RETROFIT DESIGN AND CONSTRUCTION FOR MAKING GERBER GIRDERS CONTINUOUS ON THE METROPOLITAN EXPRESSWAY

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1. Introduction

Gerber-hinged prestressed concrete (PC) bridges were a popular bridge type until around 1960s because they required relatively simple structural calculation and allowed for longer span lengths (Figure-1).

The bridge in this study is a Gerber-hinged bridge with PC box girders on the Metropolitan Expressway Shinjuku Route (Route 4) located in Sendagaya, Tokyo. Being in service for more than 50 years, the bridge shows corrosion of the shoes in the Gerber hinges due to aging (Photo-1) and also damage at notches due to stress concentration. To solve these problems, the Gerber hinges were modified and the girders were made continuous by using external tendons in combination with carbon fibers. This paper summarizes the design and retrofitting of the project.

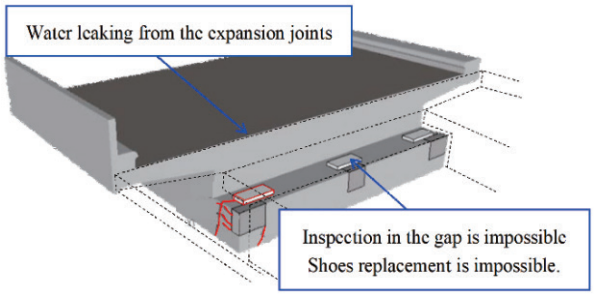

Figure-1 A Gerber hinge in a box girder

Photo-1 Damaged shoes found in a Gerber hinge

2. Design outline (Design principles)

The design load of the bridge at construction was TL-20 in accordance with the Japanese code of that time. In the present design study, strengthening of the structure was investigated along with the modification to the Gerber hinges, based on the results of load bearing capacity check (B live load) performed for the girders in accordance with the latest code (Figure-2).

The following principles were adopted for the design of the modification to the Gerber hinges to be continuous and strengthening of the structure in this project:

- Leave the existing shoes in the target Gerber hinges in place, and cast mortar.
- Use primarily the external tendon method which is a tested and proven technique for making the girders continuous.(Preliminary tensioning is made at a force of 20% of the final tensioning force by using a small-size jack.)
- To strengthen the reinforcement which is interrupted at the target Gerber hinges, check the current amount of tensile reinforcement, determine the required amount of additional tensile reinforcement, and apply an equivalent amount of carbon fibers.

3. Outline of the construction (External tendon placing)

Although it was desirable to tension the external tendons immediately after filling the Gerber hinge gaps, the external tendon placing had to be performed span by span, requiring a waiting time before application of stress. During the waiting time, expansion or shrinkage of the main girder

Table-1 Structural data of the bridge

Structure	2-span continuous PC box girder + simple PC box girder + simple PC box girder (four spans in total)
Bridge length	Approximately 195 m
Width	Approximately 19 to 22 m
Girder height	2.2 m
Completed	January, 1964

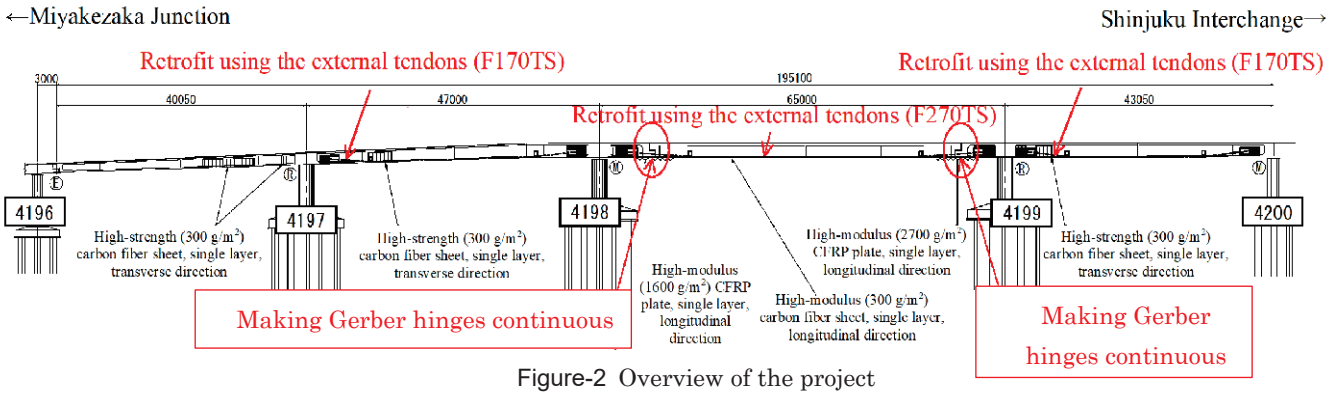

Figure-2 Overview of the project

with the temperature fluctuations could cause gaps in the construction joints in the mortar filling the Gerber hinge gaps. To minimize the problem, the retrofitting work were started from the external tendons in the span with the Gerber hinges. Preliminary tensioning was made at a force of 20% of the final tensioning force by using a small-size jack under restricted operating conditions on a narrow suspended scaffolding (Figure-3, Photo-2). Full tensioning was carried out after installation of the external tendons to the end spans was completed.

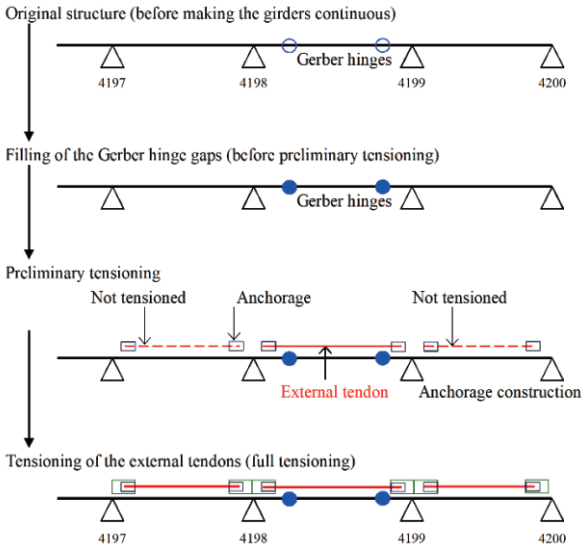

Figure-3 Steps to full tensioning

Photo-2 Preliminary tensioning

4. Concluding remarks

The project of making the Gerber hinges continuous also included various operations such as carbon fiber retrofit and concrete spalling prevention which had to be carried out in parallel.

The Gerber hinges were made continuous, and strengthening was made to carry the live load of the latest code. It is hoped that this project will be a good example of modification to the Gerber hinges in existing PC bridges, and will help future development of repair and maintenance techniques.

Photo-3 Project completed

Key Words : prestressed concrete bridge, Gerber hinge, external tendons, retrofitting.

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