Design of the Shintomei-Nakatsukawa Bridge - An extradosed bridge considering effect of large displacement due to a fault

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Abstract

The Nakatsugawa Bridge is constructed over a valley with both ends linked to a tunnel. It was confirmed that there is a fault in the valley. This fault is likely to cause a relatively large vertical displacement, and fault fracture zones are distributed over a wide area. Considering these topographical and geological conditions, we planned a triple-span PC extradosed bridge which will prevent collapse in the event of a fault displacement, averting irreparable damages. Consequently, the side span is extremely short in comparison with the central span, because of space restrictions affecting arrangement of pylons and piers. This presented a challenge in that a significant imbalance between the spans might lead to a negative reaction at the girder end. This paper discusses a series of reviews made for bridge planning and design, and reports that the balance between the spans was improved successfully by using light weight butterfly webs exclusively for the central span.

Keywords: Extradosed Bridge, butterfly web, fault fracture zone, negative reaction force, balance of span

1 Introduction

The Shin-Tomei Expressway, in conjunction with the Shin-Meishin Expressway, is a key route that connects Japan's three major metropolitan areas, Tokyo, Nagoya, and Osaka to drive the Japanese economy as a major artery supporting human interaction and logistics, and serves as an alternative to the Tomei and Meishin Expressways. The Nakatsugawa Bridge, the topic of this paper, is a bridge which is currently being constructed on the Shin-Tomei Expressway in Kanagawa Prefecture.

The Nakatsugawa Bridge on the Shin-Tomei Expressway is a triple-span PC extradosed bridge that is planned to cross the Nakatsugawa River in a steep valley involving a fault fracture zone, linking to tunnels at both ends of the bridge.

In designing a bridge for the site, we arranged the main tower and bridge piers along the road bridge route on the sloped site, since it was necessary that the bridge be constructed with a long mid span crossing over the river and fault-fractured zone which extends over a wide area. The study identified a difficult problem in that the end spans are very short compared with the middle span, resulting in a poor span balance which inevitably creates a negative reaction force at the girder ends. The geological survey shows there is concern that the fault may trigger a relative displacement of up to 3 m.

In order to solve these problems, this paper discusses the basic plan which uses light weight butterfly webs only in the middle span to improve the span-to-span balance, and also reports the verification of the bridge in terms of safety in the event of a large scale earthquake and fault displacement.

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