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

首都高速 1 号羽田線　勝島地区橋梁


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Synopsis

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 has been in service for over 50 years since opening in 1963. Originally a Gerber bridge with a series of 3-span continuous prestressed-concrete (PC) box girders, it elevates the expressway over a prefectural road (**Fig.1**).

Structural Data

Owner: Metropolitan Expressway Company Limited.
Design: P.S. Mitsubishi Construction Co., Ltd.
Construction: P.S. Mitsubishi Construction Co., Ltd.
Location: Shinagawa-ku, Tokyo
Bridge Length: 476.5m
Bridge Structure: (**Figs.3, 4**)
Original: Twelve 3-span continuous PC box girders with Gerber joints
After Renovation: Four 9-span continuous PC box girders
Width: 7.5m (effective width)
Construction Period: May 2010 – Mar. 2016

1. Introduction

During a periodic inspection, the viaduct was found to have cracks in its Gerber joints and corrosion and other damage in its Gerber shoes (**Fig.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

Fig.1 View before renovation

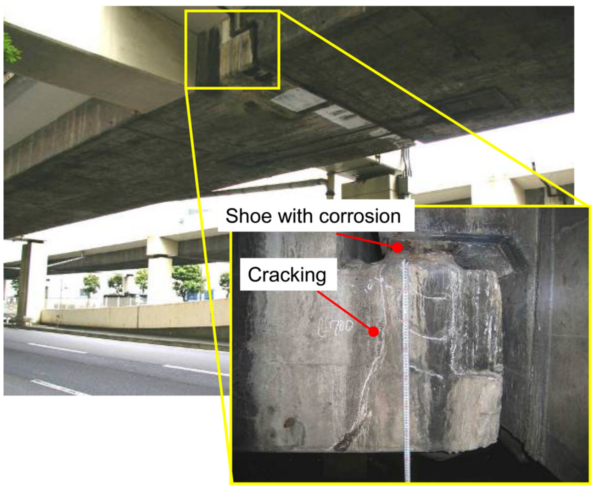

Fig.2 Damage to a Gerber joint

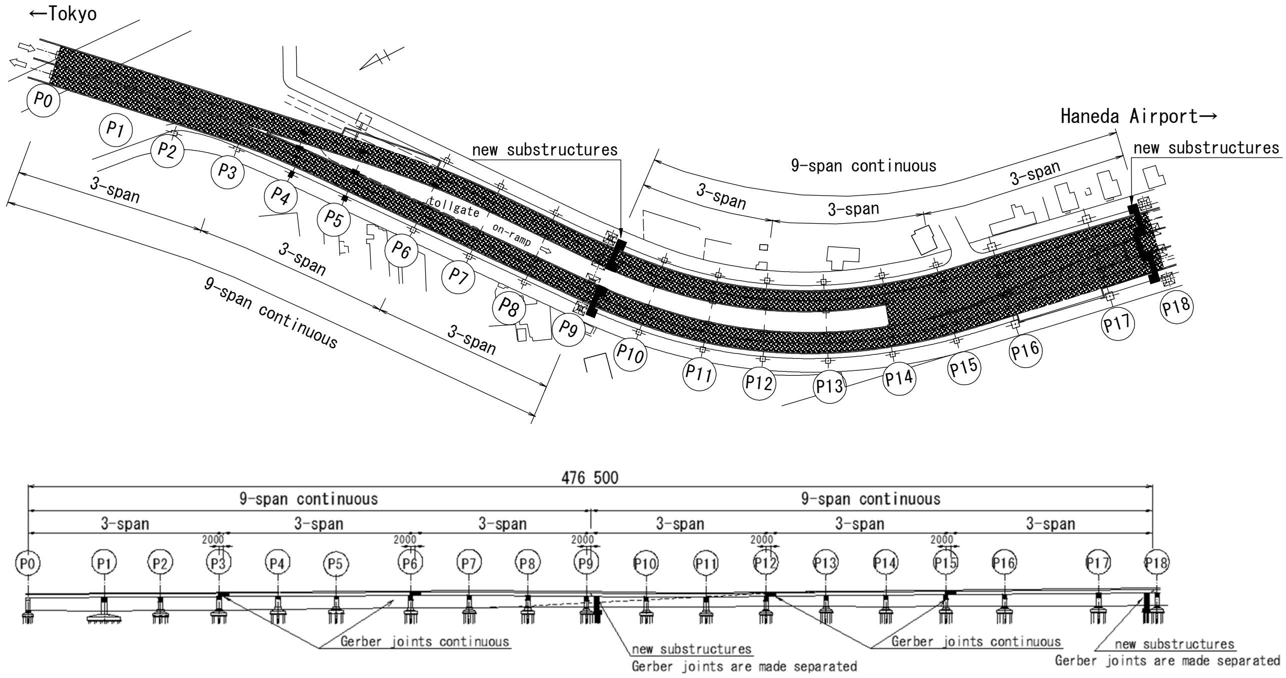

Fig.3 Overview of bridge

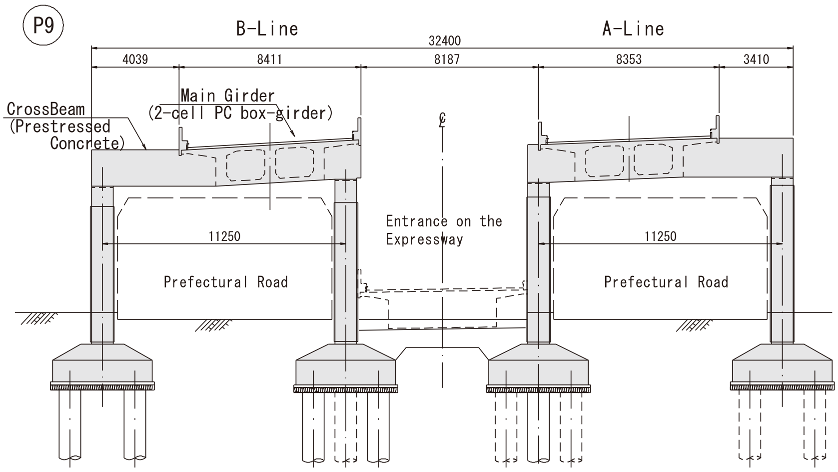

Fig.4 Cross section

bridge. External tendons were used to make the girders continuous over every nine spans (**Fig.5**). The four continuous girders were separated from each other at their joints to eliminate the Gerber system, with new substructures built to bear the reaction force from the Gerber joints. This combined method was an unprecedented approach for structural improvement of Gerber joints.

