Introduction of Chapter4 of ACECC Monitoring Guideline

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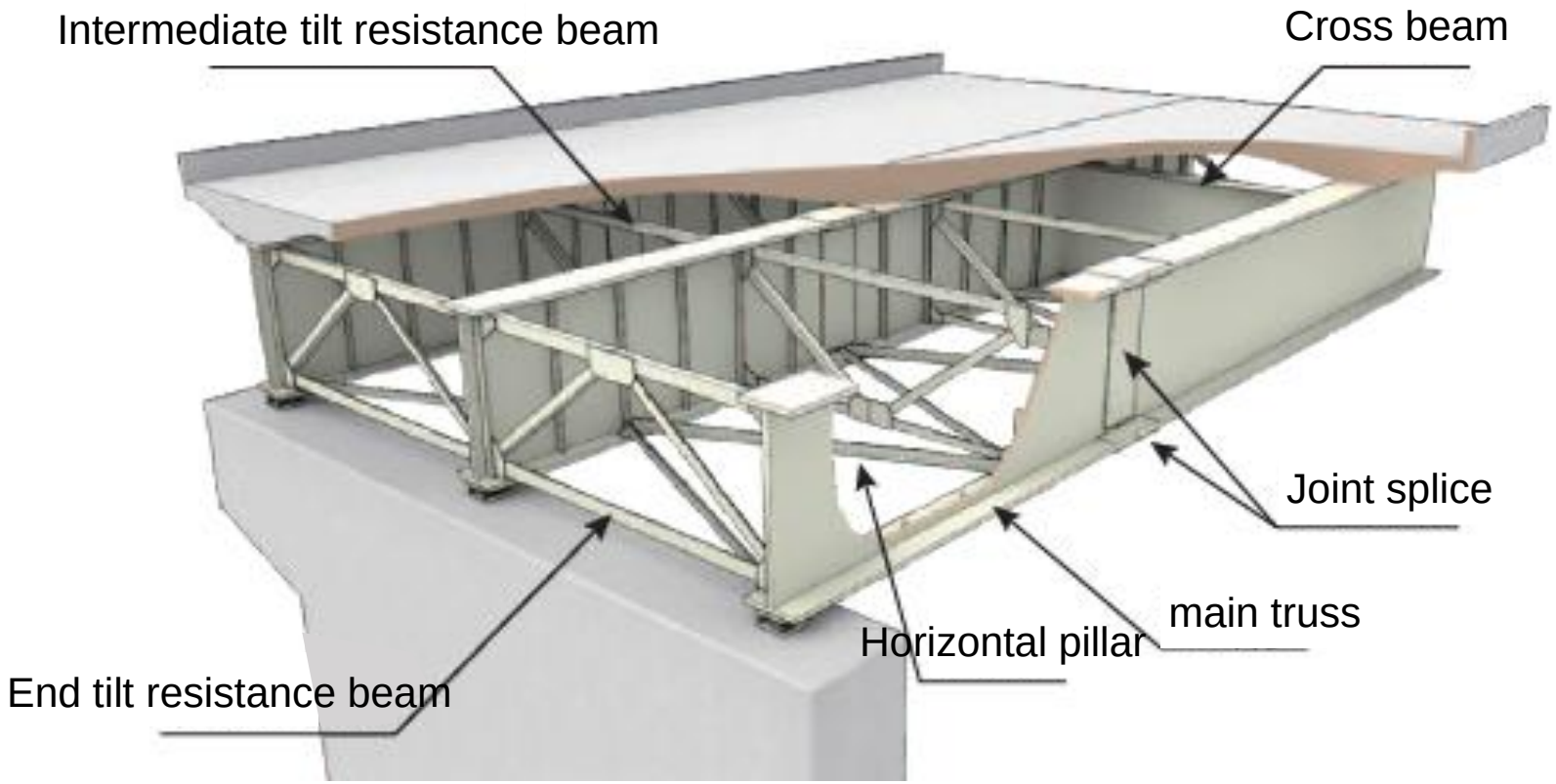
Outline

1.1 Target Structures and Changes

This chapter will focus on the components of steel trusses.



