Dynamic Behavior Analysis of Single Door Cabinet based on Experimental Test Data

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Introduction

- The Gyeongju earthquake with many contents in the high frequency range (more than 10Hz) caused substantial damage to not only structural elements, but also non-structural elements.
- In addition, precedent research studies have revealed that earthquakes that have occurred in Korea contain many high frequency contents.
- This is the time to require a seismic safety evaluation for non-structural elements of critical facilities in areas like Korea with high probability of high frequency earthquakes.
- In this study, the time history analysis was performed using the high fidelity finite element (FE) Model developed in previous studies, and the validity of the model was verified by comparing the FE and experimental results.

Experimental Test

- The size and weight of the electrical single door cabinet are 800mm×800mm×2350mm and 480kg, respectively.
- As shown in Fig. 1, accelerometers were attached to the inside and outside of the cabinet to measure the acceleration.
- As Fig. 2 displays the experimental results, 16Hz and 24Hz were the frequencies at which amplification occurred in both internal and external accelerometers, and these were judged as the global modes.
- As shown in Figure 2, the first local mode was 30.50Hz(A9) and the second local mode was 37.50Hz(A10).

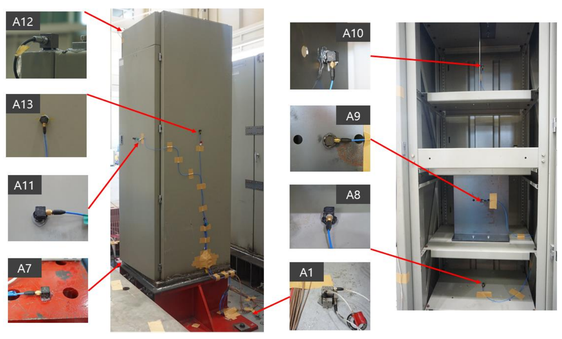


Fig. 1. Accelerometer location

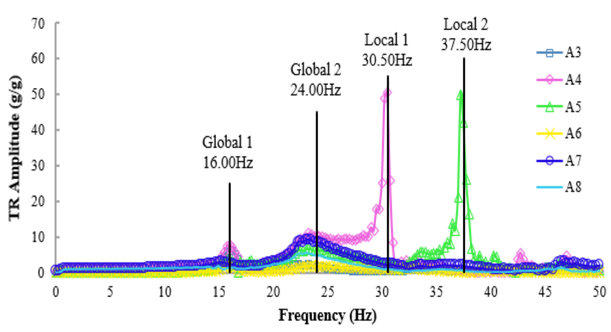


Fig. 2. Resonant frequency search test results

- The input motion used in the shaking table test generated artificial seismic waves using the RG 1.60 required response spectrum (RRS) of Fig. 3.
- Fig. 5.(A12) and Fig. 6.(A13) show the comparison of the acceleration response in the X direction and RRS.

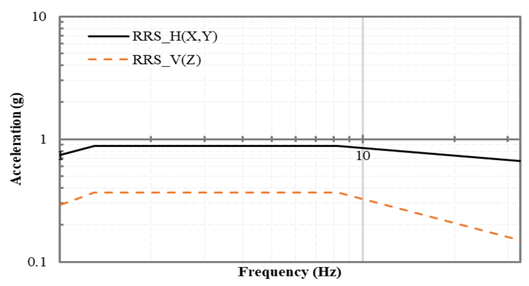


Fig. 3. Required response spectrum by RG 1.60

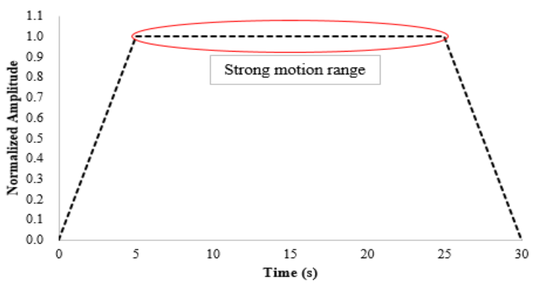


Fig. 4. Artificial earthquake envelop function

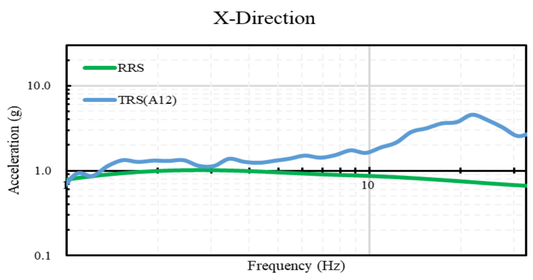


Fig. 5. Front-back(X) response in A12

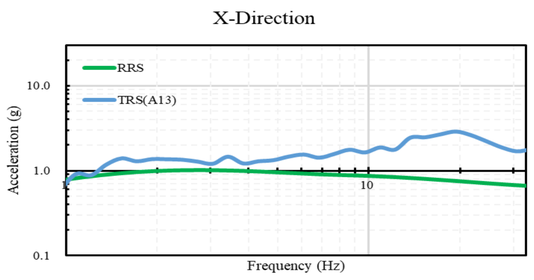


Fig. 6. Front-back(X) response in A13

Finite Element Analysis

- The elastic modulus E=200,000MPa, density $\rho=7.85\times10^{-9}$t/mm^3, and Poisson's ratio υ=0.28, which are the material properties of general steel materials, were applied for the material model.
- The 4node shell element (S4R) generally used in the ABAQUS platform was used, and the FE model is depicted in Fig. 7.

