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Performance Characteristic Test of Scale Model Lead Rubber Bearings for NPP

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1. Introduction

A seismic isolation system is one of the key issues for the safety of a nuclear power plant against great earthquake. The seismic isolation device already applied to the conventional buildings and bridges. Even there are 6 nuclear power plant unit already applied seismic isolation system in France and South Africa. Although the seismic isolation device was already used in NPP but after the Fukushima accident it seems more important than before against earthquake. For applying to an NPP, the isolation system should have enough performance capacity because the safety criteria of nuclear power plants are much higher than that of conventional structure. For the development of performance criteria of isolation system for nuclear power plant, a scale model isolation device tests were performed in this paper. For the characteristic test, 20 scale model isolation devices were manufactured and basic mechanical property test and dynamic tests were performed.

2. Basic Mechanical Property Test

For the evaluation of the variation of mechanical properties for lead rubber bearing, scale model LRBs were manufactured. A drawing and manufactured LRBs are shown in Figure 1.

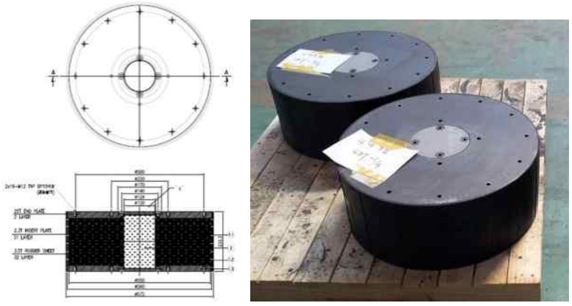


Figure 1. Drawing and LRB for Mechanical property test

A basic property tests were performed for all 20 specimens. Test results are shown in Figure 2 and 3. As shown in Figure 2 and 3, mechanical properties of all 20 specimens were not many differences but in the case of compare to the target properties, the variation is not so negligible.

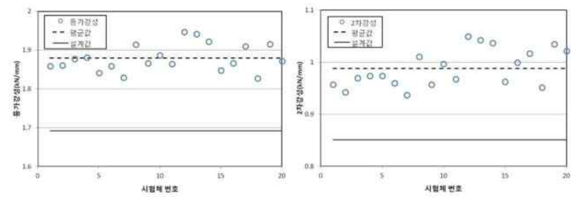


Figure 2. The variation of effective stiffness and 2ndary stiffness of all LRB specimens

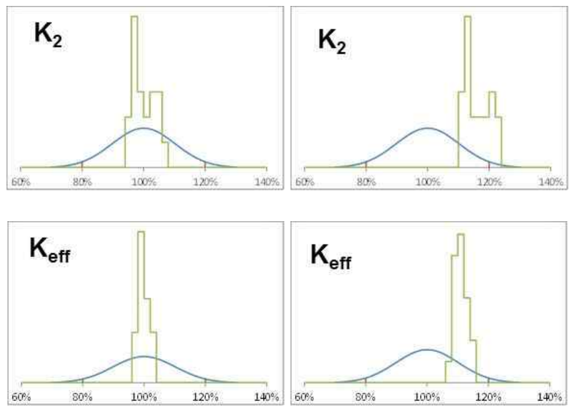


Figure 3. The distribution of mechanical properties for LRB specimens

3. Dynamic Performance Test

In general, mechanical property tests are performed in the static speed situation. But in the case of earthquake, isolation bearing must move dynamically. So, the dynamic property should be considered for performance criteria of isolation bearing. For the performing a dynamic property test, an isolation system which combined 4 LRB specimens as shown in Figure 4 was prepared. The static test can be performed in Korea but there is no facility that can be performed dynamic test for isolation bearing. The main differences between Korean and UCSD SRMD facility are sumarized in the Table 1. The differencies are a reason why we should use UCSD SRMD facility for performing isolation deveice test. Therefore, a purposes of this test are development of a performance test method for isolation device considering the differences between Korean and UCSD facility.

Figure 4. An isolation system for performing a dynamic test

Table 1. Differences between the capacity of isolation device test facility

	Korea	UCSD SRMD
Dimension	1D	3D
Motion	static	Dynamic
Motion	sine	Earthquake
Stroke	small	Large
Specimen	small	Large

3.1 Differences between static and dynamic test

For the compare the difference between static and dynamic test, the results of static loading test (0.005Hz) and dynamic loading test (0.1Hz) were compared and shown in Figure 5. As shown in Figure 5, not many differences recognized between static and dynamic test.

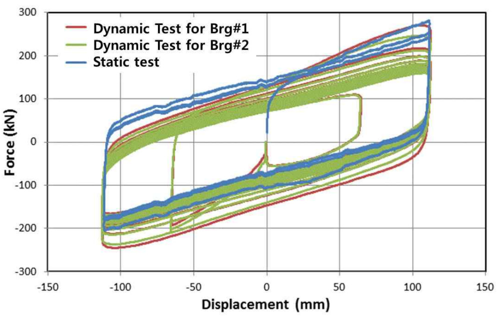


Figure 5. The differences between static and dynamic loading test

3.2 Differences between harmonic and earthquake motion

For the compare the differences between results of harmonic motion and irregular earthquake motion, two results for the same bearing are compared and shown in Figure 6. As shown in Figure 6, a stiffness of two tests is not many differences but a damping is a little difference. But the differences of damping properties are very difficult to conclude that caused by harmonic and earthquake motion.

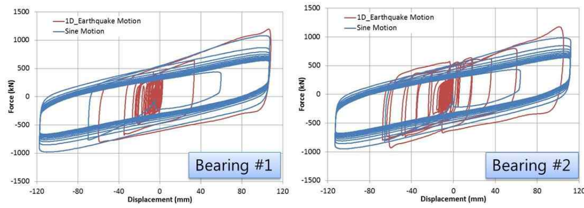
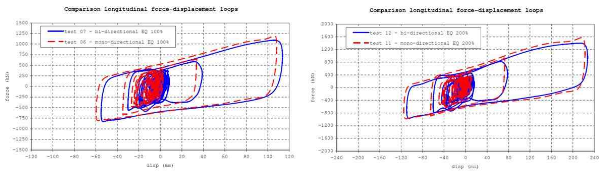


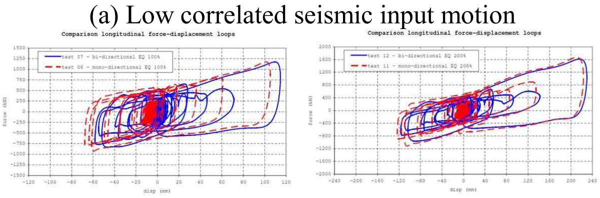
Figure 6. Differences between harmonic and earthquake motion

3.3 Differences between 1D and 2D input motion

For the compare the difference between 1-dimensional and 2-dimensional input motion, 1-D and 2-D tests were performed. In this time, the differences according to correlation of bi-directional seismic input motion. The results are shown in Figure 7, according to the correlation effect and 1-d, 2-D input motion.



(a) Low correlated seismic input motion



(b) High correlated seismic input motion

Figure 7. Differences between 1D and 2D input motion

5. Conclusions

In this study, seismic isolation device tests were performed for the evaluation of performance criteria of isolation system. Through this test, it can be recognized that in the case of considering a mechanical property test, dynamic and multi degree of loading conditions should be determined. But these differences should be examined how much affect to the global structural behavior.

ACKNOWLEDGEMENT

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