An Experimental Study of Seismic Reinforcing System for Electric Panel on the Access Floor

J. B. Jang[a*], J. R. Lee[b], K. M. Hwang[a], K. W. Ham[a]
[a]*Earthquake Eng. Group, KEPRI, 103-16, Munji-Dong, Yuseong-Gu, Daejeon, 305-380*
[b]*Powerentech. Co.,103-16, Munji-Dong, Yuseong-Gu, Daejeon, 305-380*
[*]*Corresponding author: jbjang@kepri.re.kr*

1. Introduction

The important basic facilities of public fields such as electric power, communication and gas, have been damaged due to the large earthquakes recently throughout the world. Especially, most of the electric panels which are essential to the operation of the basic facilities, are installed without anchorage on the access floor and then are very weak against the earthquake. Therefore, there is a high possibility that an electric panel may lose its function due to overturning and sliding during the earthquake.

In order to prevent the damage of an electric panel on the access floor from the earthquake, seismic reinforcing system is developed and its seismic capacity is verified through the shaking table test in this study.

2. Seismic Reinforcing System

The developed seismic reinforcing system is for the electric panel on the access floor and secures the seismic safety of both the access floor and an electric panel by preventing overturning and sliding from the earthquake. Also, the distinctive feature of the seismic reinforcing system is that the installation is possible without movement and power breakdown of an electric panel. Fig. 1 shows a front view of seismic reinforcing system.

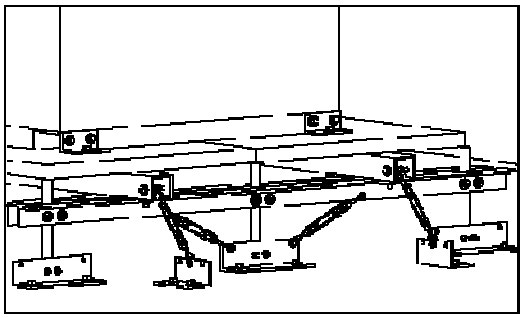


Fig. 1. A front view of seismic reinforcing system

3. Shaking Table Test

Numerical analysis is possible to verify the seismic safety of seismic reinforcing system but numerical analysis is very difficult to exactly simulate the dynamic characteristics of an electric panel, interaction and connection conditions between seismic reinforcing system and an electric panel. Therefore, shaking table test is carried out in order to analyze accurately the performance of seismic reinforcing system during and after the earthquake. 6 DOF shaking table is used for this study.

3.1 Electric Panels

Two types of electric panels which are commonly used in the industrial field, are used in this study. In order to analyze the dynamic characteristics of the electric panels, impact hammer test is adopted. Table 1 shows the structural and dynamic characteristics and Fig. 2 shows the electric panels.

(a) No. 1 (b) No. 2

Fig. 2. Electric panels

Table 1. Structural & dynamic characteristics of electric panels

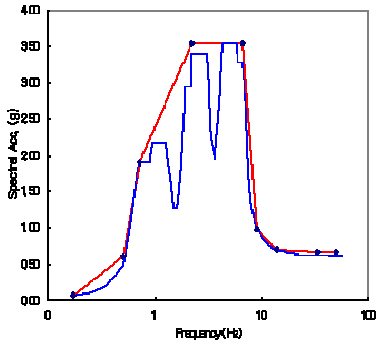
Electric panel	Dimension [W×D×H] (cm)	Weight (kN)	Natural frequency (Hz)	
			X axis	Y axis
No. 1	90×57×235	6.0	15.5	5.5
No. 2	80×73×235	7.9	20.5	19.5

3.2 The Enveloped Response Spectrum

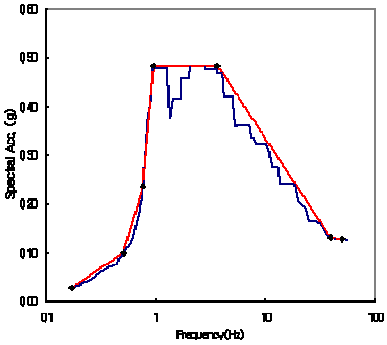
It is used the enveloped response spectrum which can envelope every floor response spectrum generated at each floor in building as input motion for shaking table test because most of the electric panels are installed at several floors in building. The enveloped response spectrum is calculated through the time history analysis using the finite element model of building. Fig. 3 shows the enveloped response spectrum.

