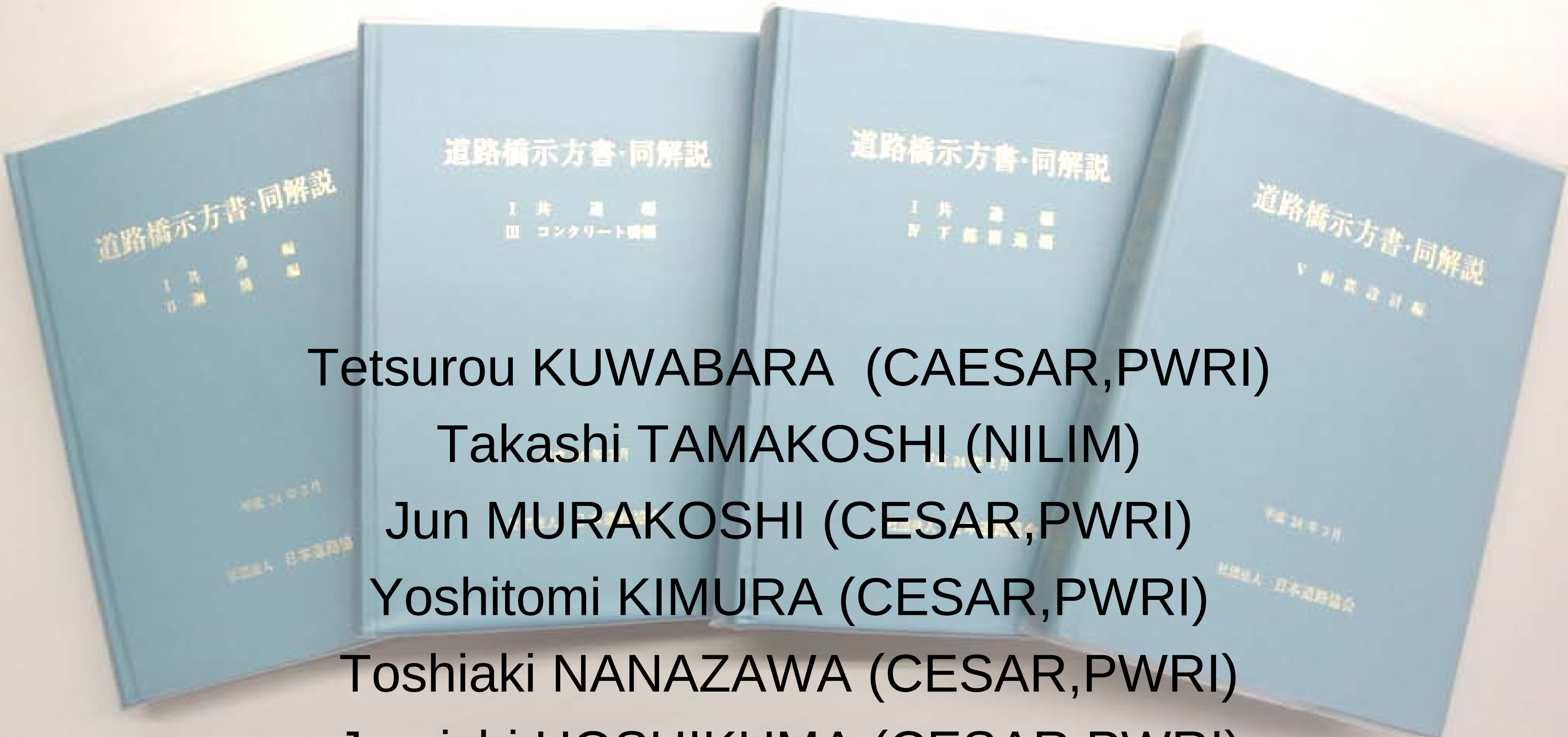
44th UJNR Panel Meeting
2013/02/20 Gaithersburg

Outline of Japanese Design Specifications for Highway Bridges in 2012



Tetsurou KUWABARA (CAESAR,PWRI)
Takashi TAMAKOSHI (NILIM)
Jun MURAKOSHI (CESAR,PWRI)
Yoshitomi KIMURA (CESAR,PWRI)
Toshiaki NANAZAWA (CESAR,PWRI)
Jun-ichi HOSHIKUMA (CESAR,PWRI)

Background of Revision of Japanese Design Specifications for Highway Bridge

The 2002 Specifications

Introduction of the performance-based design concept

Improvement of the durability to design the sustainable bridges

- ✓ Accumulation of the technical research achievements in terms of safety, serviceability and durability of the bridges
- ✓ Lessons learned from the recent earthquake, the durability related damages of existing bridges
- ✓ Review of the damage estimation by the upcoming great earthquakes such as Tokai, Tonankai, and Nankai earthquake

