# Seismic Response Analysis of an Instrumented Base-Isolated Building in the 2011 Great East-Japan Earthquake

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## Summary

This paper describes a study on seismic response of a base-isolated building in Tokyo Bay area. The building is instrumented with triaxial accelerometers at twenty-four locations and seismic responses were recorded since October 2010. The building experienced strong shaking during the March 11, 2011 Great East-Japan Earthquake. Series of aftershocks that follow the large main shock earthquake were also recorded and they provide a comprehensive database on the building seismic responses. Response analysis shows that base isolation system performed as intended during the main shock. In addition, rotational motion had a great influence on the structure motions since the building has asymmetrical shape. We also observe the change in modal parameters, especially reduction of the first few natural frequencies of the building after the March 11, 2011 main shock.

**Keywords:** *seismic response, instrumented building, base-isolation, vibration monitoring, system identification, Great East-Japan Earthquake*

## 1. Introduction

After the 1995 Hyogo-ken Earthquake base-isolated buildings become more popular in Japan especially for hospital, school, university and office. Base-isolation system is selected for safety reason during an earthquake and for serviceability reason after earthquake. Recently many base-isolation buildings are instrumented with vibration measurement system. The objective of the instrumentation system is to investigate seismic performance of the buildings and to ensure that the isolation system functioning as designed. In this paper, we describe a study on seismic response of asymmetric base-isolated building. Focus of the paper is on the seismic response analysis of the buildings before, during and after the March 11, 2011 Great East-Japan earthquake. Analysis is conducted using system identification and structural modeling.

## 2. Description of the Building and Seismic Monitoring System

The monitored building is a university campus located in Tokyo Bay area. The building consists of two parts, seven story classroom building and fourteen story research building. Both buildings are made of steel frames and connected at the corner by elevator shaft to form an L-shaped asymmetric structure. The fourteen story research building has vertical opening from the center of the second floor to the seventh floor that makes it separated into two buildings, referred to as the southeast research building and the northwest research building, respectively. Meanwhile, the seven-story classroom building has some voids on its floor to provide access for escalator.

The isolation system consists of several types of isolator, namely, multilayered natural rubber, sliding bearing, u-shaped steel dampers and lead damper. They are arranged at various distances to support a 70m x 25m concrete floor slab that supports the research and classroom buildings.

The building is built on a reclaimed area near Tokyo Bay thus amplification of seismic motion is anticipated. Vibration monitoring system was installed on the buildings in order to monitor closely the building condition during an earthquake and to evaluate performance of base-isolation system. The monitoring system consists of vibration sensors such as triaxial accelerometers and displacement-meters. The sensors are installed on 27 locations including foundation, basement and upper structure. The system records various levels of ground excitation and small tremor by setting

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