3.3 Test Results

Shaking table tests are carried out considering two types of electric panels and two types of access floors such as steel panel and wood panel.



(a) Horizontal direction (X, Y axis)



(b) Vertical direction (Z axis)
Fig. 3. The enveloped response spectrum

The state of electric panel and seismic reinforcing system is examined by visual inspection before and after shaking table test in order to judge the seismic safety of seismic reinforcing system.

[1] Seismic Reinforcing System for Steel Panel

Fig. 2 shows electric panels on the access floor with seismic reinforcing system for steel panel and the height of access floor is 35 cm. Fig. 4 shows both the test response spectrum and required response spectrum.

During the shaking table tests, electric panel 1 shows heavier vibration than electric panel 2 and that is because the natural frequency of electric panel 1 exists in the maximum amplification interval of the enveloped response spectrum as shown in Fig. 3.

As a result of tests, seismic reinforcing system prevents overturning and sliding of electric panels from the earthquake and secures the seismic safety of both electric panel and access floor.

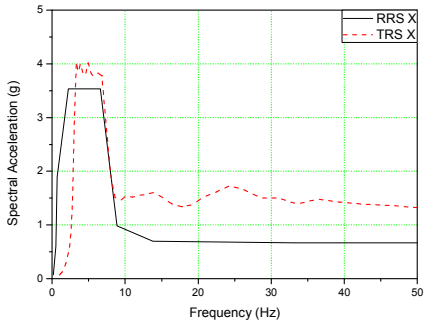
[2] Seismic Reinforcing System for wood Panel

The conditions of shaking table tests are same as the steel panel and the vibration of electric panels is almost same as the seismic reinforcing system for steel panel. Also, seismic reinforcing system prevents overturning and sliding of electric panels from the earthquake and secures the seismic safety of both electric panel and access floor.

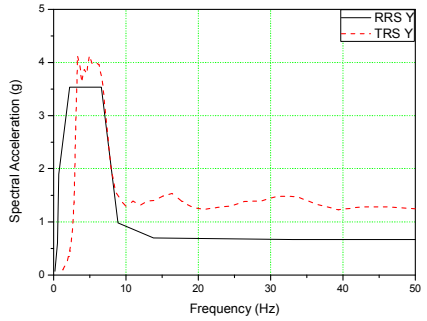
4. Conclusions

In order to prevent the damage of electric panel on the access floor from the earthquake, seismic reinforcing system is developed and its seismic capacity is verified through the shaking table test in this study.

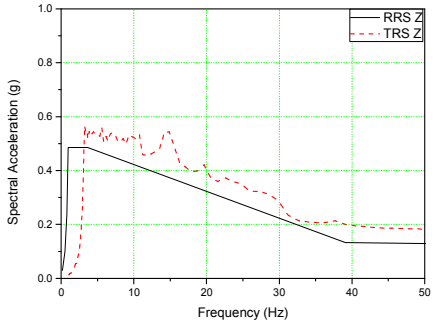
As a result of tests, seismic reinforcing system successfully prevents overturning and sliding of electric panels from the earthquake and secures the seismic safety of both electric panel and access floor.



(a) Horizontal X-direction



(b) Horizontal Y-direction



(c) Vertical Z-direction
Fig. 4. Test and required response spectrum

REFERENCES

[1] Lee, J.R., Kim, W.C., Yeo, G.T., Hwang, Y.G., Jang, J.B., Development of Seismic Reinforcing System for Electric Panel without Power Breakdown, KEPCO, 2008.
[2] IEEE Power Engineering Society, IEEE Recommended Practice for Seismic Design of Substations, 2005.
[3] IEEE Power Engineering Society, IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations, 1987.