Katsushima Area Viaduct
on the Metropolitan Expressway Haneda Route (Route 1)

1. Bridge Data

Owner:	Metropolitan Expressway Company Limited
Design:	P.S. Mitsubishi Construction Co., Ltd. Oriental Consultants Co., Ltd
Construction:	P.S. Mitsubishi Construction Co., Ltd.
Location:	Tokyo
Bridge length:	476.5 m
Bridge structure:	Original: Twelve 3-span continuous PC box girders with the Gerber system After renovation: Four 9-span continuous PC box girders
Width:	7.5m(effective width)

2. Background and Outline of Project

The Metropolitan Expressway Haneda Route (Route 1) is one route of the urban expressway system built for the 1964 Tokyo Olympic Games. The viaduct that is the focus of this project, which has been in service for over 50 years since opening in 1963, was originally a Gerber bridge with a series of three-span continuous prestressed concrete (PC) box girders that elevates the expressway over a prefectural road **(Photo 1).**

The bridge was found to have cracks in the Gerber joints and corrosion and other damage in the Gerber shoes during a periodic inspection **(Photo 2)**. The purpose of this project was to improve the durability of the Gerber joints as well as the earthquake resistance and ease of maintenance of the entire bridge. The girders were made continuous over every nine spans by using external tendons **(Photo 3)**. The resulting four continuous girders were separated from each other at the joints to eliminate the Gerber system, with new substructures built to bear the reaction force from the Gerber joints. This combined method was an approach to the structural improvement of Gerber joints without precedent.

The project also included the replacement of steel shoes, strengthening using carbon fiber sheets and other work to enhance the overall performance of the bridge. The work took about six years in total to complete.

Photo 1. Post-renovation view

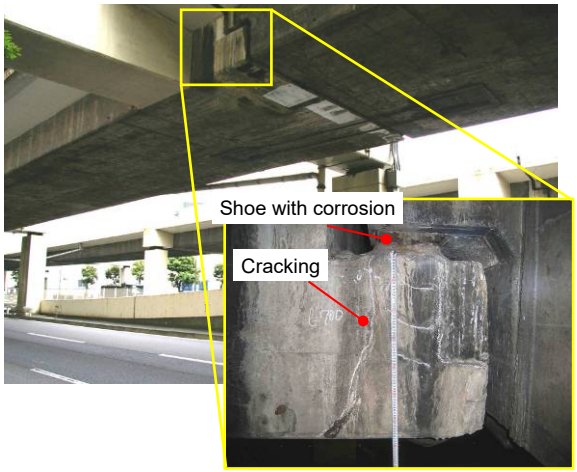

Photo 2. Damage to a Gerber joint

3. Features of the Project

1. **Transforming the original Gerber bridge girders into continuous girders and separating the new girders at Gerber joints**
   - The three-span continuous PC box girders of the original Gerber bridge were transformed into nine-span continuous girders, with new substructures constructed below the ends of the new continuous girders to eliminate the Gerber system.
   - Non-shrinking mortar was injected to fill the Gerber joints, while the girders were made

continuous by external prestressing.

- The effectiveness of making the girders continuous was verified by carrying out measurements using a 25-ton test truck before and after the work, in combination with finite element analysis.

2. Renovation work under challenging conditions

- Both the Metropolitan Expressway (65,000 vehicles/day) and the prefectural road located under it (15,000 vehicles/day) needed to be kept open to traffic during the work.
- All work, including new substructure work and steel shoe replacement, had to be carried out under difficult conditions, such as the severe clearance requirements for the prefectural road, the complexity of the alignment of the expressway and the very limited space available within the girders.

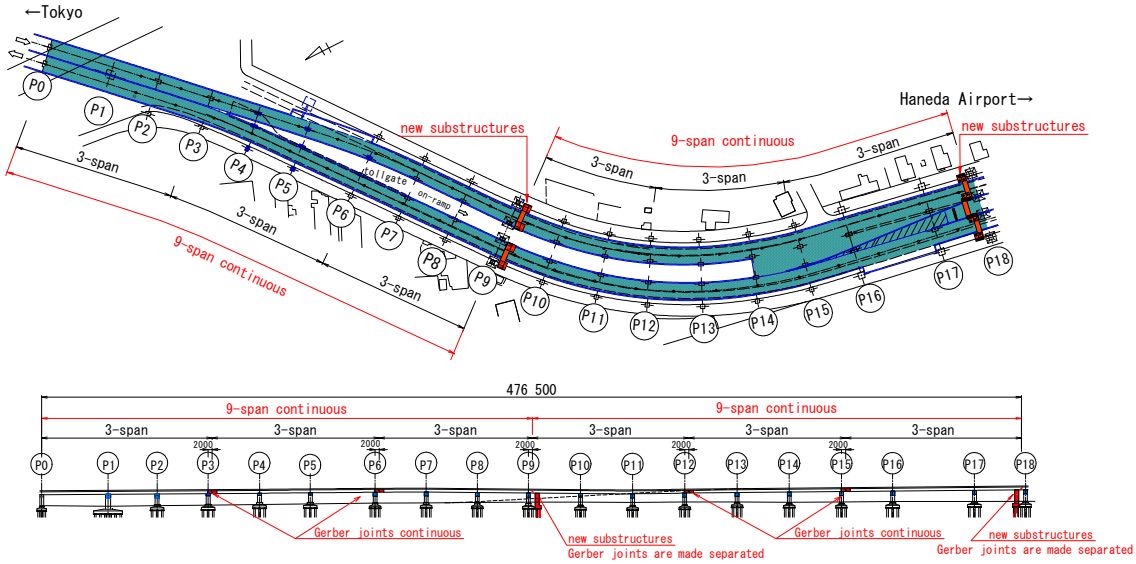

Figure 1. Overview of bridge

Photo 3. External tendons

Photo 4. Water jet drilling

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4. Features of the Work

1. Making the Gerber girders continuous (Photo 5)

1) The gaps between girders were cleaned with water jets before work to make them continuous.
2) Transparent formwork was used for mortar injection in the girder gaps so as to allow monitoring of the filling process.
3) Through-holes were made in the cross beams for installing external tendons. Water jet drilling was used to make the horizontal holes that have a length of up to 4,250 mm **(Photo 4)**.

2. Separating the continuous girders at the Gerber joints (Photo 6)

1) The continuous girders were structurally separated from each other at the Gerber joints left at

the ends. New substructures were constructed below the suspended spans to bear the reaction force of the superstructure. The Gerber shoes were cut using wire saws to structurally separate the girders.

2) In order to ensure safety of the work on the in-service bridge, the reaction force was transferred in a phased manner by measuring load and displacement during the work and checking the measurements against the design values.

3. Replacement of the steel shoes

1) All existing steel shoes were replaced with rubber shoes following seismic design using an analysis model simulating the new continuous girder configuration.

2) **Temporary shoring** was installed over the prefectural road on which special traffic controls were implemented. The reaction force (up to about 5000 kN) was transferred to the shoring and then the existing shoes were cut, removed and replaced with new shoes.

Photo 5. Gerber joints made continuous

Photo 6. Gerber joints separated with new substructure

Photo 7. Completion View