The development of a structural design method in the pile-head seismic isolation approach based on static horizontal load tests

Ryuichi TERADA
Structural Engineer
Associate
Nikken Sekkei Ltd.
Tokyo, JPN
terada@nikken.co.jp.

Takashi FUKUSHIMA
Structural Engineer
Nikken Sekkei Ltd.
Tokyo, JPN
takashi.fukushima@nikken.co.jp

Yuji YAMANO
Structural Engineer
Partner
Nikken Sekkei Ltd.
Tokyo, JPN
yamano@nikken.co.jp

Masayuki YANAGI
Engineer Section
Acting Manager
SWCC Showa Device
Technology Co.,Ltd.
Kanagawa, JPN
m.yanagi038@dt.swcc.co.jp

Miyuki KAIHOTSU
Engineer Section
SWCC Showa Device
Technology Co.,Ltd.
Kanagawa, JPN
m.kaihotsu019@dt.swcc.co.jp

Satoshi MAENO
Engineer Section
SWCC Showa Device
Technology Co.,Ltd.
Kanagawa, JPN
s.maeno033@dt.swcc.co.jp

Summary

The pile-head seismic isolation approach, which installs seismic-isolation apparatus directly on pile heads to omit grade beams in the foundation, is an economical option but has an issue of pile heads rotating during earthquakes, causing the upper and lower flanges to lose parallel alignment. This study conducted life-size static horizontal load tests to clarify the correlation between the flanges' relative rotation angles and performance, and reflected them in the structural designs for large-scale logistics buildings.

Keywords: seismically isolated structure; pile-head seismic isolation; low cost; seismic isolation member; pile-head rotation angle; inclination; life-size test; load test

1. Introduction

The seismic isolation structural design, which minimizes shaking from seismic motions, was proven to be effective in the Great East Japan Earthquake on March 11, 2011, and appear set to proliferate in coming years. With the seismic isolation design relatively more expensive than the quake-resistant design, one of the goals for this structural design approach is to pursue the enhancement of its economic performance.

The pile-head seismic isolation approach, which installs seismic isolation apparatus directly on pile heads, saves costs for main frame construction and civil engineering, and is therefore being adopted in increasing numbers as an economic design option. However, due to the lack of grade beams in the foundation, pile heads rotate significantly during an earthquake, causing the undersurface of isolation bearings to tilt. Its impact on seismic isolation performance and safety has yet to be fully verified.

This study conducted static horizontal load tests on multilayer rubber isolators and elastic side bearings with the lower flange being tilted, in order to identify the rate of changes in horizontal stiffness and coefficient of friction, and determine the allowable level of relative

https://doi.org/10.2749/222137912805111762