

## Dynamic response of bridge system with knocking-off members

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## Summary

Displacement restrainer, restraints transverse movement of the superstructure of the isolated bridges, is adopted to protect expansion joints from damage during earthquake. Here to mitigate damage of bridge pier and/or its foundation and to enhance redundancy of the isolated viaducts in a strong earthquake, it can be considered that the displacement of the superstructure against a small and moderate earthquake is restraint and the displacement against a strong earthquake is freed to shift to isolated condition. Knock-off members will provide these responses of the vibration system.

This study presents the outline of some of displacement restrainers having the knock-off function and reveals the effectiveness of the knock-off in the isolated bridge system through dynamic loading test using small-size shaking table. It is also analytically verified the influences of the breaking characteristics on seismic response of the system.

**Keywords:** viaduct; isolation; knock-off member; seismic response.

## 1. Introduction

Seismic isolation works to reduce the reaction force delivered to the substructures, like bridge piers and its foundation, and is mainly expected in the bridge direction of a viaduct in the seismic design. The transverse movement of the superstructure is usually restraint by use of displacement restrainers like steel side block, set aside of both sides of the isolating bearings [1].

When considering a more effective and rational use of the isolating effect of the isolating bearings, the isolating effects not only in the direction of the bridge axis but also in the transverse direction is to be considered in the seismic design of the viaduct. Then, preferably required for an advanced types of displacement restrainers is to fix the movement of superstructure against a small and moderate earthquake, which sometimes occurs during the bridge design life, and to release it against a strong earthquake, which rarely occurs but has strong energy. Here, displacement restrainers are categorized into a bar/bolt type, a column type and a beam type. The authors focus on adding knock-off function to these 3 types of the displacement restrainers by installing a slit section to them. Then, these improved displacement restrainers can be designed as the joint protector against the Level 1 Earthquake with the maximum ground acceleration of 150-200 gals which is defined in the Japanese Specification for Highway Bridges (JSHB) [1] and as the knock-off member against the Level 2 Earthquake like the Hyogo-ken Nambu Earthquake [2]. The design formulae calculating the breaking load of these members are proposed based on static breaking test results and the effectiveness of these members are verified through the nonlinear dynamic response analysis and small-size shaking table test of a vibration system supposing a viaduct in the case of the steel side block with knock-off function, for example.