Thermal image measurement analysis of human response according to operating variables of seismic simulator

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1. Introduction

The purpose of this study is to verify the physical and mental responses of operators under a seismic situation at a nuclear power plant. For this, the amplitude value suitable for the use of a seismic simulator is derived. Next, the human psychological response to the amplitude value was measured and analyzed using a thermal imaging camera.

2. Methods and Results

2.1 Derivation of Gal Value According to Amplitude Variation

As shown in Fig. 1~2, in the first pilot test, a six-axis drive was operated at different amplitudes within the same driving time and frequency in each direction (Surge, Sway, and Heave). The operation was performed five times per amplitude in each direction. The maximum amplitude was determined by visually checking the movement of the top plate to a non-hazardous point. Next, the mean value of the gal values identified in the seismograph connected to the six-axis drive system was then derived.

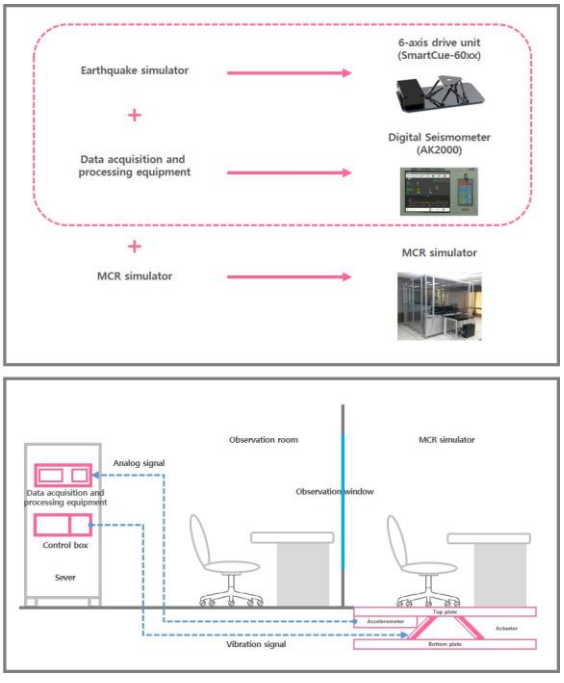


Fig. 1. Composition and placement of seismic simulator

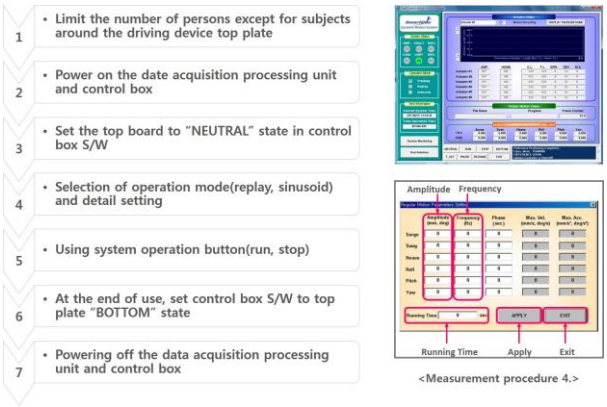
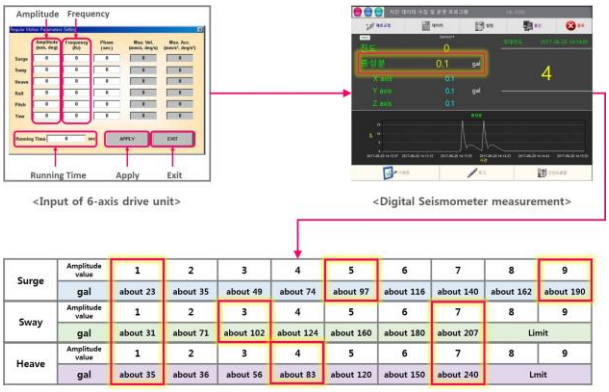


Fig. 2. Procedure of Pilot Test 1

As shown in Fig. 3, the amplitude values corresponding to 0.1 g of the reactor tripping standard were confirmed as a Surge, 5; Sway, 3; and Heave, 4. The amplitude limit value to be tested safely in each direction of the seismic simulation device was confirmed as Surge, 9; Sway, 7; and Heave, 7.