↓

The 2012 Specifications

Significant Points of the 2012 Specifications

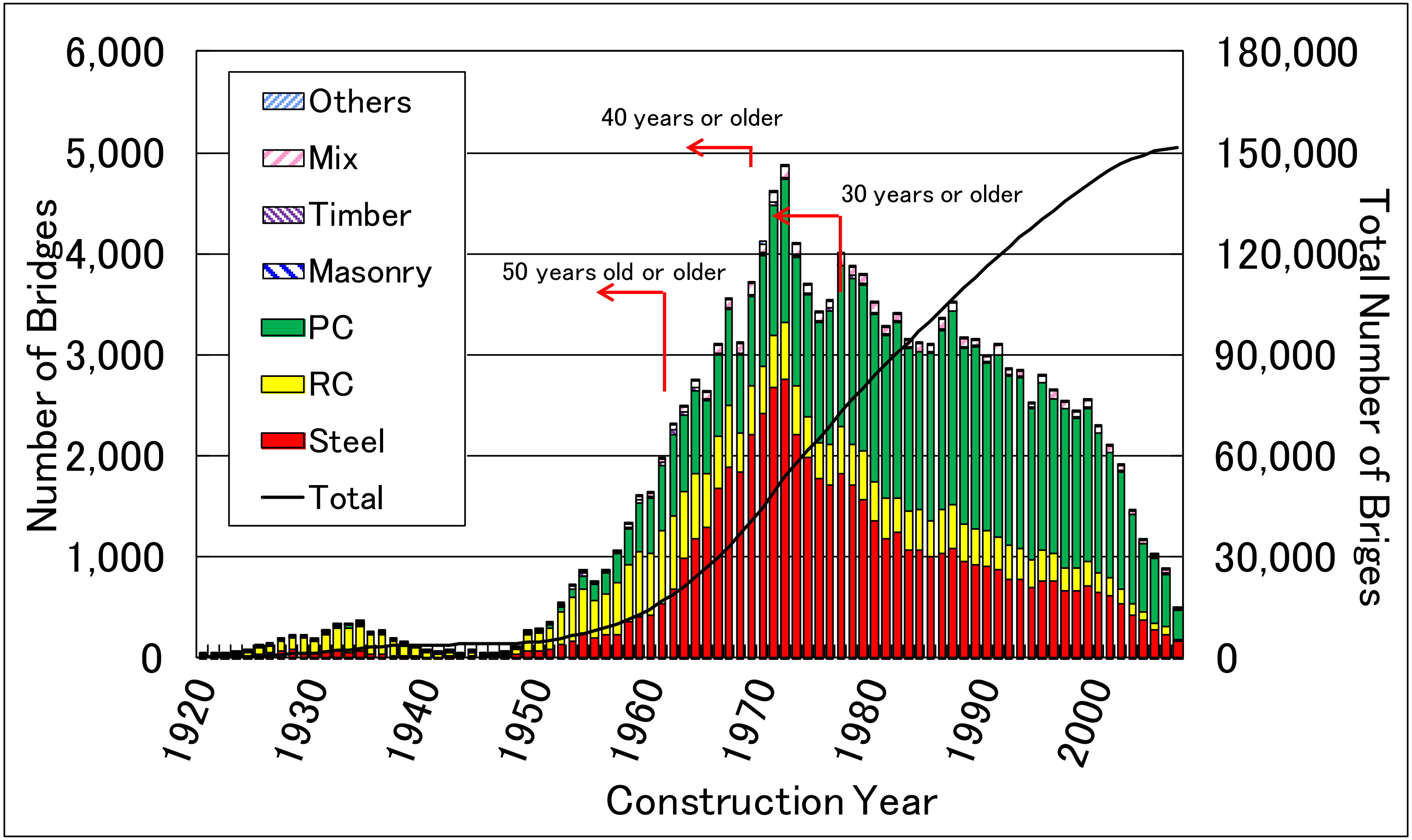
- ✓ Improvement of the requirements for easy and secure maintenance

- ✓ Revision of design earthquake ground motions for interplate-type earthquake (Level 2 Type I earthquake)

- ✓ Introduction or improvement of specifications based on recent research achievements
  - Introduction of integral abutment bridge
  - Improvement of minimum thickness of steel deck plate to enhanced fatigue durability

etc…

The Number of Road Bridges Constructed in Past Years (2011)



*Bridge length is 15m or more

Reference : Technical Note of NILIM, No.645,July 2011

Fundamental Principal of Maintenance

Damage of bearings for water leakage around end of girders

Damage of expansion joint

Fundamental Principal of Maintenance

Background

- ✓ Performance of bridges has changed by applying for various factors such as live load, seismic, environmental effects in their service period.

- ✓ To perceive change of bridge condition by bridge inspection is important to sustain the bridges for a long time.

- ✓ Most of existing bridges are difficult to inspect because they were designed without a view to inspecting.

Fundamental Principal of Maintenance

2012 Specifications

- ✓ Improve the requirements that structural systems which maintenance is expected to be difficult and insecure should be avoided.

- ✓ Bridges should be designed in consideration of maintenance methods such as periodic and emergency inspection, repair, retrofitted works easily and securely.

