Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte

Band: 79 (1998)

Artikel: Effects of the Hyogo-Ken-Nanbu earthquake on the Akashi Kaikyo bridge

Autor: Goto, Atsushi / Moritani, Toshimi / Kurihara, Toshihiro

DOI: https://doi.org/10.5169/seals-59870

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

Effects of the Hyogo-Ken-Nanbu Earthquake on the Akashi Kaikyo Bridge

Atsushi GOTO
Eng., Third Design Div.
Honshu-Shikoku Bridge Authority
Kobe, Japan

Atsushi Goto born in 1964. He graduated from Civil Eng. Dept of Gifu National College of Technology in 1984.

Toshimi MORITANI
Mgr, Third Design Div.
Honshu-Shikoku Bridge Authority
Kobe, Japan

Toshimi Moritani born in 1950. He graduated from Civil Eng. Dept of Gifu Univ. in 1973.

Toshihiro KURIHARA
Dep. Mgr, Third Design Div.
Honshu-Shikoku Bridge Authority
Kobe, Japan

Toshihiro Kurihara born in 1953. He graduated from civil Eng. Dept of Oita National College of Technology in 1974.

Summary

The Hyogo-ken-Nanbu Earthquake of 17 January 1995 (magnitude 7.2) caused devastation in the city of Kobe and surrounding areas. After the earthquake, the Akashi Kaikyo Bridge(approximately 4km long suspension bridge with a center span of 1990m) located a few kilometers away from the epicenter, which was at that time under construction, was inspected but apart from the change in span length that occurred as a result of fluctuation of the sea bed, no damage was found in the bridge structure. Records obtained from velocity meters installed on the towers indicated that the acceleration response at the top level of the towers was approximately 1,100 gals at transverse to the bridge axial direction. Further, measurements of settlement in the foundation ground showed that the ground under tower 2P subsided by about 20 mm.

This information was used to check the post-earthquake soundness of the bridge structure. Unfortunately, earthquake records from which to estimate the actual input earthquake motion were unavailable. Thus, the input motion was estimated from records taken in areas surrounding the bridge and from the velocity meter readings. A response analysis method incorporating the latest findings, such as the dependence of the ground on strains, was used to analyze the bridge. This procedure demonstrated the post-earthquake soundness of the bridge and also revealed information about the bridge's earthquake resistance after completion.

1. Occurrence of the Earthquake

Ever since work commenced in 1986, the bridge has been scheduled for completion by the end of fiscal 1998. At the time of the earthquake, the substructures and towers had been completed, the strands of the main cables had all been installed, and cable squeezing work to round the cable cross section was underway, ready for erection of the stiffening girders.

2. Earthquake Records at the Bridge

No significant records were obtained from seismographs installed near the bridge for design and construction purposes. However, velocities were recorded by meters installed at the top and at the mid-points of the towers; they had been fitted to facilitate the measurement of wind-induced vibrations.

These records indicated that the maximum instantaneous velocity at the tower tops exceeded 100 kines. In terms of acceleration, this represents a maximum acceleration of about 1,100 gals.

3. Results of Inspections and Surveys after the Earthquake

No damage was found in the bridge structure members, such as the anchorages, tower foundations, towers or cables. However, because of fluctuation of the sea bed where the foundation was installed, the center span length increased by approx. 80cm, and the span length on the Awaji Island side increased by approx.30cm. Moreover, ground subsidence of approx.20mm was confirmed in the 2P foundation ground.

4. Effects of Displacement of Foundation and Measures

Based on the results of inspections and surveys mentioned above, investigations were carried out on additional stresses that arise as a result of the displacement of the foundation, and the corresponding measures to be adopted. Results demonstrated that the additional stresses in the cables, main tower foundations, and tower-top saddles were within allowable limits. To cope with the change in bridge shape caused by the relative displacement of the foundations, including the changes in span, stiffening girder lengths were increased — 80 cm was added to two panels in the central span and 34 cm to an anchorage end panel in the Awaji side span.

5. Earthquake Response Analysis

In designing the bridge, the design input earthquake motion was taken to be that resulting from a marine earthquake of magnitude about 8.6. To complement this, the stochastically evaluated motion of a magnitude 6.0 or greater earthquake within a radius of 300 km of the bridge was also considered. However, the motion caused by this strong local earthquake exceeded these input motions assumed in the design of the bridge.

Subsequently, earthquake response analysis was carried out to elucidate bridge behavior during the earthquake, evaluate the post-earthquake soundness of the bridge, and obtain data on the earthquake-resistance of the completed bridge. This analysis entailed consideration of the following scenarios: the foundation system alone; the bridge system while under construction; and the bridge system after completion.

Since records yielding direct estimates of the input earthquake motion are unavailable, the inputs used in the analysis were estimated from records collected in the vicinity of the bridge as well as from the velocity meter readings.

In analyzing the foundation system, it was necessary to take into account the magnitude of the input earthquake motion, the dependence of the ground on strain, and nonlinearities arising through separation of the foundations from the ground. To accomplish this, the modified R-O model was used to obtain the dependence of the ground on strain and a nonlinear spring was used between the foundations and the ground to take separation into account. For the analysis of the completed bridge system, the spring between foundations and the ground was evaluated and the effects of TMDs in the towers were also studied.

The results of this analysis demonstrated the soundness of the bridge in its under-construction state when the earthquake struck, while also providing data about the bridge's earthquake resistance once it is complete.