Targeted Abnormalities

- Visible abnormalities: Decreased rigidity
- Invisible abnormalities: Deterioration of paint (corrosion protection), abnormal clearances

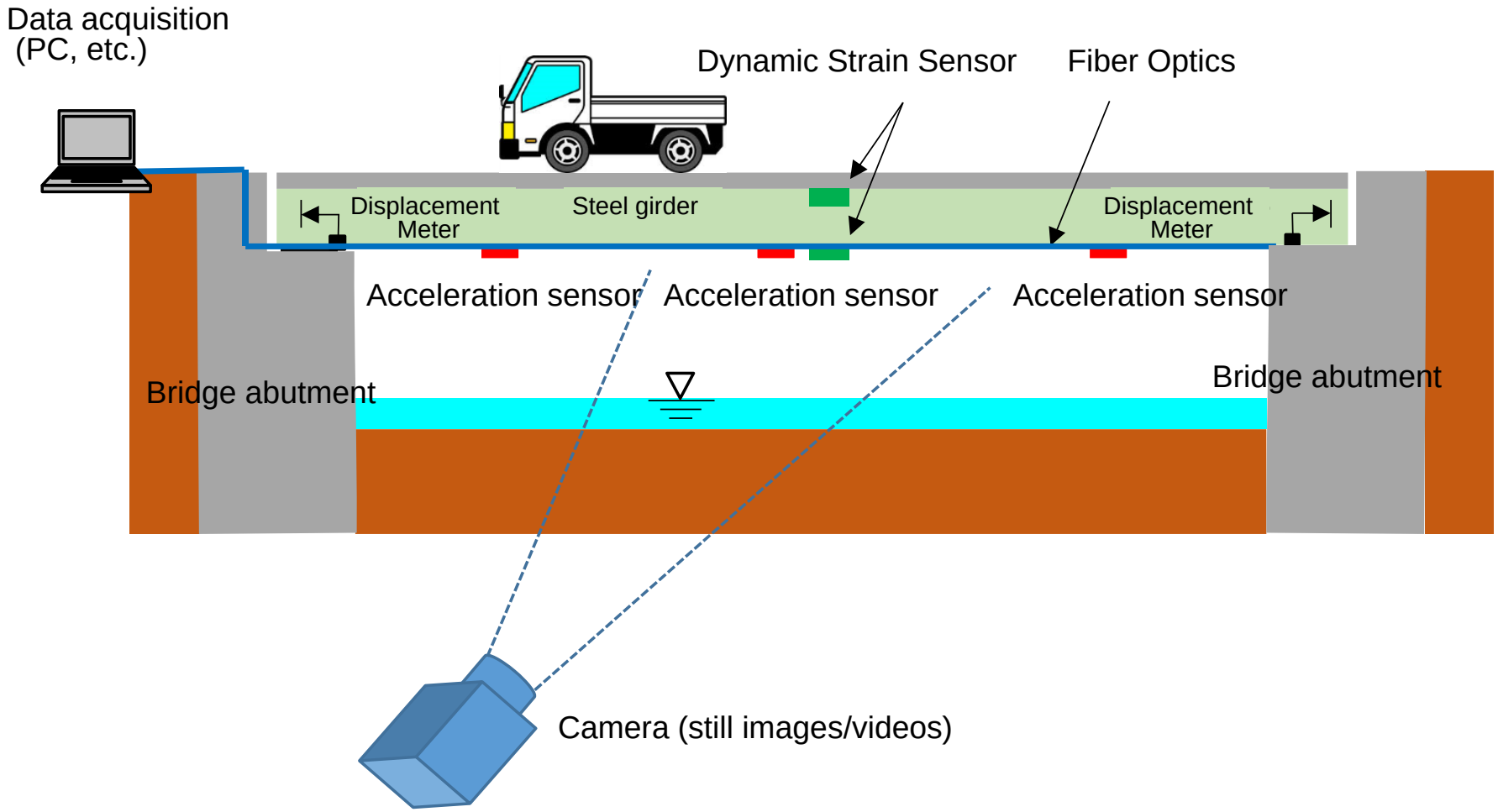
1.2 Current Status and Challenges in the Inspection of Steel Trusses

(1) The inspection of steel trusses is conducted based on guidelines such as the Road Bridge Regular Inspection Manual to understand and diagnose the condition of each component and identify necessary measures for the relevant road bridge. It is intended to gather necessary information for the avoidance of damage to road users and third parties, prevention of long-term failures such as bridge collapse, timely response to bridge longevity, and to properly maintain and manage the bridge.

