

**Zeitschrift:** IABSE reports = Rapports AIPC = IVBH Berichte  
**Band:** 79 (1998)

**Artikel:** Reconstruction design for PC girders damaged by the Kobe Earthquake  
**Autor:** Kanaji, Hidesada  
**DOI:** <https://doi.org/10.5169/seals-59997>

### **Nutzungsbedingungen**

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. [Mehr erfahren](#)

### **Conditions d'utilisation**

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. [En savoir plus](#)

### **Terms of use**

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. [Find out more](#)

**Download PDF:** 01.04.2026

**ETH-Bibliothek Zürich, E-Periodica, <https://www.e-periodica.ch>**

## Reconstruction Design for PC Girders Damaged by the Kobe Earthquake

**Hidesada KANAJI**  
Civil Eng.  
Hanshin Expressway Public Corp.  
Osaka, Japan

Hidesada Kanaji, born 1962, received his Master Degree of Eng. in 1988 from Kobe Univ. He has been engaged mainly in designing expressway structures and supervising construction site.

### Summary

The bridge discussed in this paper has simple composite PC girders supported by six RC T-beam piers and one RC rigid frame pier. It is located in Nada Ward, Kobe and was severely damaged by the Kobe Earthquake. The damage included inclination of the eccentric piers and damage to the end cross beams. To restore the bridge, a girder connection with isolators was used to distribute and reduce inertia force. Specifically, the slab-rubber-hinge girder connection method was developed. Isolators with both lead-rubber bearings (LRB) and sliding rubber bearings (SRB) and restrainers having rubber-sheathed chains were also used. Foundations, piers and girders except the damaged end cross beams were reused with some repair.

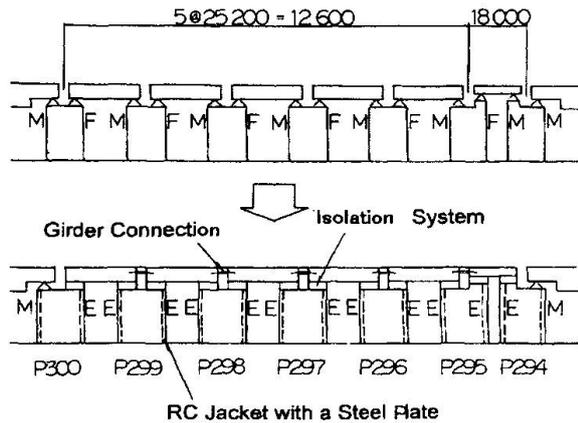
### 1. Basic of Structural Framework Design

In the design, focus was placed on developing a girder connection structure and employing omnidirectional seismic isolation to decrease both longitudinal and lateral inertia forces acting on eccentric piers whose reinforcement possibilities were limited (see **Fig. 1**). The preliminary design was first drawn up by applying the seismic coefficient method and the final, comprehensive design was based on the nonlinear dynamic analysis of the seismic record of the Kobe Earthquake at the Japan Meteorological Agency Kobe station. In addition, to verify the validity of the adopted isolated structures, the cumulative strain energy was calculated by analysis of the entire bridge, obtaining the proportions of seismic energy shared by the foundations, piers and isolation bearings (see **Fig. 2**).

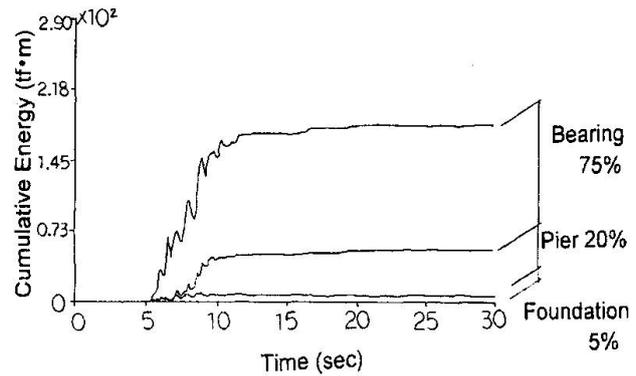
### 2. Characteristic Structure Components

#### 2.1 LRB-SRB Combined Isolation System

Two kinds of bearings, shown in **Fig. 3**, were applied to the bridge. SRBs were placed under the main girders to support the vertical load, and LRBs were placed in the gaps left under the end cross beams by removing part of their underside to absorb inertia force during an earthquake. This system was applied to the bridge in this paper which made use of thin rubber pad bearings

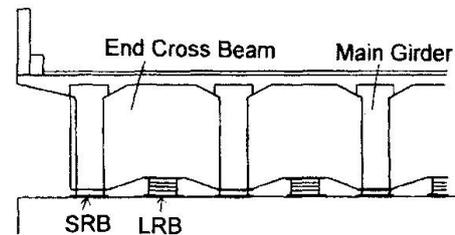


**Fig. 1** Structural Framework



**Fig. 2** Cumulative Strain Energy

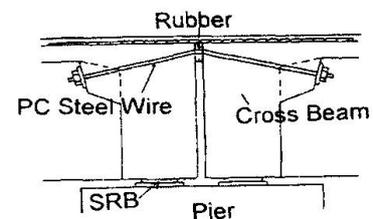
under girders so as to limit the vertical change in that part of the bridge. The following are the main results verified by the performance tests: (1) the horizontal stiffness and damping capacity of LRB depended on the vertical load, but were within the design limit regardless of the small vertical load; (2) there were no significant changes in horizontal stiffness or damping capacity, regardless of the direction of vibration; and (3) the friction coefficient of SRB was approximately 0.1.



**Fig. 3** LRB-SRB Isolation System

## 2.2 Connected Girder Structure

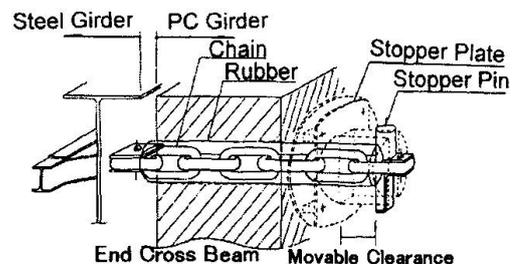
The girder connecting sections were designed to satisfy the following conditions: (1) the rotation of the joint section due to live load deflection would not be restricted; and (2) inertia force in the longitudinal direction would be transmitted through the joints. Accordingly, new slab-rubber-hinge designs as shown in **Fig. 4** were adopted. In this method, a rubber functioning like a hinge was placed on the slab and the upper parts of the cross beams were connected by PC wires.



**Fig. 4** Girder Connection

## 2.3 Restrainers

A restrainer which could work in directions both longitudinal and lateral was required for an omnidirectional isolation system. Rubber-sheathed chains as shown in **Fig. 5** were adopted. Their impact-absorbing properties can also minimize the probability of destruction due to impact. An impact-tension test was conducted to check the impact-absorbing capability with a high-speed tension tester.



**Fig. 5** Restrainer with Rubber-sheathed Chain