prevention

Disaster caused by extreme rainfall for a short time



#### ◆ Ground anchor

New type of anchor installation filling up traditional anchor with inadequate anticorrosion function



#### ◆ Slope Protection Work

Measures against land slide



### Use of rest areas as disaster-management bases

In the Great East Japan Earthquake, the Self-Defense Forces and firefighters heading to stricken areas used expressway rest areas as relay and support bases. Based on this experience and various issues, authorities are bolstering their disaster-response capabilities across Japan to respond effectively and efficiently to emergencies, using Moriya SA on the Joban Expressway as their model.

#### ◆ Moriya Service Area (Southbound) on Joban Expressway, as a disaster management base

##### Disaster-response warehouse

Inflatable tents for outdoor use, emergency food and rations, relief supplies, traffic regulation equipment and other supplies are store at this Disaster-response warehouse



##### Emergency vehicle entrance/exit

Used by emergency vehicles to enter and exit outside of expressway in times of disaster



##### Generators and rooftop solar-power generation facilities



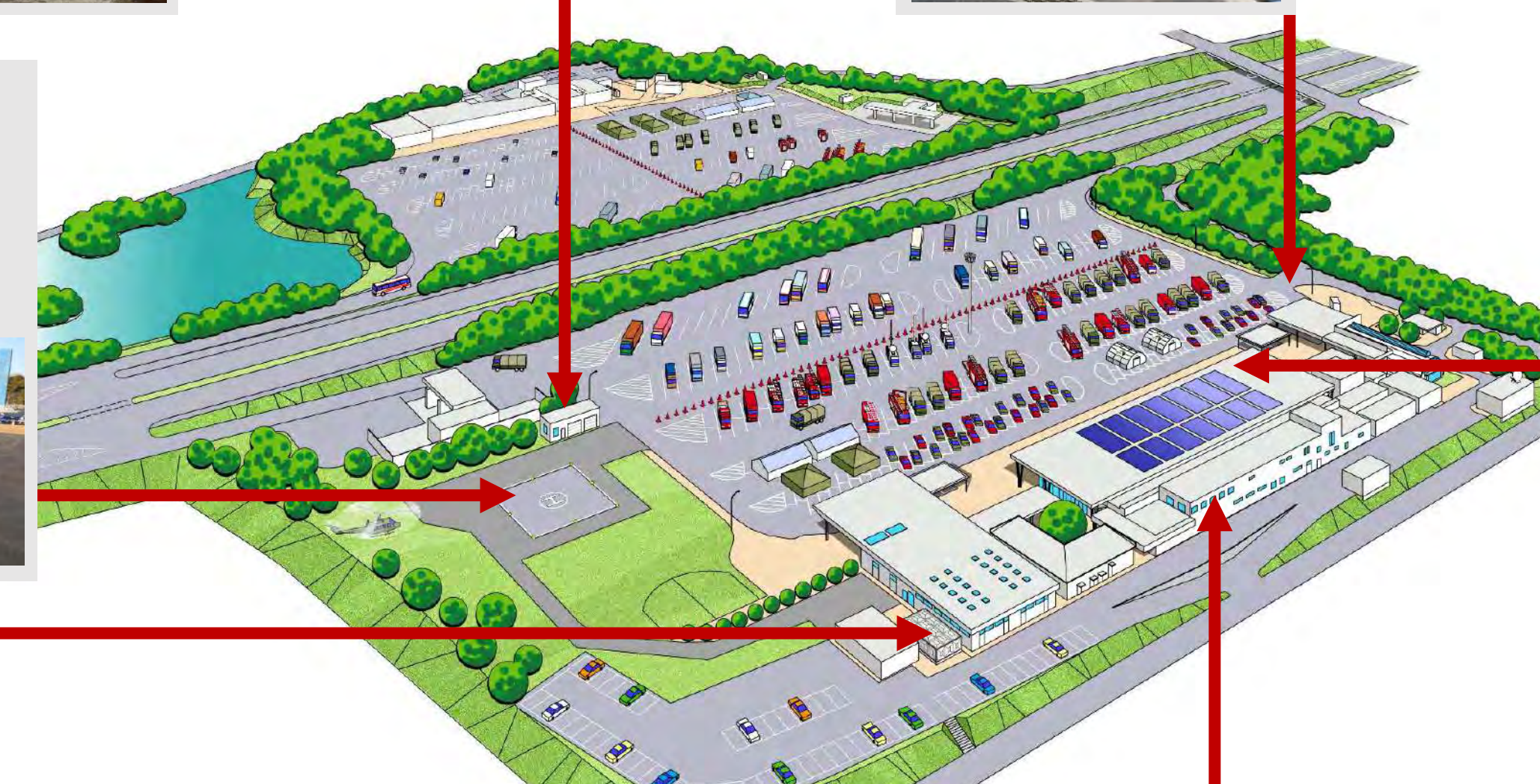
Solar-power generation panels on the roofs of commercial facilities