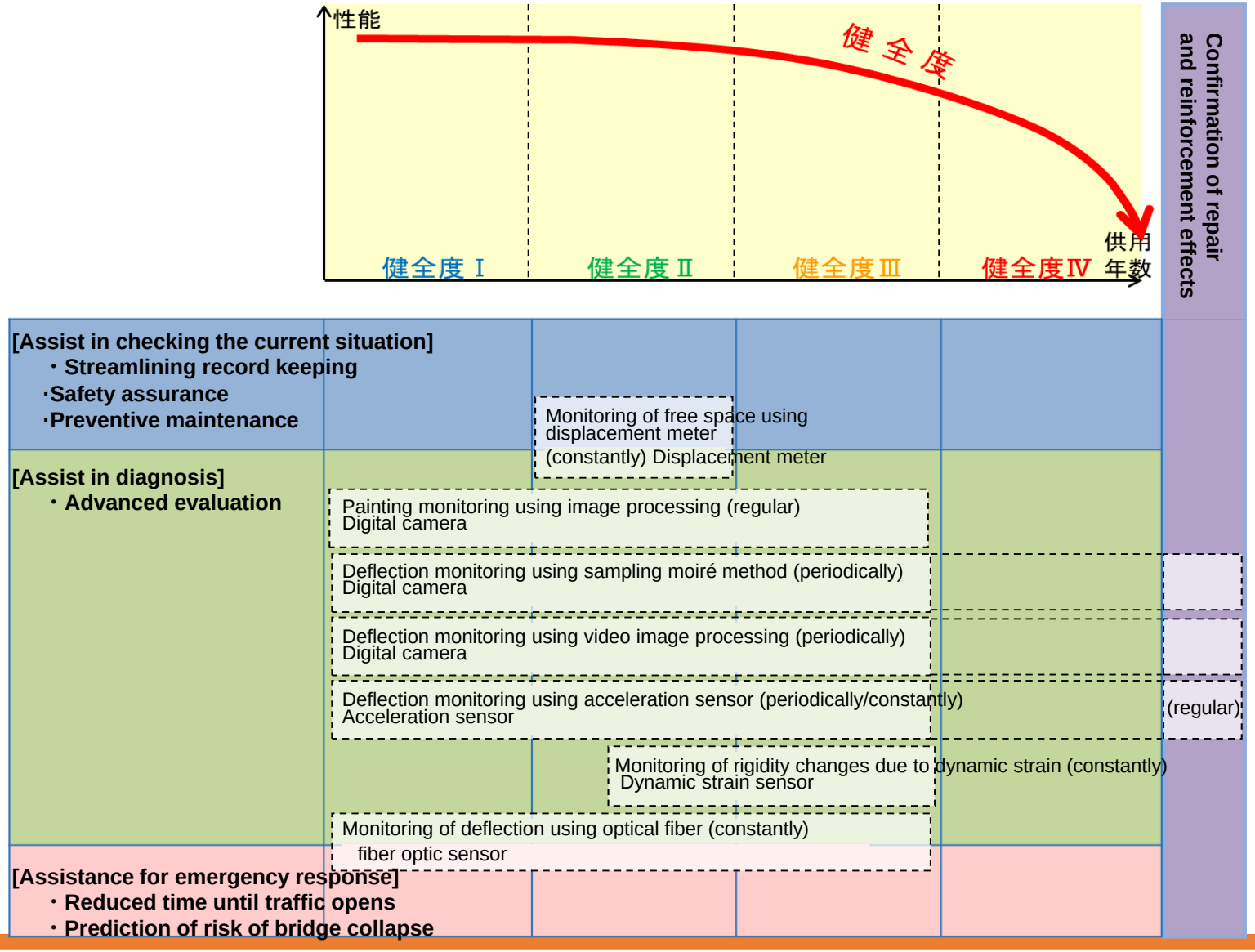
(2) In implementing monitoring, it is necessary to thoroughly consider the labor and cost for a vast number of assets, and to devise effective plans and implementation against challenges such as difficulty in making engineering judgments that ensure objectivity and uniformity.

1.3 Purpose of Monitoring and Anticipated Scenarios

The monitoring of steel girders needs to be appropriately selected and differentiated according to the administrator's usage purposes, maintenance needs, and anticipated scenarios.



Types and Objectives of Monitoring in the Maintenance of Steel Trusses



2.1 Types and Purpose of Monitoring Technologies

Steel girder monitoring technology is often used to observe changes in rigidity by measuring deflection and strain. In addition to these, it is also possible to monitor whether the expansion and contraction of the steel girder is not hindered by measuring the free displacement of the girder end. The purpose of monitoring steel girders is primarily used for inspection assistance and diagnostic assistance, and administrators select the monitoring that effectively meets each purpose.