Surge	Amplitude value	1	2	3	4	5	6	7	8	9
	gal	about 23	about 35	about 49	about 74	about 97	about 116	about 140	about 162	about 190
Sway	Amplitude value	1	2	3	4	5	6	7	8	9
	gal	about 31	about 71	about 102	about 124	about 160	about 180	about 207	Limit	
Heave	Amplitude value	1	2	3	4	5	6	7	8	9
	gal	about 35	about 36	about 56	about 83	about 120	about 150	about 240	Limit	

Fig. 3. Results of Pilot Test 1

2.2 Identification of Human Response Changes by Thermal Image Measurement when Amplitude is Changed

As shown in Fig. 4, the temperature change was measured on the subject's forehead using an infrared camera. The variables were the amplitude minimum value, namely, 0.1 g (100 gal) or similar value, and the maximum value in each direction. The measurement sequence was carried out randomly. In addition, the

subjects performed a simple task (Stroop test) during the experiment.

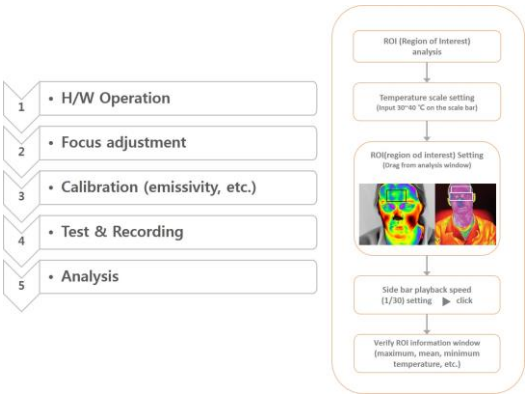
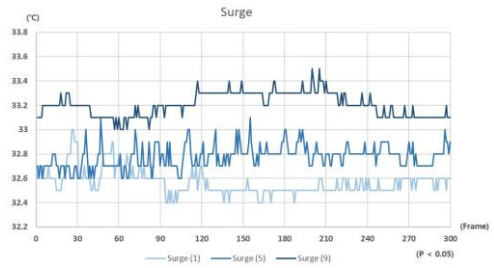


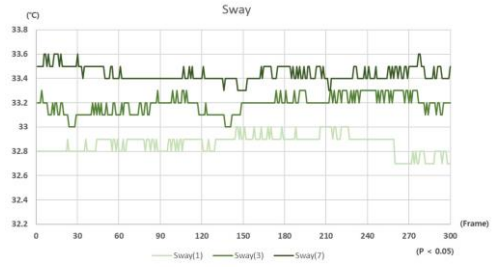
Fig. 4. Measurement procedure and analysis method of pilot test 2

As shown in Fig. 5~7, in the Surge and Sway direction, the lowest value, a similarity value of 0.1 g (100 gal), and the maximum value were clearly distinguished based on the amplitude. In the Heave direction, the distinction of the thermographic measurement of a 0.1 g similarity value and the maximum value was unclear.



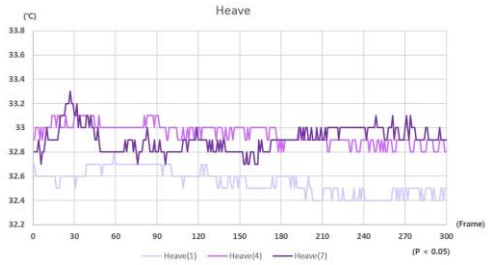
Surge Amplitude	1	5	9
gal value	23	97	190
Mean	32.566	32.776	33.206
S.D.	0.101	0.097	0.096

Fig. 5. Results of Pilot Test 2 (Surge)



Sway Amplitude	1	3	7
gal value	31	102	207
Mean	32.863	33.188	33.439
S.D.	0.077	0.077	0.062

Fig. 6. Results of Pilot Test 2 (Sway)



Heave Amplitude	1	4	7
gal value	35	83	240
Mean	32.554	32.950	32.907
S.D.	0.104	0.082	0.104

Fig. 7. Results of Pilot Test 2 (Heave)

3. Conclusions

To prevent injuries and accidents that may occur in the experiment, safety was considered as a top priority. As a result, the limits of amplitude that can be safely tested were confirmed as Surge, 9; Sway, 7; Heave, 7. The amplitude values corresponding to the reactor tripping criterion of 0.1 g were Surge, 5; Sway, 3; Heave, 4. Sensitivity to vibration is large at 5 to 10 Hz in Heave. In addition, the sensitivity of a Surge and Sway was found to be larger at 2 Hz [7]. This test used a frequency of 2.5 Hz for consistency of safety and experimental variable, and consequently, the results were consistent with the results of previous studies. This study is the basic step of the correlation study between the change in amplitude and thermal image data. In the subsequent studies, a number of subjects will be tested to clarify the correlation among the data.

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