High-Frequency Excitation Performance Evaluation of Bare Condition Shake Table

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Keywords : high-frequency, seismic, excitation, shake table

1. Introduction

The design response spectrum of US NRC Regulatory Guide 1.60 (RG 1.60) is generally applied the seismic design of nuclear power plants(NPP) in Korea. However, the ground motion response spectrum(GMRS) of the western United States, where spectral acceleration in the low-frequency range predominates, was generally involved in RG 1.60 design response spectrum. In contrast, the GMRS of the central and eastern United States(CEUS) are known to be dominated by high-frequency range as shown in Fig. 1. While ground motions involving high frequencies may not significantly affect massive concrete structures, it can have a significant impact on the structural integrity or electric functionality of certain NPP structural members, equipment, and components. Based on these considerations, the Electric Power Research Institute (EPRI) conducted an electric functional performance evaluation of seismic-sensitive NPP equipment and components under high-frequency seismic loads using a shaking table. In this study, to investigate the seismic-sensitive of equipment and components applied to NPP in Korea, a high-frequency excitation performance evaluation of bare condition shake table was conducted at the Nuclear Structural Seismic Testing Center of Central Research Institute of Korea Hydro & Nuclear Power Co., Ltd.,(KHNP-CRI) under artificial seismic loads using 6-DOF shake table.

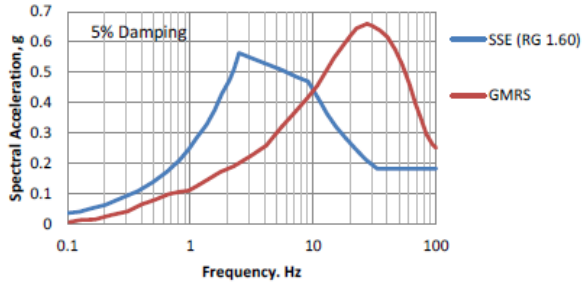

Fig. 1 RG 1.60 spectrum and CEUS GMRS

2. Methods and Results

The manufacturer specifications of the shake table employed in this study are summarized in Table 1. According to the manufacturer's data, the spectral acceleration of bare condition shake table including all frequency ranges is designed to reach maximum of 15.5 g in the vertical direction, and 11.5 g and 12.5 g in the horizontal directions, respectively. However, since the actuator stroke of shake table occurred in not large in the high-frequency range above 10 Hz, contrary to the low-frequency region, it is expected that higher spectral accelerations can be achieved in the high-frequency range. To simulate and validate high-frequency seismic load ranges of shake table, excitation tests were conducted using three required response spectrum (RRS) with frequency ranges of 10–100 Hz and peak spectral accelerations of 30 g, 40 g, and 46 g, respectively. The shake table excitation test results and RRS are shown in Fig. 2. The test response spectrum (TRS) satisfied the RRS for all three levels, respectively. Based on these results, it is expected that light-weight equipment and components, such as single cabinets, fuses, and relays, are capable of testing high-frequency spectral accelerations of approximately 40–44 g, even within the high-frequency range.

Table I: Manufacturer Specifications of the Shake Table

Index	**Specifications**	
Table size	2,500 mm X 2,500 mm	
Frequency range	0.8 ~ 100 Hz	
Maximum payload	2 ton	
Acceleration (bare condition)	Vert.	15.5 g
	Horiz.(EW)	11.5 g
	Horiz.(NS)	12.5 g

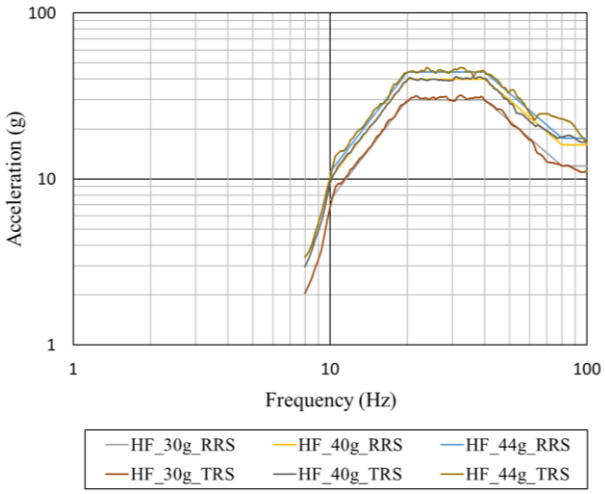

Fig. 2 Excitation test results

3. Conclusions

In this study, the high-frequency excitation performance evaluation of bare condition shake table was performed using a 6-DOF shake table operated by the KHNP-CRI. The test results confirmed that TRS in the range of 40–45 g can be reliably reproduced in the high-frequency range, thereby validating the applicability of the facility for high-frequency excitation testing of light-weight NPP equipments and components.

REFERENCES

[1] Electric Power Research Institute, High Frequency Program: High Frequency Testing Summary, EPRI 3002002997, 2014.
[2] Electric Power Research Institute, High Frequency Program, Application Guidance for Functional Confirmation and Fragility Evaluation, EPRI 3002004396, 2015.