2.1 Types and Purpose of Monitoring Technologies

1) Monitoring of the clearance using a displacement gauge

The condition of the clearance of the expansion device is monitored by a contact-type displacement gauge or a non-contact-type camera, to supervise the function of the supporting part.

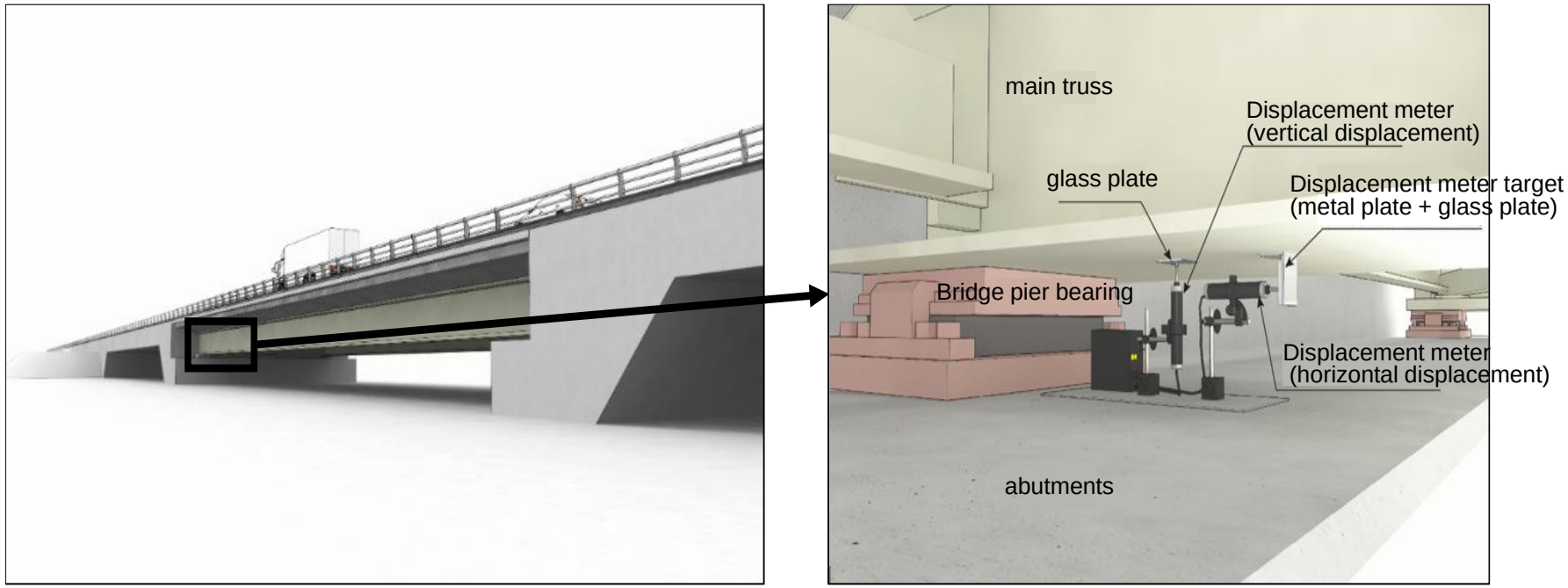


Image of Monitoring by Contact Displacement Meter

During disasters such as earthquakes, it is possible to check the degree of damage and the level difference in the supporting part, which can be used as a basis for deciding whether or not it can be used.

2.1 Types and Purpose of Monitoring Technologies

2) Monitoring Paintwork Through Image Processing

Images of the paint film are captured from a distance, and the degree of degradation of the paint film is determined. Deformation at the end of the beam often starts from the deterioration of the paint film, which leads to the corrosion of the steel material. If deterioration of the end of the beam is anticipated, it is possible to avoid severe deformation by regularly monitoring the condition of the paint film using this method.