Fundamental Principal of Maintenance

Example of providing the walkway

Example of strengthening of main girder in advance for temporary jack up

Revision of Design Earthquake Ground Motion

Design Earthquake Ground Motion

✓Level 1: highly probable to occur during service period

✓Level 2: high intensity with less probability to occur during the service period

<Type I> Ground motion by large-scale interplate earthquake in the subduction area

<Type II> Ground motion by near-field shallow earthquake

Background

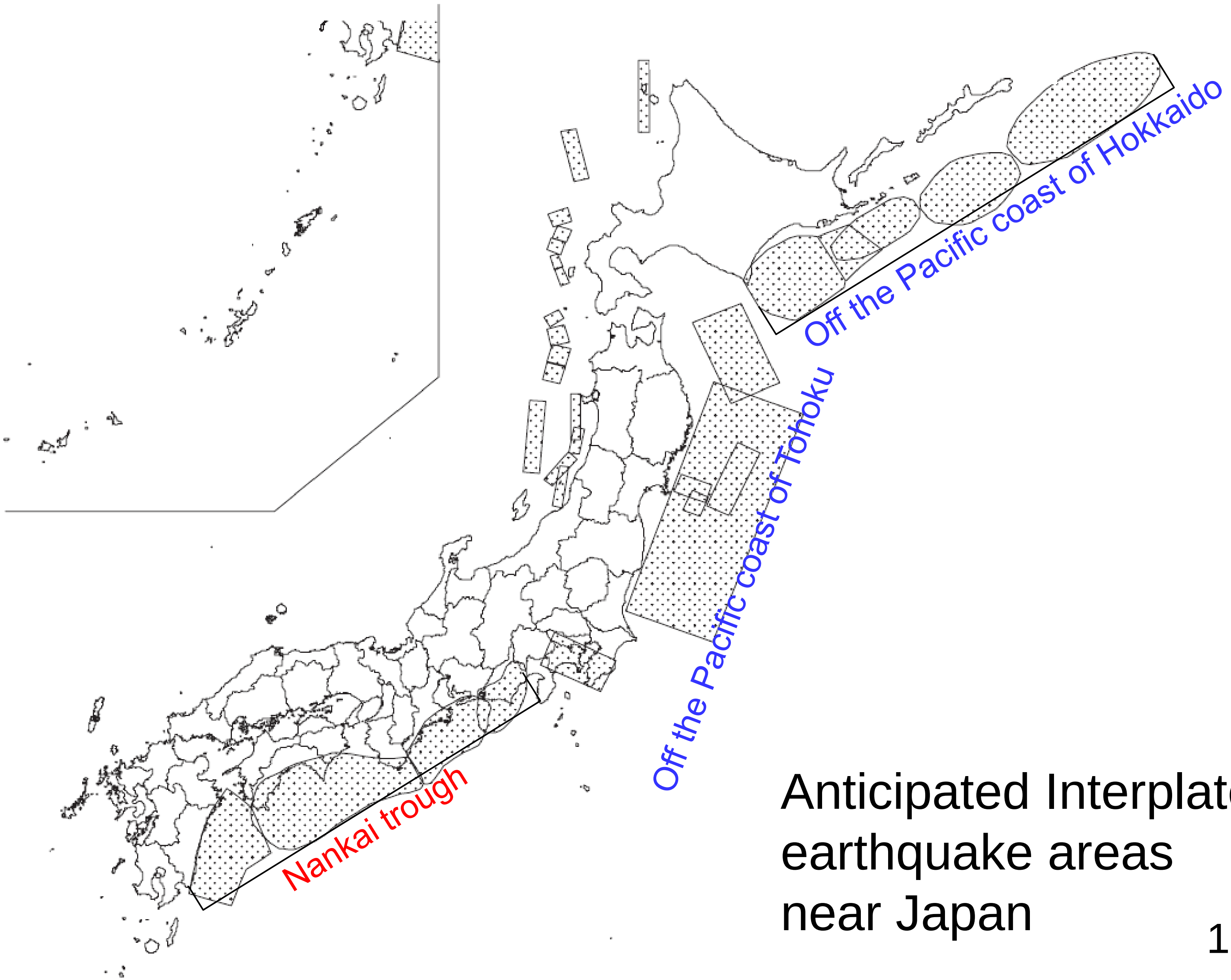
The occurrence of great interplate earthquakes near Japan has been highly anticipated.

2012 Specifications

✓Type I of Level 2 earthquake motion (for Interplate earthquake) was revised based on new attenuation relationships.

