

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

Band: 14 (1992)

Artikel: Hybrid isolation system using friction-controllable sliding bearings

Autor: Fujii, Shuni / Kawamura, Soichi / Feng, Quing

DOI: <https://doi.org/10.5169/seals-853216>

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: 03.02.2026

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



Hybrid Isolation System Using Friction-Controllable Sliding Bearings

Système hybride d'isolation basé sur des appuis glissants à friction

Hybride Isolation mit Gleitlagern beeinflussbarer Reibung

Shuni FUJII

Chier Eng.
Taisei Corporation
Tokyo, Japan

Qing FENG

Research Assist.
Princeton Univ.
Princeton, NJ, USA

Solchi KAWAMURA

Res. Group Leader
Taisei Corporation
Yokohama, Japan

Masanobu SHINOZUKA

Dir.
NCEE
Buffalo, NY, USA

1. INTRODUCTION

The sliding isolation system represents a reliable vibration suppression technology. Such a sliding isolation system, however, has some limitation in its capability; it is not efficient for small to medium earthquakes, and it tends to suffer a large sliding displacement during large earthquakes. The objective of this research then is to develop a hybrid isolation system using friction-controllable sliding bearing, where by controlling the friction force, the sliding displacement will be confined within an acceptable range, while keeping the overall isolation performance optimal under the circumstances.

2. HYBRID ISOLATION SYSTEM

In the hybrid isolation system, a friction controllable sliding bearing or variable friction bearing (VFB) is used instead of an ordinary sliding bearing. The VFB is a carved out steel disk with a sliding material placed around its perimeter and a fluid chamber inside. The fluid pressure and the corresponding up-lifting force created by the fluid pressure can be controlled, resulting in a controllable friction force. Pressure control hardware system including computers connected to the VFB's controls the pressure according to a control algorithm so as to achieve an optimal isolation performance .

A simple one-degree of freedom model composed of a mass supported by VFB's is considered. A control algorithm based on the instantaneous optimal control theory[1], has been developed.

3. SHAKING TABLE TEST [2]

3.1 Description of Test

A pilot isolation system, including the VFB's and a pressure control system, has been constructed and tested on a shaking table. The model structure was a rigid body with the total mass of 12 tons supported by four VFB's. The sliding surface of the VFB consists of 1 mm thick brass plate while a stainless steel sheet is placed on the shaking table to provide a sliding surface over which the VFB's can slide.

The control system consists of a 16 bit microcomputer with a numerical co-processor , and 12 bit A/D and D/A converters. Based on the response signals measured by sensors, the computer calculates the pressure control signal according to the control algorithm, and the signal was sent to the servo amplifier.

The shaking table test was conducted under unidirectional (horizontal)

earthquake as well as sinusoidal excitations.

3.2 Test Result

A test performed off-line indicated that the friction force decreases linearly as the pressure increases within the interface. Also in another test, the relation between the pressure and the friction force under control signals was established. The results of these tests are modeled and used in the simulation. Performance of the hybrid control system is compared with that of the passive isolation system under different intensities of input seismic motion. As shown in Figure 1, the hybrid control system performs better than the passive system in the sense that the reduction of response acceleration has been achieved for small to medium seismic inputs, and at the same time, the maximum displacement has also been reduced. The residual displacement has been found to be nearly zero under hybrid control, which appears to be another advantage of this hybrid system.

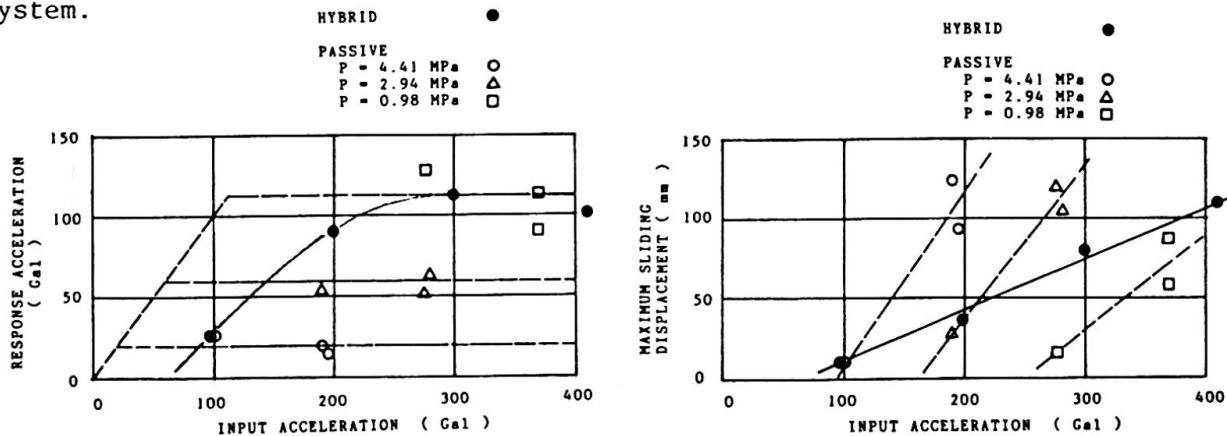


Fig. 1 Hybrid and Passive Cases

4. SIMULATION

The test results were simulated numerically exhibiting reasonably good agreement. Since some of the parameters and mathematical models involved some degrees of uncertainty, the good agreement observed is an indication of robustness of the hybrid system. The parametric study performed, also by means of simulation, identified most appropriate control parameters.

5. CONCLUSIONS

- (1) Significantly beneficial effect of the hybrid control on the reduction of the sliding displacement as well as the reduction of the input force, has been verified through shaking table test.
- (2) The pilot hybrid isolation system using the VFB's appears to be quite robust in the fact of uncertainty involved in various aspects of the control model.
- (3) Structural response simulated by the numerical analysis showed good agreement with the observation in the shaking table test, implying that the numerical model identified in the present study represents the reality reasonably well.

REFERENCES

- [1] YANG, J.N., et al., "Optimal Control of Nonlinear Flexible Structures", Technical Report of NCEER-88-0002. (1988)
- [2] FENG, Q., et al., "Hybrid Isolation System Using Friction Controllable Sliding Bearings", 8th VPI and SU Symposium on Dynamic and Large Structures, May 1991.