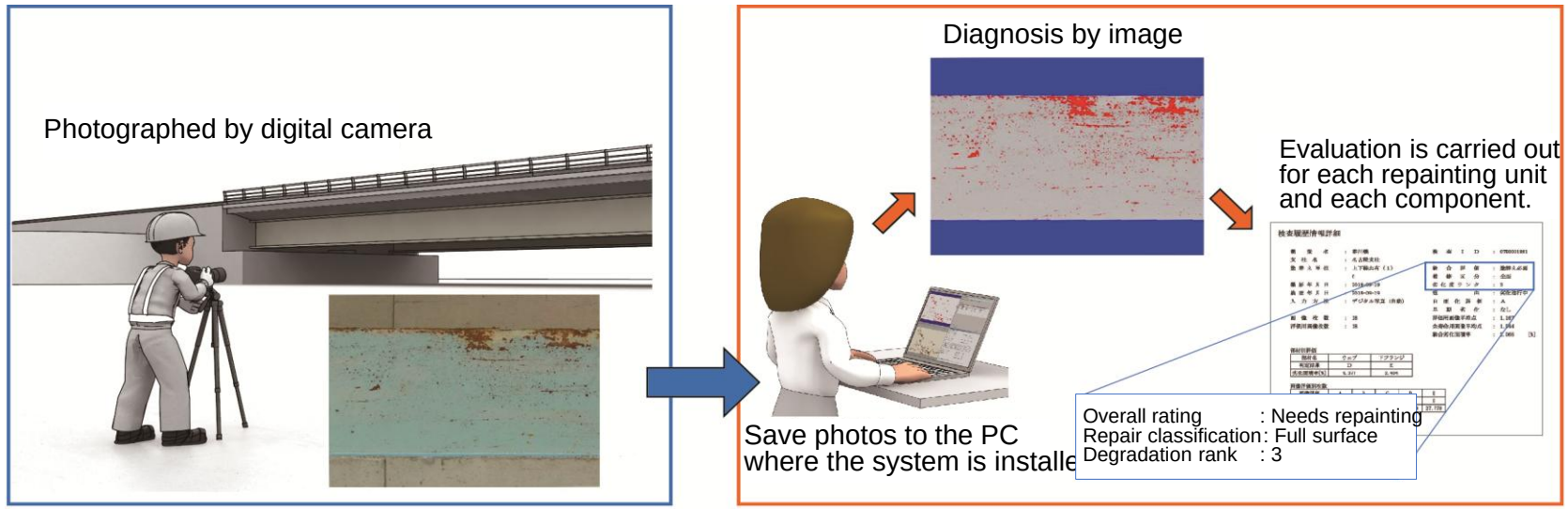


Image of Monitoring Paintwork through Image Processing

In this technology, it is possible to make a quantitative determination of the degree of degradation by using the relationship between the grain size of rust on the coating surface and the corrosion of steel materials (corrosion depth).

2.1 Types and Purpose of Monitoring Technologies

3) Monitoring of deflection using video image processing

This is a non-contact type of monitoring where the deflection value is obtained by shooting and analyzing from a distance using a camera.

