

Zeitschrift: IABSE congress report = Rapport du congrès AIPC = IVBH
Kongressbericht

Band: 12 (1984)

Artikel: Vibration control of stiffening arch bridge

Autor: Honda, Hideyuki / Kobori, Tameo

DOI: <https://doi.org/10.5169/seals-12238>

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: 10.08.2025

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



Vibration Control of Stiffening Arch Bridge

Hideyuki HONDA

Dr. Eng., Assoc. Prof.
Kanazawa Inst. of Tech.
Ishikawa, Japan

Tameo KOBORI

Dr. Eng., Prof.
Kanazawa University
Kanazawa, Japan

A variety of technical problems related to highway bridges have been pointed out, because an increasing number of heavy trucks are seen on nation's highway in recent years, and the method of reinforcement of bridges has become the center of wide interest. In the reinforcement of bridges, it is necessary to consider the serviceability of bridges not only in terms of statistical and dynamical problems, but also the vibration felt by pedestrians.

In this paper, a particular stiffening arch bridge (Lohse girder bridge), which holds these problems described above, is considered as case study. The method of reinforcement is investigated by the insertion of diagonal hangers. In order to find out the most efficient of reinforcement on this bridge, a statistical inference method (a design of experiments) is applied to this study. In this method, the evaluation of vibration control is investigated. It is considered that the acceleration corresponds to the magnitude of vibration on the bridge and the velocity corresponds to the vibration felt by a pedestrian. Each effective value of the response acceleration and velocity is calculated by dynamic analysis of nonstationary response of the bridge with inserted diagonal hangers under a moving heavy vehicle, and the optimum combination of diagonal hangers is estimated from these effective values. The effect of insertion of the estimated optimum combination on the serviceability of this bridge based on the vibration sensibility of pedestrian, and the statistical and dynamic problems is investigated.

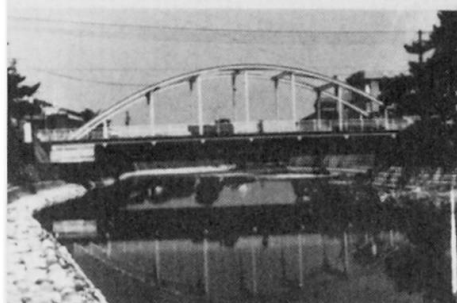
Using the calculated results described above, and taking aesthetic point into consideration, actual construction was done to reinforce the bridge. Before and after testing was done to determine the effect of the insertion of the diagonal hangers. From the measured results of this field test, it could be seen that these results bore out the predictions of the analytical study.

The major conclusions of this study can be summarized as follows:

- (1) The load carrying capacity of the stiffening girder increases because the applied load is dispersed by these diagonal hangers.
- (2) The excitation of the first asymmetric vibration is eliminated because the vibration mode is changed by the alteration of the bridge structure system and the natural frequency increases.
- (3) The serviceability of this bridge is improved because the vibration felt by the pedestrian decreases.

Finally, from the results of this analytical study and field test, it is recognized that the method of reinforcement using diagonal hangers is a successful way for vibration control in the stiffening arch bridge.

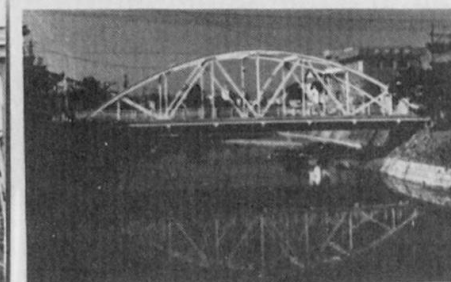
VIBRATION CONTROL OF STIFFENING ARCH BRIDGE



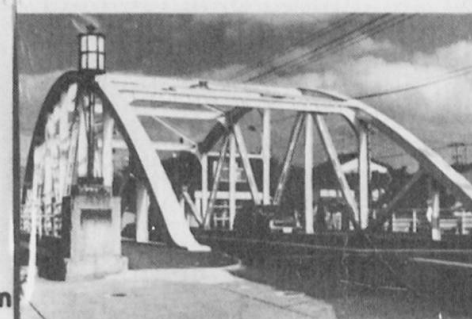
Scenery of NAKAJIMA bridge
(it was constructed at 1955).