The project also involved replacing the steel shoes, strengthening using carbon fiber sheets, and other work to enhance the performance of the entire bridge, all of which took about six years in total to complete.

2. Features of Project

(1) Improvement of Gerber Joints

Making the Gerber bridge girders continuous and separating the continuous girders at the Gerber joints:

1) The Gerber bridge with 3-span continuous PC box girders was made continuous over every nine spans, and new substructures were built below the ends of the continuous girders to eliminate the Gerber system.
2) Non-shrinkage mortar was injected to fill the Gerber joints, and the girders were made continuous by external prestressing.
3) The effect of making the girders continuous was verified by carrying out measurements using a 25-ton test load truck before and after the work, in combination with finite element analysis.

(2) Construction Work

Renovation work under challenging conditions

1) Both the Metropolitan Expressway (65,000 vehicles per day) and the prefectural road located under the bridge (15,000 vehicles per day) had to be kept open to traffic during the construction.
2) All work including constructing new substructure and replacing steel shoes had to be performed under challenging conditions. These included the difficult clearance requirements for the prefectural road, the complexity of aligning the expressway, and the very limited space available inside the girders.

3. Features of Construction Work

(1) Making Gerber Hinges Continuous (Fig.8)

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 to allow monitoring of the filling process.
3) Through-holes were made in the cross beams to install external tendons. Water-jet drilling was used to make horizontal holes up to 4,250mm long (**Fig.6**).