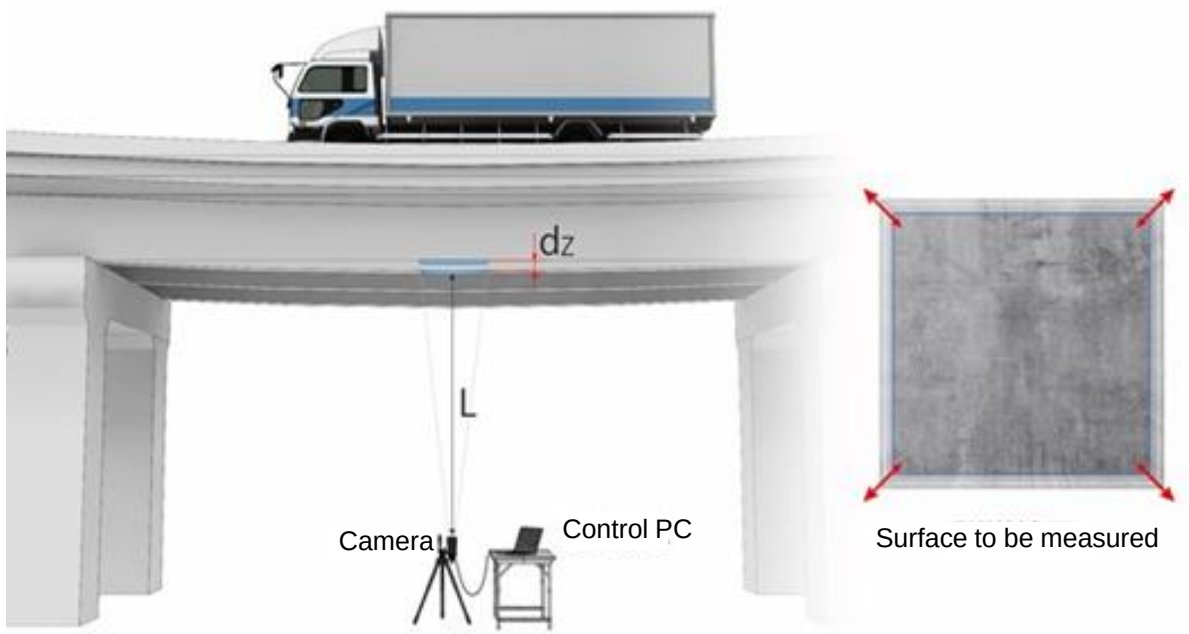


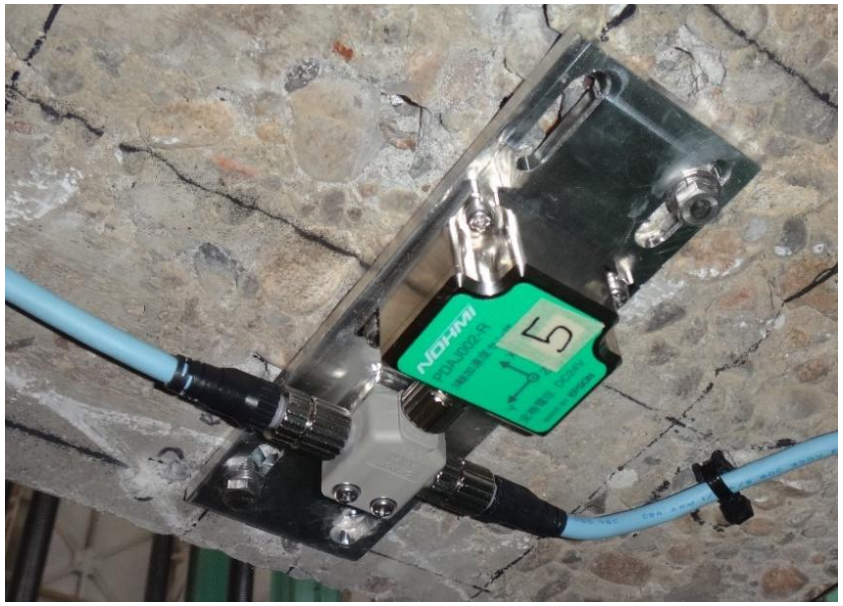
Image of Monitoring

Measurement is possible even without special markers, in environments where the entire length of the main girder is not visible, and from shots taken directly under the main girder. It is also effective in situations where access is difficult or environmental constraints only allow shooting from under the bridge. It is used for monitoring through regular measurements.

2.1 Types and Purpose of Monitoring Technologies

4) Monitoring of deformation using an accelerometer

By installing a highly reliable accelerometer on the main mast and performing regular or continuous monitoring, it is possible to measure the amount of long-term deformation.



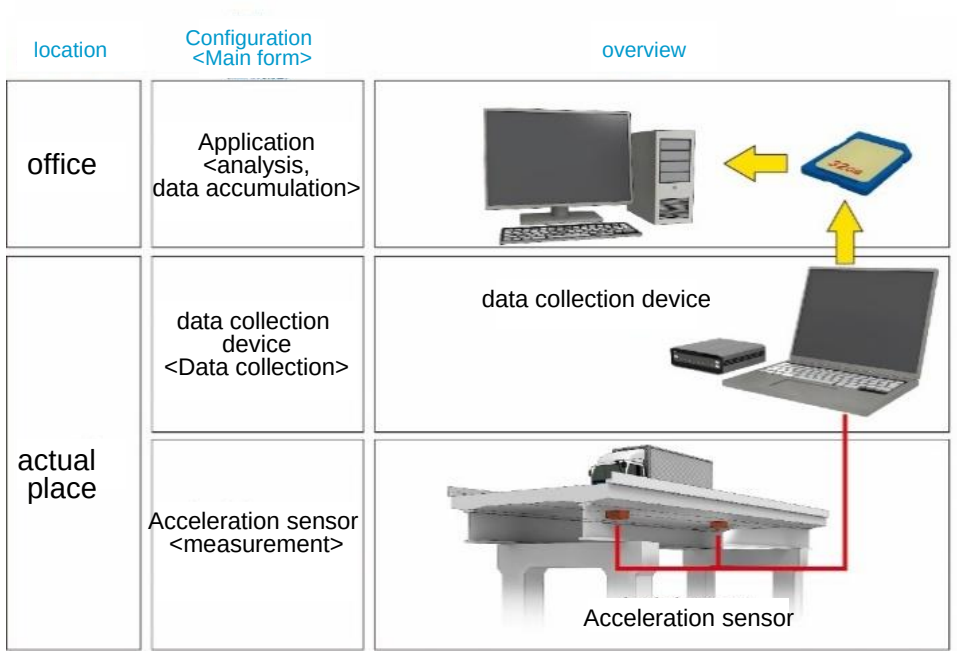


Image of Monitoring

The amount of long-term deflection is statistically stable, and by comparing past and current statistical data, it is possible to judge the trend of long-term structural deterioration.
By permanently installing the mounting base, it can handle regular measurements and continuous measurements.

