Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 23-24, 2019

Experimental Study on the ICRS Amplification Factor of Battery Charger Due to the High-frequency Earthquake

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1. Introduction

Seismic safety of nuclear power plants is important, and not only the safety of structures of nuclear power plants but also the safety of equipment is important. The equipment consists of many components, and the seismic safety of the components is also important. Recently in Korea, the earthquake which is occurred in 2016 at Gyeongju shows high-frequency ground motion characteristics [1]. Components such as relay switches are particularly sensitive to high-frequency earthquakes. In this study, the change of the In-cabinet response spectrum (ICRS) amplification factor due to the high-frequency earthquake was investigated by the shaking table test of the battery charger.

2. Test Model of Battery Charger

Figure 1 shows the Battery charger for the shaking table test. The total weight of the cabinet is 1,700 kg, and the dimension of the cabinet is 920 x 1,600 x 2,215 mm. Figure 2 shows the dimension of the cabinet and internal structure.

Fig. 1. Test Model of Battery Charger for Shaking Table Tests.

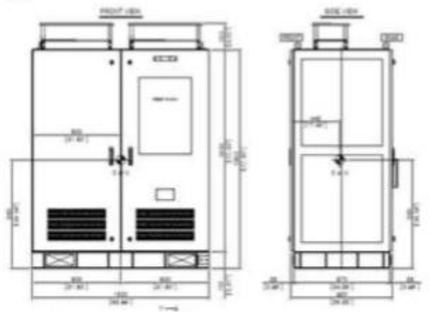


Fig. 2. Dimension of the Test Cabinet

The accelerometers are implemented inside of cabinet as shown in figure 3 to measure the in-cabinet response spectrum.

Fig. 3. Implementation of accelerometers (A7, A8, & A9)

3. Shaking Table Tests

3.1. Seismic Input

The floor response spectrum (FRS) at the location where the battery charger is installed is calculated by seismic response analyses. And also Reg. 1.60 design response spectrum (REG. 1.60) [2] and uniform hazard response spectrum (UHS) is used as input earthquakes. The input response spectrum used in the shaking table test is shown in Figure 4.

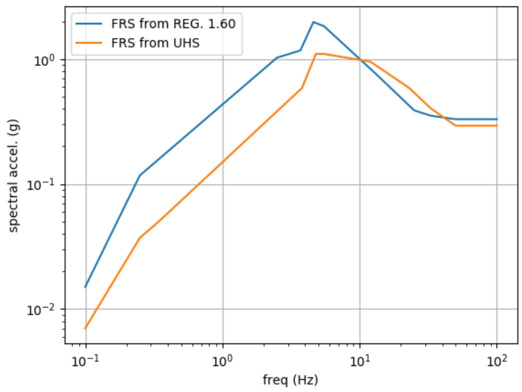
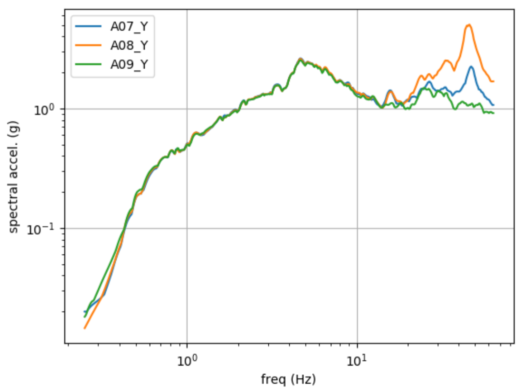


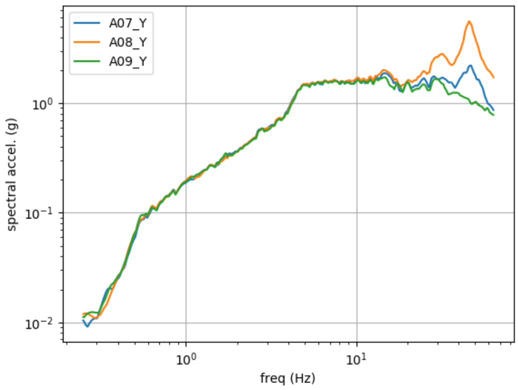
Fig. 4. Input response spectrum for the shaking table test

3.2. Test Results

As shown in Fig. 3, the direction of the dominant direction of the ICRS is the Y-direction where accelerometers of A7, A8, and A9 are installed. Therefore, response spectrums (i.e. ICRS) were calculated from the A7, A8, and A9 installed location by Y-direction acceleration in each test. The ICRS is shown in figure 5.



(a) ICRS from the REG. 1.60 input motion



(b) ICRS from the UHS input motion

Fig. 5. In-cabinet response spectrum

In order to calculate the amplification factor of the ICRS, the ICRS are divided by input response spectrum. The amplification factors are shown in figure 6.

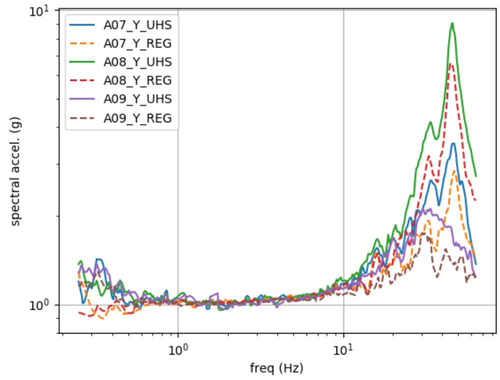


Fig. 6. Amplification factor of ICRS

As shown in figure 5, the amplification factor tendency with frequency range is similar to that of REG 1.60 (low- frequency earthquake) and UHS (high-frequency earthquake). However, it can be confirmed that the amplification factor value due to the high-frequency earthquake is larger than that of the low-frequency earthquake.

4. Conclusions

The equipment consists of many components. Components such as relays and switches are sensitive to high-frequency vibration. In this study, the comparison of the amplification factors of ICRS by a low-frequency earthquake and a high-frequency earthquake was investigated through the shaking table test of the battery charger. As a result, it was confirmed that the amplification factor tendency in a frequency range of the low-frequency earthquakes and the high - frequency earthquakes are similar to each other however the amplification values are higher when the high-frequency earthquakes are input. In other words, the seismic performance of many components due to high-frequency earthquake should be confirmed.

Acknowledgment

This work was supported by the KETEP(Korea Institute of Energy Technology Evaluation and Planning) grant funded by the Korea government(MOTIE) (No. 20171510101910 & 20161520101270)

REFERENCES

[1] S.H. Eem, & I.K. Choi (2018). Seismic Response Analysis of Nuclear Power Plant Structures and Equipment due to the Pohang Earthquake. Journal of the Earthquake Engineering Society of Korea, 22(3), 113-119.

[2] US Nuclear Regulatory Commission Regulatory Guide 1.60 (2014), “Design response spectra for seismic design of nuclear power plants”