(2) Separating Continuous Girders at Gerber Joints (Fig.9)

1) The continuous girders were structurally separated from each other at the Gerber joints left at either end. 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) To ensure safety of the work on the in-service bridge, the reaction force was transferred in a phased manner by measuring the load and displacement during the work and checking the measurements against the design values.

(3) Replacement of Steel Shoes

1) All existing steel shoes were replaced with rubber shoes (**Fig.7**) following seismic design using an analysis model that simulated 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 roughly 5,000kN) was transferred to the shoring whereupon the existing shoes were cut, removed, and replaced with new shoes.

4. Conclusion

The Katsushima Area Viaduct was completed on March 2016 (**Fig.10**). To extend the life of the Gerber beams and upgrade the performance of the bridge, the Gerber beams were integrated continuously with an external cable system and the existing bearings were relocated. This renovation project won the 2016 Tanaka Award of the Japan Society of Civil Engineers and the 2016 JPCI Award of the Japan Prestressed Concrete Institute.

Fig.5 External tendons

Fig.6 Water-jet drilling

Fig.7 After shoe replacement (before concrete painting)

References

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Fig.8 Gerber joints made continuous

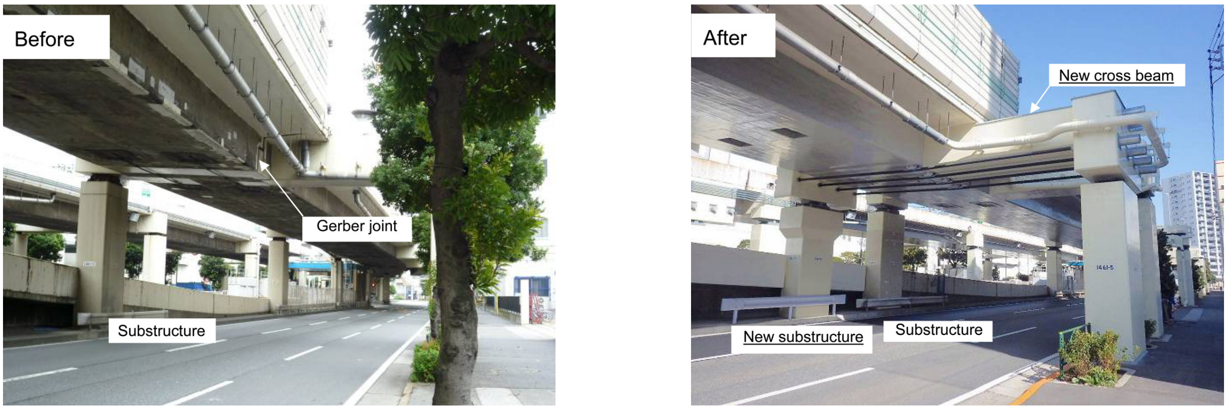

Fig.9 Gerber joints separated with new substructure

Fig.10 Completion view

概　要

首都高速1号羽田線の勝島地区橋梁は，都道の直上に建設されたゲルバーヒンジを有するPC連続箱桁橋である。当該区間は1964年の東京オリンピックに向けて羽田空港と都心を結ぶために建設された路線であり，1963年12月の供用から50年以上が経過している。これまでに実施された定期点検により，一部のPCゲルバー部のコンクリートにひび割れや支承の腐食等の状況が確認されていた。

このため，ゲルバー部の長期耐久性と橋梁全体の耐震性向上を図ることを目的として，ゲルバー部を外ケーブルにより連続一体化する他，橋梁端部は新設橋脚を設置し，ゲルバー部の反力を受け替えることで，ゲルバー構造を持たない構造に改良することとした。このような組み合わせによるゲルバー改良はこれまでにない施工であり，なおかつ供用しながら行っている。

この他に本工事では，全ての既設鋼製支承をゴム支承に取替えや，炭素繊維による主桁の曲げ・せん断補強，既設下部工の再補強等を行っており，橋梁全体の性能を向上させている。