2.2 Introduction Criteria for Monitoring Technology

When introducing monitoring, it is necessary to consider the high level of expertise required in judgments such as the state of painting, continuous monitoring of deflection, the difficulty of inspections, the difficulty of tasks by inspectors, and the characteristics of monitoring technology. In current maintenance and management operations, it is necessary to consider the optimal method of introduction, including the effects and costs of introduction.

2.3 Understanding the Concept of Management Standards in Monitoring

The concept of management standards for each monitoring technology used in steel girders is as follows.

(1) In the case of periodically implementing deflection measurements, a vehicle with a known weight is driven and the deflection is measured. Management standards are examined based on design deflection values, deflection limit values, etc.

(2) When equipment is permanently installed and continuous deflection measurements are performed, management standards are considered from pre-analysis and initial measurement results, or the comparison results between the current statistical values and the statistical values during sound conditions based on deflection distribution from traffic flow measurements are used as the management standards.

(3) In the monitoring of rigidity changes due to dynamic strain, the external factors such as live load acting from the outside, earthquakes, strong wind, flying salts, temperature changes, etc., and the response of the structure such as vibrations, strains, deflections etc. accompanying them, are used as the management standards.

(4) In the monitoring of painting, the visible rust is classified by grain size, and the weighted occupancy rate by grain size is used as the management standard.

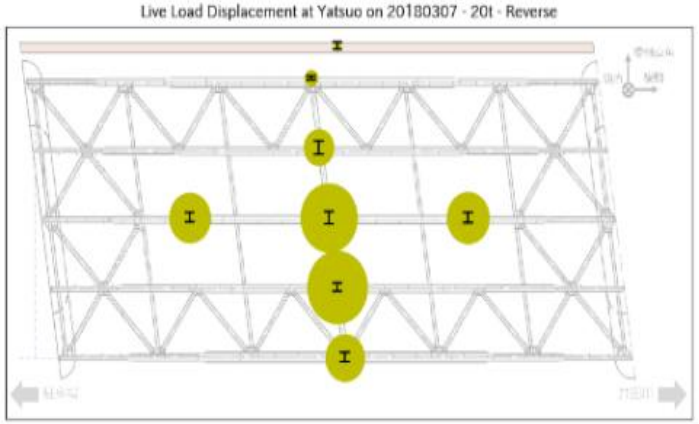
(5) In the monitoring of the free displacement of the main girder end, whether the main girder can smoothly expand and contract with changes in the outside temperature is used as the management standard.

3.1 Concept of Cost

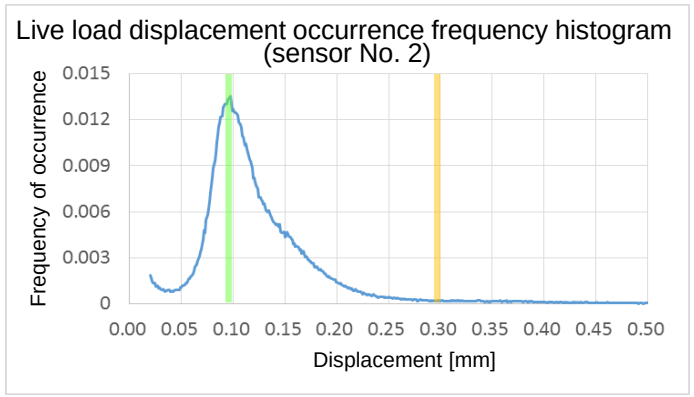
The cost required for monitoring varies depending on the scale and type of the bridge, the type and number of measuring devices installed, the requirements of the measuring system, the measurement period and frequency, and the methods of viewing, analyzing, and distributing data. Therefore, it is necessary to carefully examine the conditions required for monitoring for each site and case when calculating detailed costs.