Generators enable continuous use for 72 hours

##### Heliport for mid-size Helicopters

Nighttime illumination and a helicopter office have been installed, enabling safe landing and take-off day and night



##### Well

A well has been dug in case of interruption of water supply



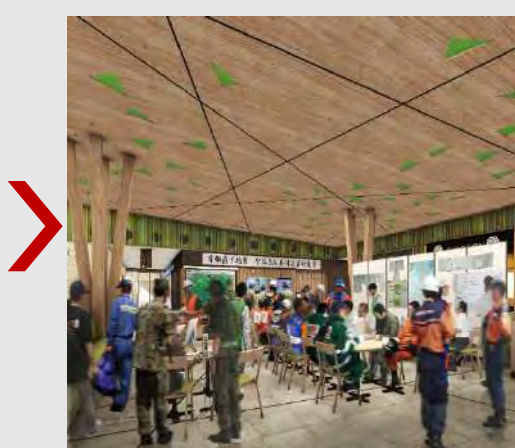
##### The food court is used as a disaster management office (1st Floor)

The food court layout can be rearrange for use as a disaster management office, under disaster situations

- Electrical power outlets and TV antenna terminals are installed
- Large monitors and whiteboards are installed



General situation



Emergency situation

##### First-aid space (2nd Floor)

The employee break lounge can be used as a first-aid



### The recovery of the Tomei expressway in Makinohara area

Immediately after the Surugawan earthquake, NEXCO-Central started emergency checkup and stopgap recovery, and 4 days later, finished temporary recovery for general traffic.



Aug. 11<sup>th</sup> 2009



Aug. 15<sup>th</sup> 2009 (4 days later)

### Earthquake Museum for educational assistance on disaster prevention

Great Hanshin-Awaji Earthquake occurred in January 1995, took precious lives and destroyed cherished livings of local communities. Earthquake Museum conveys how Hanshin Expressway responded in the 623 days to complete the restoration of the expressway system. It displays damaged structures and introduces new technologies and various activities which put into practice based on the lessons including disaster management support and educational assistance for disaster prevention.



# Expressway Network in Japan

شبكة الطرق السريعة في اليابان

Japan's Expressways are built and operated by six companies.  
The total length in operation is 10,351km, and 331 km is under construction.



**Company Name:**  
West Nippon Expressway Company Limited  
**Head Office:** Osaka  
**Expressways in Operation:** 3,533km  
**Traffic Volume:** 2.95million vehicles/day  
**Toll Revenue:** US\$ 7.1billion  
**Expressway under construction:** 72km