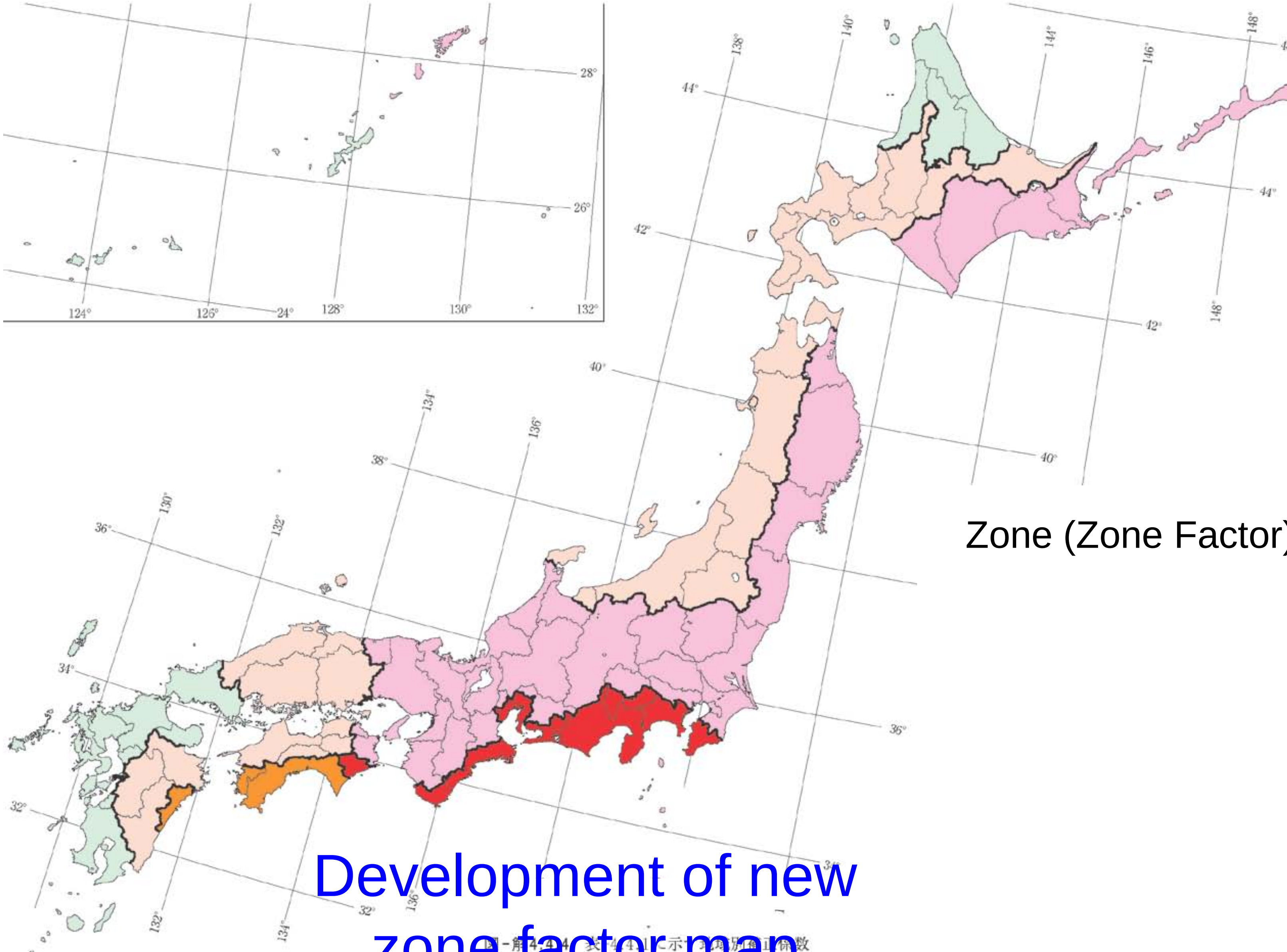
✓Zone factors for Type I earthquake motion were revised.

Revision of Design Earthquake Ground Motion



Anticipated Interplate earthquake areas near Japan

Revision of Design Earthquake Ground Motion



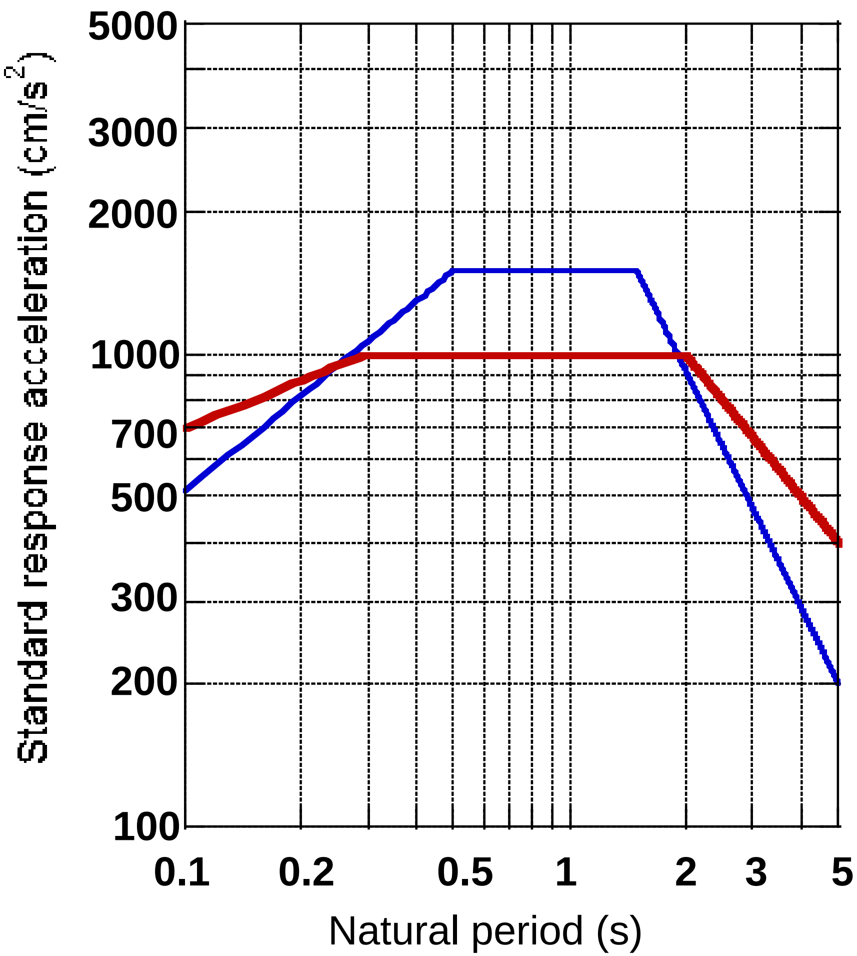
Zone (Zone Factor)