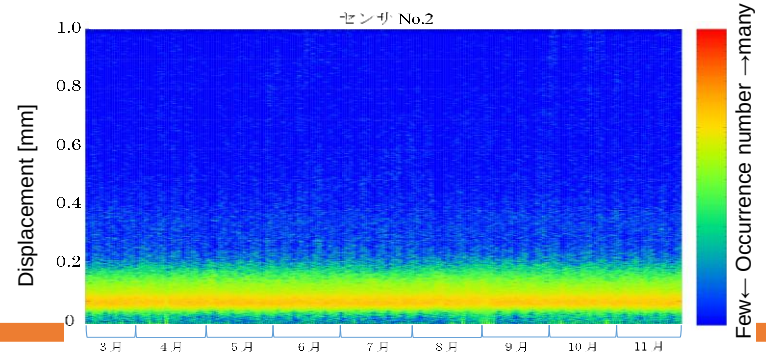
3.2 Implementation Examples

Measurement Conditions



Vehicle flex during operation





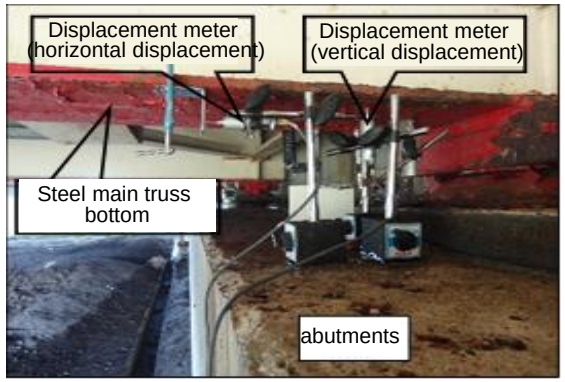
Deflection Distribution

<Objective>
In order to quantitatively evaluate the degradation of structural performance associated with deformation of steel girders that cannot be confirmed by visual inspection, we aim to understand the deflection of bridges and its changes over the long term.

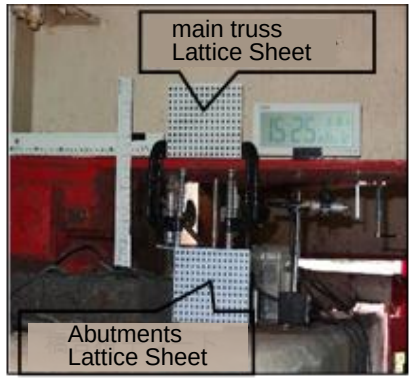
3.2 Implementation Examples

<Objective>
By measuring the inter-span displacement, we aim to understand the potential for damage to girders and bridge bearings, etc. due to the restraint horizontal forces generated by the expansion and contraction of the bridge body.

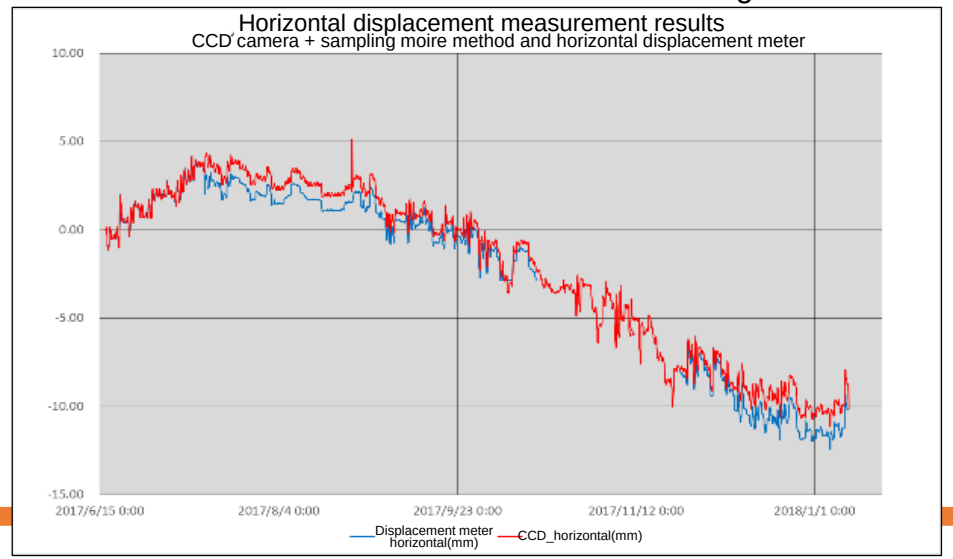
Bridge Pier and Bearing Part



Rod Type Displacement Meter
Installation Diagram



Sampling Moire Method
Displacement Meter Installation Diagram (For Comparison)



Measurement Results

Thank you for your kind attention!