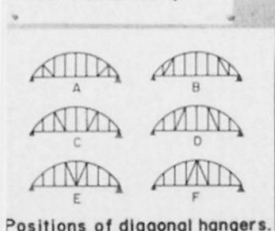
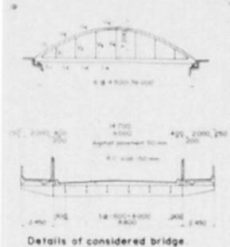
Construction for reinforcement.



Reinforced bridge based on optimum
combination of diagonal hangers.



Reinforced bridge based on optimum
combination of diagonal hangers.



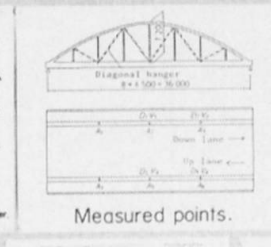
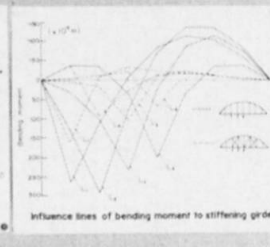
Vehicle load and roadway properties.

Vehicle (CV) 20 kN
Wheel length of roadway (mm) 700 × 200
PG of roadway roughness (mm) 0.01
Vehicle weight (kN) 10000 (10,000, 10,000, 10,000)
Spring stiffness (N/mm) 100000 (100,000, 100,000, 100,000)
Damping factor (N/mm) 10000 (10,000, 10,000, 10,000)
PG of roadway load (kN/m) 100 (100, 100, 100, 100)
Vehicle width (mm) 2000 (2000, 2000, 2000, 2000)
Vehicle speed (km/h) 100 (100, 100, 100, 100)

Results of analysis of variance.

Effective values	Factorial effects
Acceleration	** ** ** ** **
Velocity	** ** ** **

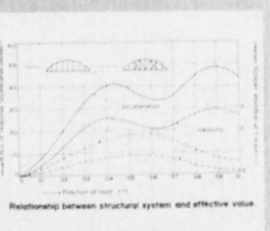
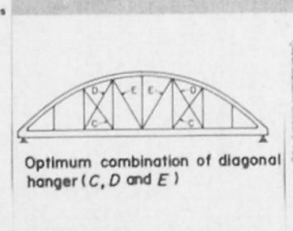
* Level of significance 5%
** Level of significance 1%
*** Main effect of factor
**** Interaction effect of factor C and D



S and VQ to each structural system of bridge under a moving dump truck.

Natural frequencies and effective values on treatment conditions.

Treatment	Natural frequency (Hz)	Effective value
1	1.00	1.00
2	1.05	1.05
3	1.10	1.10
4	1.15	1.15
5	1.20	1.20
6	1.25	1.25
7	1.30	1.30
8	1.35	1.35
9	1.40	1.40
10	1.45	1.45
11	1.50	1.50
12	1.55	1.55
13	1.60	1.60
14	1.65	1.65
15	1.70	1.70
16	1.75	1.75
17	1.80	1.80
18	1.85	1.85
19	1.90	1.90
20	1.95	1.95
21	2.00	2.00
22	2.05	2.05
23	2.10	2.10
24	2.15	2.15
25	2.20	2.20
26	2.25	2.25
27	2.30	2.30
28	2.35	2.35
29	2.40	2.40
30	2.45	2.45
31	2.50	2.50
32	2.55	2.55



Results of field test.

Test No.	Location	Vehicle	Speed (km/h)	Acceleration (m/s²)	Velocity (mm/s)
1	100m	CV	100	0.01	0.01
2	200m	CV	100	0.02	0.02
3	300m	CV	100	0.03	0.03
4	400m	CV	100	0.04	0.04
5	500m	CV	100	0.05	0.05
6	600m	CV	100	0.06	0.06
7	700m	CV	100	0.07	0.07
8	800m	CV	100	0.08	0.08
9	900m	CV	100	0.09	0.09
10	1000m	CV	100	0.10	0.10