Development of new zone factor map

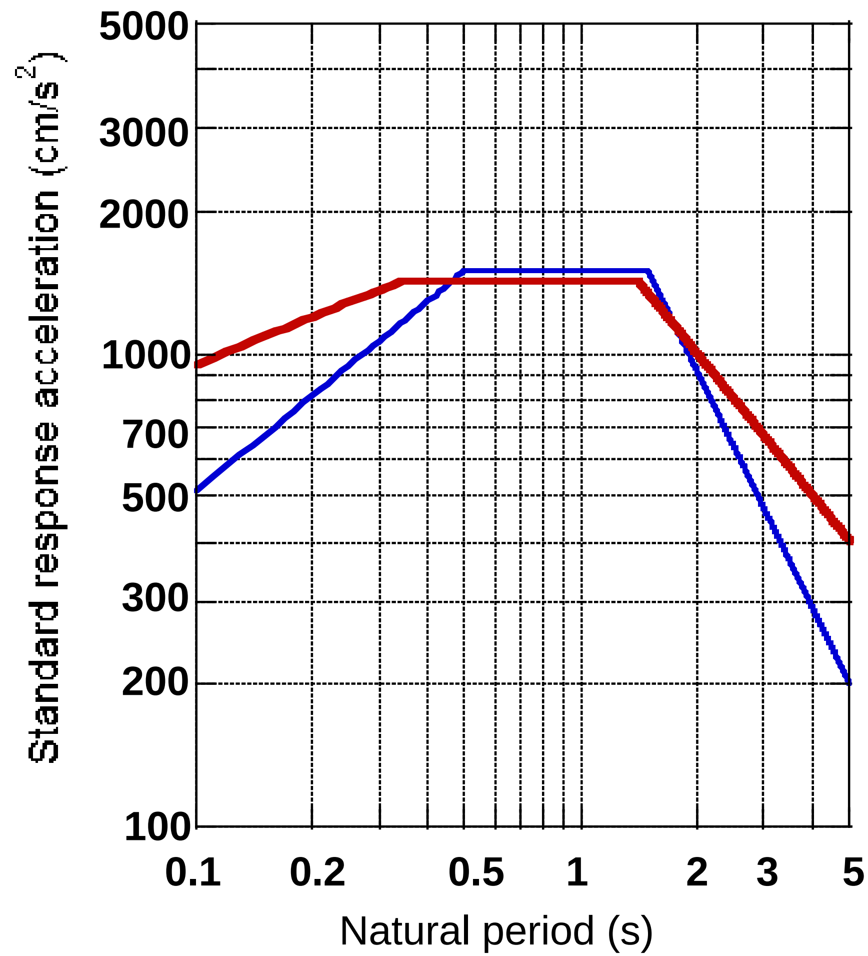
Revised Design Acceleration Response Spectra

Type I
Type II

Zone: A1 (Soil Profile Type III)

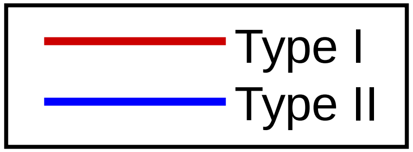


Previous(2002)

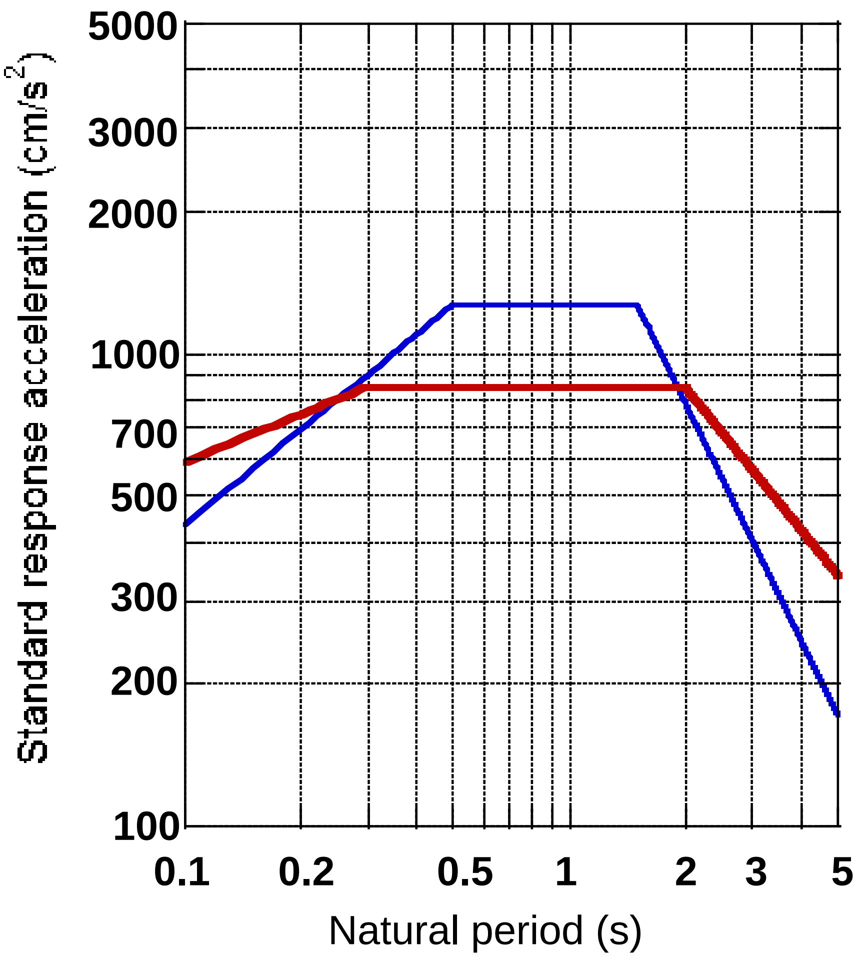


Revised (2012)

