Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte

Band: 64 (1991)

Artikel: Design and constrcution of Shinkawaotogawa bridge

Autor: Kimura, Hideo / Kuroiwa, Tadashi / Hanada, Tadaomi

DOI: https://doi.org/10.5169/seals-49319

Design and Construction of Shinkawaotogawa Bridge

Projet et construction du pont de Shinkawaotogawa

Entwurf und Bau der Shinkawaotogawa-Brücke

Hideo KIMURA Civil Engineer
Tadashi KUROIWA Civil Engineer
Japan Highway Public Corporation
Tokyo, Japan

Tadaomi HANADA Civil Engineer
Hideyuki NAKAJIMA Civil Engineer
Fuji PS Concrete Co. Ltd.
Tokyo, Japan

Hiroshi SHINKAWA Civil Engineer
PC Bridge co. Ltd.
Tokyo, Japan

1. General

Sinkawaotogawa Bridge is a 7-span continuous frame structure of span length approximately 90 m long showing in Fig. 1. It locates between oimatsuda and Gotenba on the reconstructed route of the Tohmei Expressway.
This bridge does not require bearinge at bridge piers.
On such point of view, it becomes economical. Also the improvement in drivability is trafical because of less expansion and contraction devices.

Since the bridge is statically indeterminate stracture of high order, the cracking may occur in unforessen seismic actions. However, the reinforced and prestressed concrete with multi-fixed-pier can possess enough toughness. This system is excelling in a seismic resistance compared with continuous-girder type and T-frame bridge with single pier.
Consequently in recent years, prestressed concrete continuous-frame bridges have been planned and constructed in large number in Japan.

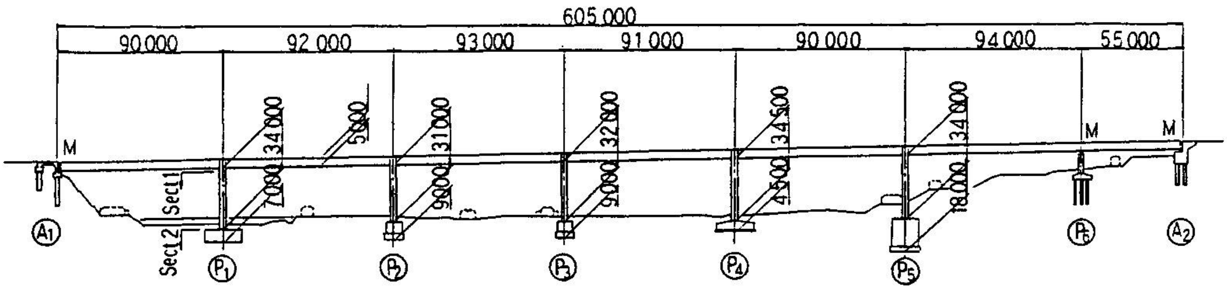

Fig. 1 Side view of Shinkawaotogawa Bridge

For a multi-span continuous-frame bridge, excessive section forces may be produced at fixed piers at the ends because of deformation due to creep, drying shrinkage, secondary prestress, temperature variation, etc. Therefore this type of structure had been considered to be unsuitable in the past for a bridge such as this one with short piers of 31.0 to 34.5 m in relation to fixed span length of 366 m. However designing was made possible by alleyiating restraining forces using a flexible structure with pier width 3.0 m which is thin compared with conventional bridges. By making the pier cross section small, excessively large tensile stresses are produced in the concrete. The occurrence of cracking cannot be avoided. Further, extremely high stresses are produced during earthquakes. It will be necessary to consider that behaviors will extend into the elastoplastic range. For this reason, the strengths and deformation capacities of the bridge piers were calculated by elasto-plastic analyses. It had been confirmed was ascertained that there was ample allowance in a seismic safety.

2. ELASTO-PLASTIC SEISMIC RESPONSE ANALYSIS OF BRIDGE PIER

The strength possessed by the bridge pier cross section against cyclic loads exceeding the yield point was analytically evaluated from the composition law of concrete and steel. In performing this analysis the restrained and unrestrained concrete and reinforcing bars comprising the bridge pier cross section were divided into a large number of fiber elements, and bending moment-curvature relationships under cyclic loads in the elastoplastic range were calculated based on the stress-strain relationship hypothesized for each element.

As a result of examining by load simulation the cyclic amplitude increasing load of inelastic behavior of the bridge pier cross section under action of axial force corresponding to actual load, yield strength M_y = 42,000 tm and ultimate strength M_u = 49,000 tm were calculated.

On examining the bending moment-curvature ratio shown in Fig. 3, in spite of the fact that a considerable cyclic load is sustained in the plastic range, the maximum strength in the hysteresis loop having dropped almost none at all indicated that this bridge pier cross section had much deformation capability. It was judged from this analysis that this bridge pier had ample allowance in a seismic stability according to both strength and deformation capabilities.

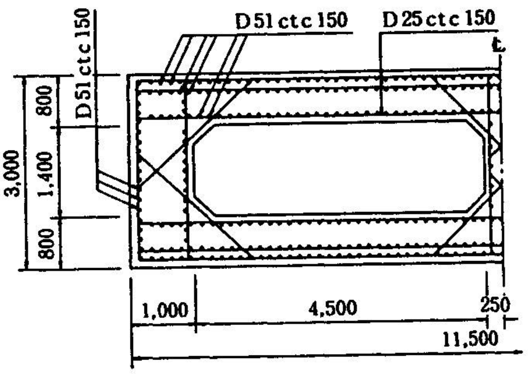

Fig. 2 Bridge pier cross section arrangement

Table 1 Design section force, stress intensity of bridge pier

Dead load + seismic + temperature

	Section 1	Section 2
Bending moment (tm)	30,992	31,591
Axial force (ton)	5,023	6,447
Reinforcing bar stress intensity (kg/cm^2)	2,696	2,664
Concrete stress (kg/cm^2)	144	142

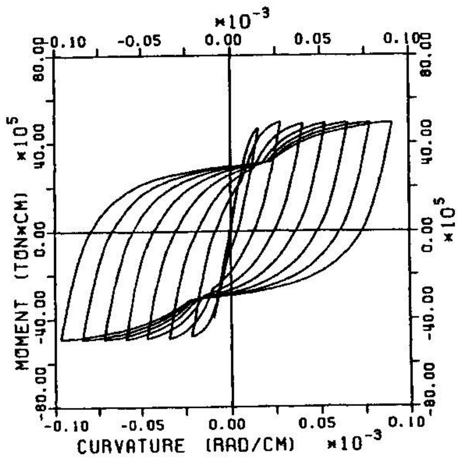

Fig. 3 Moment(M)-curvature(ϕ) relationship, (0-30 sec) N=6,447 ton, cyclic amplitude incremental load