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초고압 대형차단기의 내진검증: 245kV Gas-filled Circuit Breaker

Seismic Qualification on the Large High Voltage Circuit Breaker: 245kV Gas-filled Circuit Breaker

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1. Introduction

The objective of this study is to conduct seismic qualification test of 245kV 50/63kA Gas-filled Circuit Breaker (GCB). The seismic qualification level was High specified by High required response spectrum.

The seismic qualification test program was conducted by Korea Institute of Machinery and Materials (KIMM) for the seismic qualification of 245kV 50/63kA Gas Circuit Breaker (GCB) of Hyosung Corporation in accordance with the international standard procedure, IEEE Std 693-2005[1]. The test specimen was classified as Class 1E equipment. Seismic qualification test was intended to demonstrate that test specimen had the adequate integrity to withstand the stresses of specified seismic event and performed their functions.

2. Seismic Test Procedure

2.1 Equipment Tested

The equipment to be qualified, one 245kV 50/63kA GCB, is designed and fabricated by Hyosung. Principal parameters are summarized in Table 1. Photo 1 shows test setup on the shaking table.

Table 1: Principal parameters of the test equipment

Equipment No.	Size L×W×H	Type	Location
245 HCBH 50	5022×2800 ×4716	245kV 50/63kA GCB	High seismic level

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Photo. 1: Support-mounted configuration of 245kV GCB on shake-table

2.2 Test Sequence

The qualification procedure was conducted in five stages:

a) Stage 1: Resonant frequency search. A resonant frequency search was conducted to determine resonant frequencies.

b) Stage 2: Time history test based on the High required response spectrum as shown in Fig. 1. The equipment and support structure were tested.

c) Stage 3: Time history operational test. The circuit breaker and support structure were subjected to the same test described above in stage 2 with the addition of a breaker open-close-open (O-C-O) operation, during the strong motion. Breaker operation was initiated at approximately the time at which the normalized Arias Intensity of 50% of maximum is achieved for one horizontal component of motion. During this test, the breaker was filled with gas at the rated operating pressure.

d) Stage 4: Sine beat test. The equipment and support structure were tested.

e) Stage 5: Resonant frequency search. A resonant frequency search were conducted.

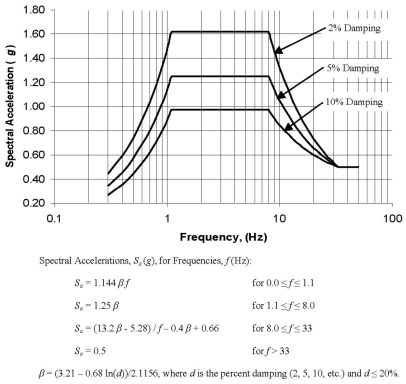


Fig. 1: High required response spectrum, 0.5g

3. Seismic Test Results

3.1 Resonance Frequency Search

The first test was conducted to determine the natural frequencies of the test specimen. The last resonant frequency search test was used to determine whether there was a significant change. A change of more than 20% in the resonant frequencies as a result of qualification testing was used only as one parameter to determine whether there are structural changes and the significance of the changes.

3.2 Time History and Sine Beat Test

The equipment and supporting structure was subjected to one time history test. The input motion time history satisfied the requirements given below. When calculating response spectra, the 1.1 Hz frequency point was used in all cases, and additional frequency points are developed from this starting point, according to the stated resolution limits.

After completing the time history test, the circuit breaker and support structure were subjected to the same test with the addition of a breaker open-close-open (O-C-O) operation, during the strong motion.

The comparison plots of TRS with RRS are presented in Fig. 2 for the time history test as an example. The acceleration responses and the relative displacements were also evaluated.

The 10 cycle sine beat test was performed at the predominant resonant frequencies, once in each of the three orthogonal axes. Sine beat testing was run at the specified input value in each direction of the horizontal axes and at the 80% of the specified value in the vertical axis. Since the high seismic level was specified, the input value was 0.5g. Fig. 3 shows the acceleration response at the sine beat test as an example.

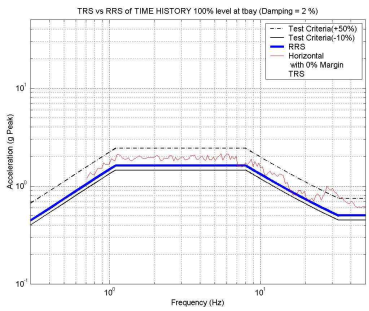
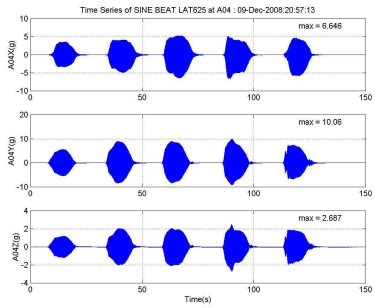


Fig. 2: TRS vs. RRS at Time History Test in Y direction



(d) Location No. 4

Fig. 3: Acceleration Time Histories of Sine Beat Test at 6.25Hz in Y-Direction

4. Conclusion

KIMM conducts seismic qualification test of 245kV 50/63kA Gas-filled Circuit Breaker (GCB) based on IEEE std 693-2005 first time in Korea supported by Hyosung corps. This study which performed seismic test of Gas-filled Circuit Breaker is very meaningful that first tried test in Korea. The seismic qualification level was High specified by High required response spectrum. This study demonstrated that the test specimen possessed sufficient structural integrity and to continue its mechanical and electrical functions after seismic events.

References

[1] IEEE Std 693-2005, IEEE Recommended Practice for Seismic Design of Substations.