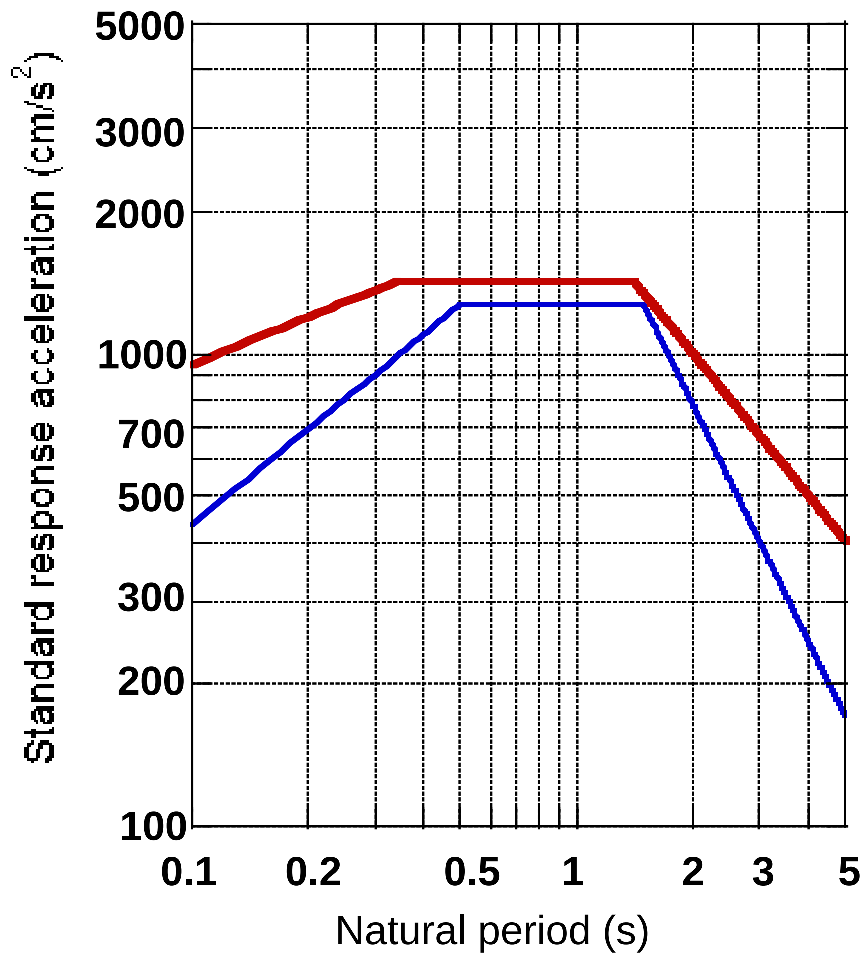
Revised Design Acceleration Response Spectra



Zone: B1 (Soil Profile Type III)



Previous(2002)



Revised (2012)

Design Considerations of Tsunami Effects

Superstructures inundated and washed away following failure of bearing supports

Superstructures inundated but survived

Design Considerations of Tsunami Effects

Background

Many bridges were washed away by extreme tsunami

2012 Specifications

✓Local plan for disaster prevention shall be considered in planning of road network, structural planning and design of bridges

Recommendation

✓For Prevention

Securing of sufficient clearance for tsunami wave height

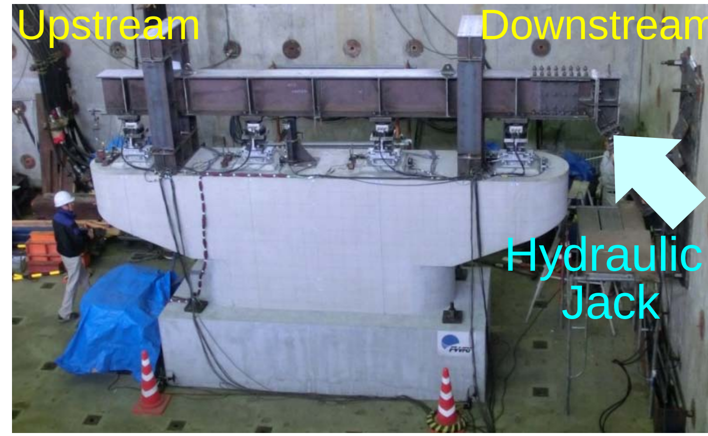
✓ For Mitigation

Considerations in structural design to mitigate the tsunami-induced effect to bridges, and preparation of a recovery plan in advance

