The 2025 World Congress on
Advances in Structural Engineering and Mechanics (ASEM25)
BEXCO, Busan, Korea, August 11-14, 2025

Numerical Analysis of Smart Control System for Enhancing Horizontal and Vertical Seismic Performance of a Electrical Cabinet

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ABSTRACT

With the increasing frequency and intensity of earthquakes in the Republic of Korea, seismic design requirements for nuclear power plants have become more stringent. Within these facilities, electrical cabinets house critical equipment for monitoring abnormal signals and halt operations upon detecting such anomalies. Therefore, preventing damage to this equipment is crucial, as its failure can lead to widespread system malfunctions, significant economic losses, and severe threats to public safety. Damage to electrical cabinets can be classified into structural damage caused by high seismic energy and functional damage induced by high accelerations. Functional damage can occur at accelerations lower than those required for structural damage, thus making effective control of both horizontal and vertical acceleration responses within cabinets critically important.

In this study, a smart control system was introduced to enhance the seismic performance of electrical cabinets in both horizontal and vertical directions. A horizontal base isolation system was implemented to improve horizontal seismic resistance, while vertical springs combined with vertical magnetorheological(MR) dampers were utilized to enhance vertical seismic performance. Numerical analyses were conducted using Matlab and Simulink to verify seismic performance. The electrical cabinet used in the shake table tests was selected as the target structure and modeled in two dimensions. The model was validated by comparing its dynamic characteristics. To reflect the detailed dynamic behavior of the MR damper, the Modified Bouc-Wen model was applied.

ACKNOWLEDGEMENTS
This work was supported by KOREA HYDRO & NUCLEAR POWER CO., LTD (No. 2023-TECH-03).

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