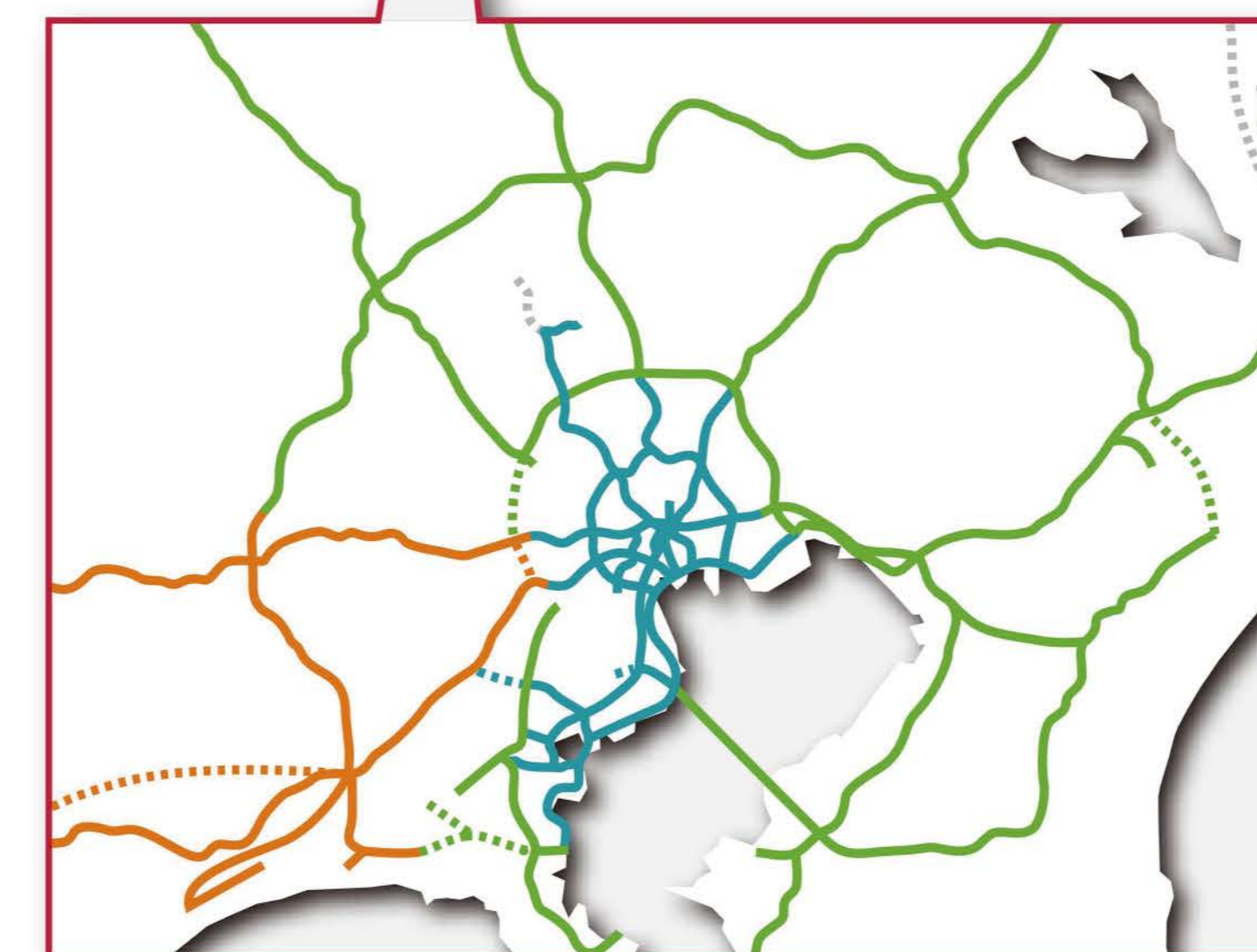
**Company Name:**  
Hanshin Expressway Company Limited  
**Head Office:** Osaka  
**Expressway in Operation:** 250.4km  
**Traffic Volume:** 0.72million vehicles/day  
**Toll Revenue:** US\$ 1.7billion  
**Expressway under Construction:** 34.2km



**Company Name:**  
Honshu-shikoku Bridge Expressway Company Limited  
**Head Office:** Kobe  
**Expressway in Operation:** 172.9km  
**Traffic Volume:** 0.12million vehicles/day  
**Toll Revenue:** US\$ 0.6billion



Fukuoka



Sapporo

Sendai



**Company Name:**  
East Nippon Expressway Company Limited  
**Head Office:** Tokyo  
**Expressway in Operation:** 3,943km  
**Traffic Volume:** 2.95million vehicles/day  
**Toll Revenue:** US\$ 7.82billion  
**Expressway under Construction:** 75km



**Company Name:**  
Central Nippon Expressway Company Limited  
**Head Office:** Nagoya  
**Expressway in Operation:** 2,132km  
**Traffic Volume:** 1.98million vehicles/day  
**Toll Revenue:** US\$ 6.30billion  
**Expressway under Construction:** 132km



**Company Name:**  
Metropolitan Expressway Company Limited  
**Head Office:** Tokyo  
**Expressway in Operation:** 320.1km  
**Traffic Volume:** 1.02million vehicles/day  
**Toll Revenue:** US\$ 2.4billion  
**Expressway under Construction:** 17.5km

———— In operation  
..... Under construction

As of JULY 1<sup>st</sup>, 2019

Note: Revenue is for year ended March 31, 2019 and calculated by the exchange rate of 110 JPY for 1 US\$