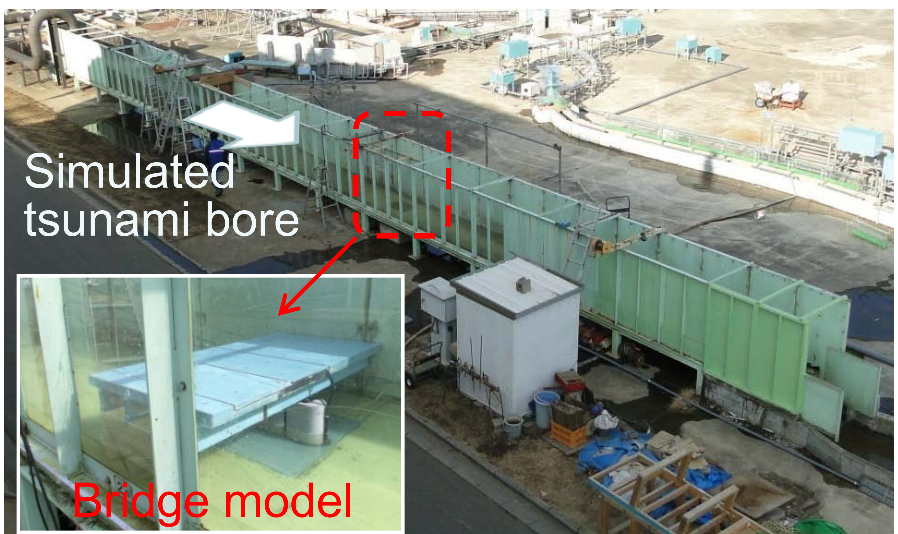
Experimental Approach to Study Behavior of Bearing Supports under Tsunami-induced Force

Experimental works to study

- ✓ Response of bearing supports under tsunami-induced force through 1/20-scaled flume test
- ✓ Resistant capacity of bearing supports under tsunami-induced force through 1/2-scaled static loading test

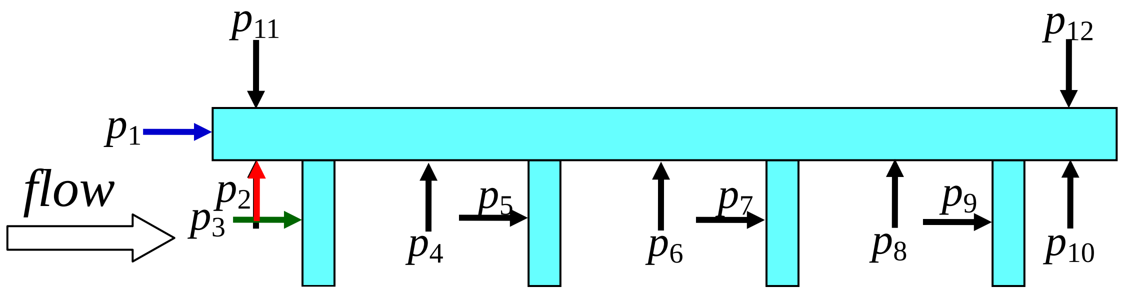


Static loading test to examine resistant capacity of bearing supports

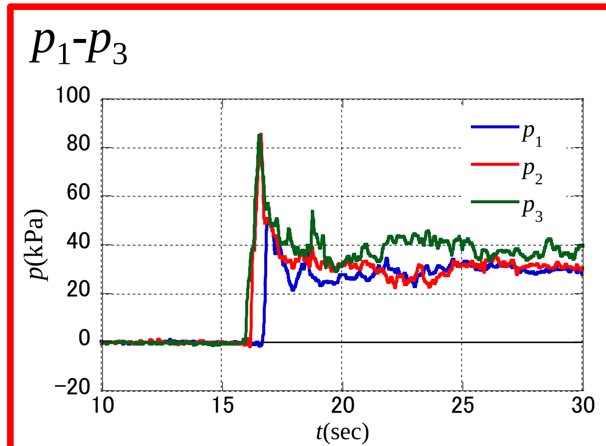


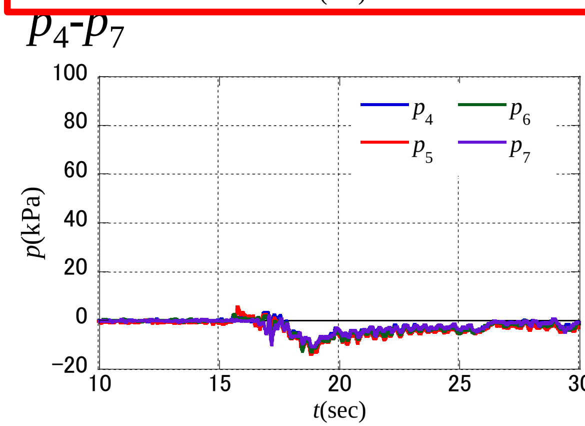
Flume test for bridge model to study response of bearing supports