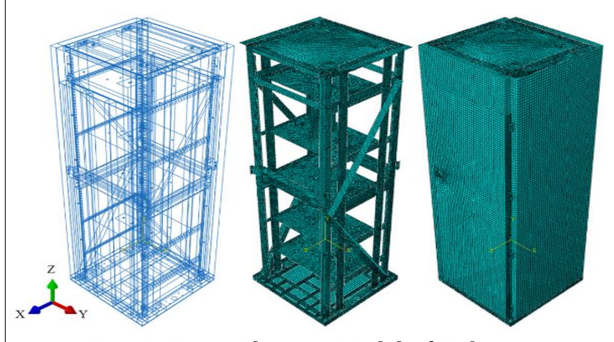
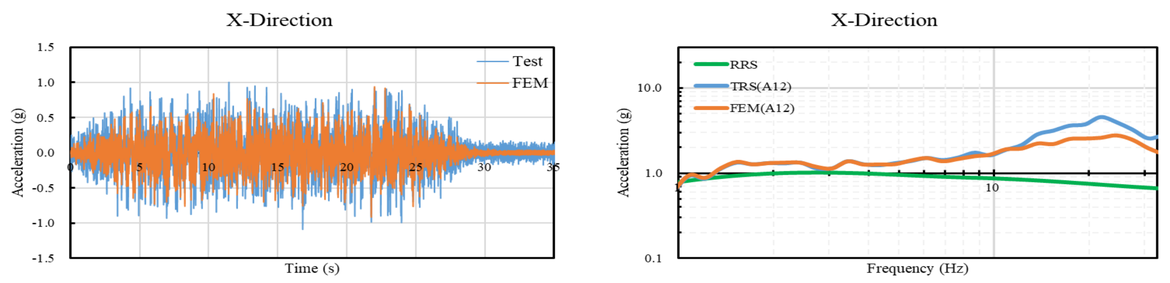


Fig. 7. Finite Element Model of Cabinet

Table 1: Compare to resonant frequency search test result and FE analysis result

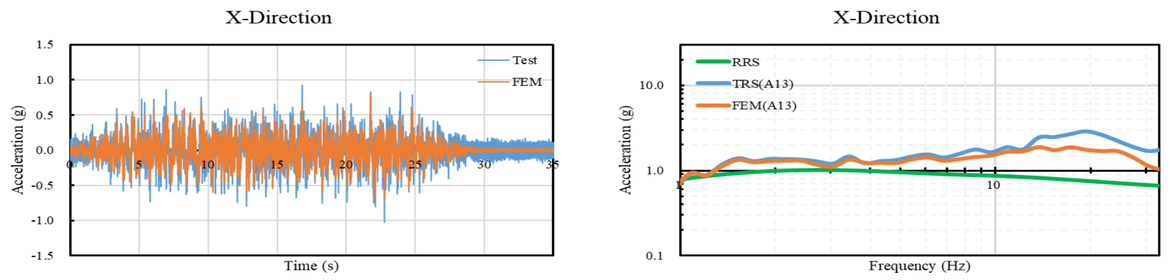
Mode	Experimental Test	FE Analysis
1st Global	16.00 Hz	16.11Hz
2nd Global	24.00Hz	23.86Hz
1st Local	30.50Hz	30.81Hz
2nd Local	37.50Hz	37.25Hz

- The responses of the top (A12) and the side (A13) were compared, and it was found that both locations matched well with the experimental results.
- At the spectrum less than 10Hz, front-back direction matched well.
- At the range greater than 10Hz, the trends of matched well, but the analysis revealed slightly smaller responses.



(a) Time domain (b) Frequency domain

Fig. 8. Front-back direction response compare to test an FE analysis result in A12



(a) Time domain (b) Frequency domain

Fig. 9. Front-back direction response compare to test an FE analysis result in A13

Conclusion

- In this study, the Time History Analysis was performed using the High-Fidelity FE Model developed in the previous study.
- The responses of the top (A12) and side door (A13) measured in the experiment were compared with the analysis results.
- When the responses were compared in the time domain, it was revealed that the response between 5sec and 25sec, which is the duration of a strong earthquake, was matched well.
- When compared in the frequency domain, the overall trend was matched well, so it is judged that the developed model can represent the behavior of the cabinet caused by the earthquake. In future studies, the experimental result and analysis result of the accelerometer located inside will be compared.

Acknowledgement

This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIT) (No. 2021R1A2C1010278).

Korea Nuclear Society Spring Meeting 2021
2021, May 12-14, Online

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