Observed Hydrodynamic Pressure



Flow pattern for 4-main girder bridge



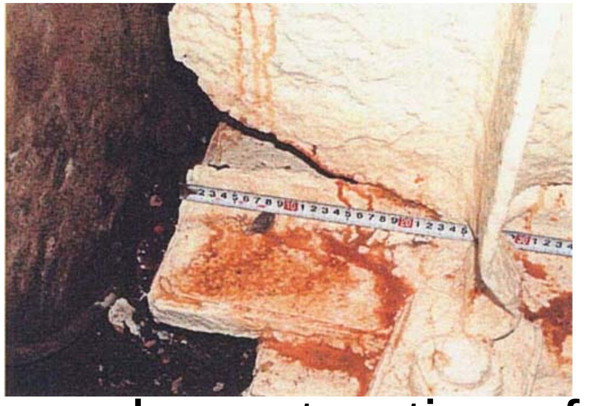


Pressure unit converted to full scale

Introduction of Integral Abutment Bridges

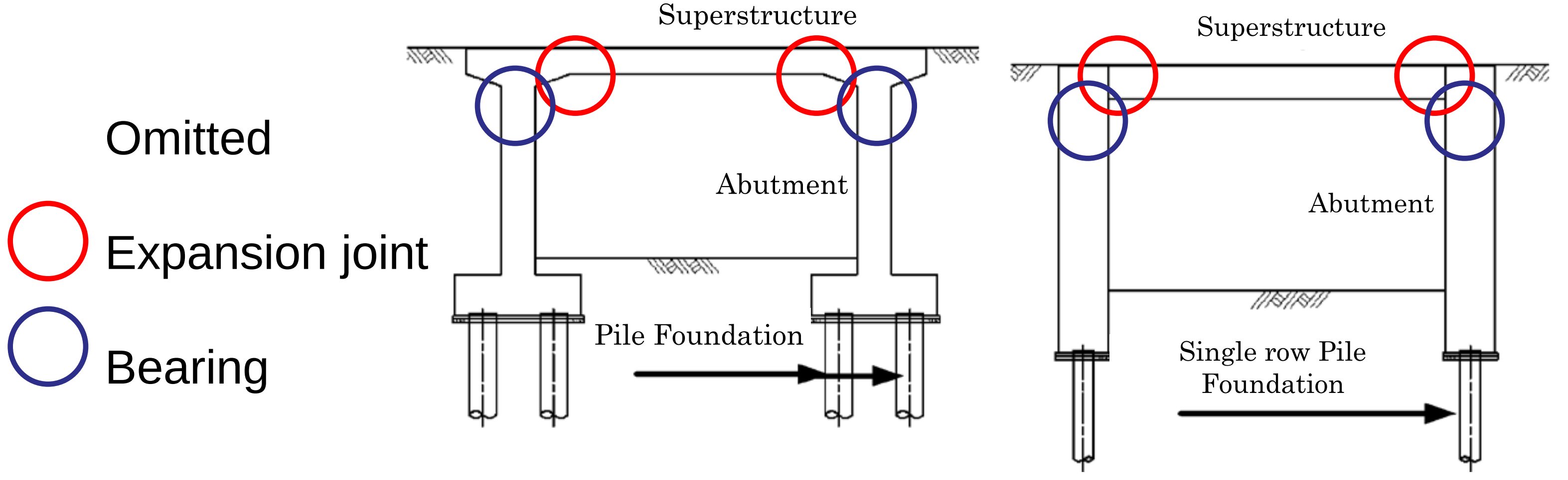
Background

Maintenance related problems such as corrosion at the end of girder and bearing with most of existing bridges



2012 Specifications

Introduced fundamental principal of design and construction of integral abutment bridges which systems are omitted the bearing and expansion joint



(a) Portal Frame Bridge (b) Integral Abutment Bridge

Improvement of Fatigue Durability of Steel Deck

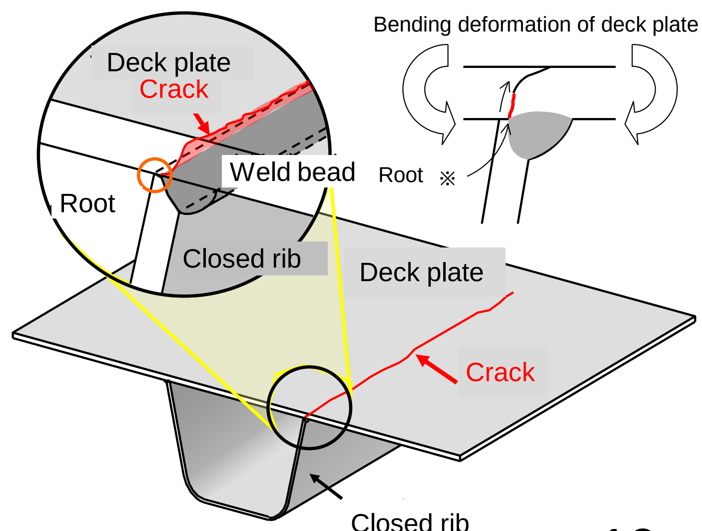
Background

Fatigue cracks to penetrate a deck in a weld of closed rib and deck plate have been increased in the existing steel slabs.

Damage of Pavement on the Crack

2012 Specifications

Minimum thickness of deck plate where wheel load of heavy vehicle is always loaded is prescribed more than 16mm (previous: 12mm) in case of steel deck using closed rib.



Summaries

- ✓ The 2012 Design Specifications for Highway Bridges were revised about mainly;
  - Designing the bridge with consideration of the maintenance and redundancy
  - Revision of design ground motions for interplate-type earthquake
  - Introduction or improvement of specifications based on recent research results

- ✓ We continue to examine to introduce the load and resistance factor design concept for next revision.

- ✓ T/C G initiates collaborative research program on tsunami effects on bridge performance.

Thank you for your kind attention

Standard Acceleration Response Spectra (Type I earthquake)