

# State of the Art in Earthquake Engineering of Korea

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## ABSTRACT

The Korea Earthquake Engineering Research Center (KEERC) was established in Korea in 1997 to prepare solutions to reduce earthquake losses by developing technologies, procedures, knowledge, and tools for seismic design and rehabilitation of buildings and infrastructures considering the multitude of socio-economic and engineering issues. The research approach is aimed at developing earthquake engineering strategies in low to moderate seismic regions. Since the establishment of the KEERC, the KEERC emphasized on fundamental research and then applied research during the 1<sup>st</sup> and 2<sup>nd</sup> stages (from Year 1997 to Year 2002). Upon the previous research efforts, the KEERC structured its research program along the 3 thrusts and several special projects for the 3<sup>rd</sup> stage. In each thrust several coordinated research projects are being carried out, with the aim of developing an integrated framework into which individual research result will be assembled. In parallel with the major thrusts, the special projects are being carried in compliance with the timely demand of performance-based design and information technology advancement. This paper overviews the KEERC, its research programs, information service system and facilities focusing on the current stage.

## **INTRODUCTION**

The Korea Earthquake Engineering Research Center (KEERC), established in 1997, has focused on the development of engineering solutions to reduce possible earthquake losses in low and moderate seismicity regions. The center is funded principally by a grant from KOSEF with matching funds from public corporations and private industries. The primary goal of the KEERC is to contribute to the mitigation of earthquake hazards through researches in the area of seismic hazard evaluation, seismic analysis and design technology and social preparedness. Eventually the aim of the KEERC is to protect the people and the social and economic system from the seismic hazards and to contribute to the development of national economy. To accomplish the KEERC goal, research programs have been continuously examined and refined from stage to stage. In the beginning stage from 1997 to 1999, the KEERC as the first national center for research, education, and industrial interaction in the domain of earthquake engineering in Korea emphasized the fundamental and multi-disciplinary research. And during the 2<sup>nd</sup> stage from 2000 to 2002 thrust areas focused on the applied research. The KEERC is now in the middle of the 3<sup>rd</sup> stage which spans from 2003 to 2005 and is driving individual research project to develop an integrated framework toward the ultimate goal of the KEERC. The research results will be appeared as applicable, practical and useful to the related industry and public. This paper discusses the researches being done during the 3<sup>rd</sup> stage in more detail.

## **RESEARCH PROGRAM OF KEERC**

In the beginning of the establishment of the KEERC, 31 researchers from 16 organizations were participated and in the second stage the participating professors were 27. Currently the 20 prominent researchers from 8 organizations are participating in the coordinated and integrated research activities. The majors of researchers are geology, civil and architectural engineering, etc., which are related to earthquake engineering and science. The research division comprises of three major research groups and several special projects. The special projects were formed in compliance with the timely demand of performance-based design and information technology advancement. Note that all the research projects are compliment when it is integrated toward the ultimate goal of the KEERC as shown in Figure 1.

The three major research themes are targeting three major aspects: Systematization of Moderate Seismic Region Technique, Innovative Seismic Technology and Earthquake Damage Assessment System of National Infrastructures (Figure 2). The research theme I groups the interrelated researches to development and transfer of seismic design methods for the building structures and foundation in the moderate earthquake region while the research theme II for bridge structures. These two research groups are built upon the fundamental studies done through the previous stages. The research theme III is newly reformed to extend the research area from general building and bridge structures to national infrastructures. Under major research division, more detailed research topics were specified as follows:

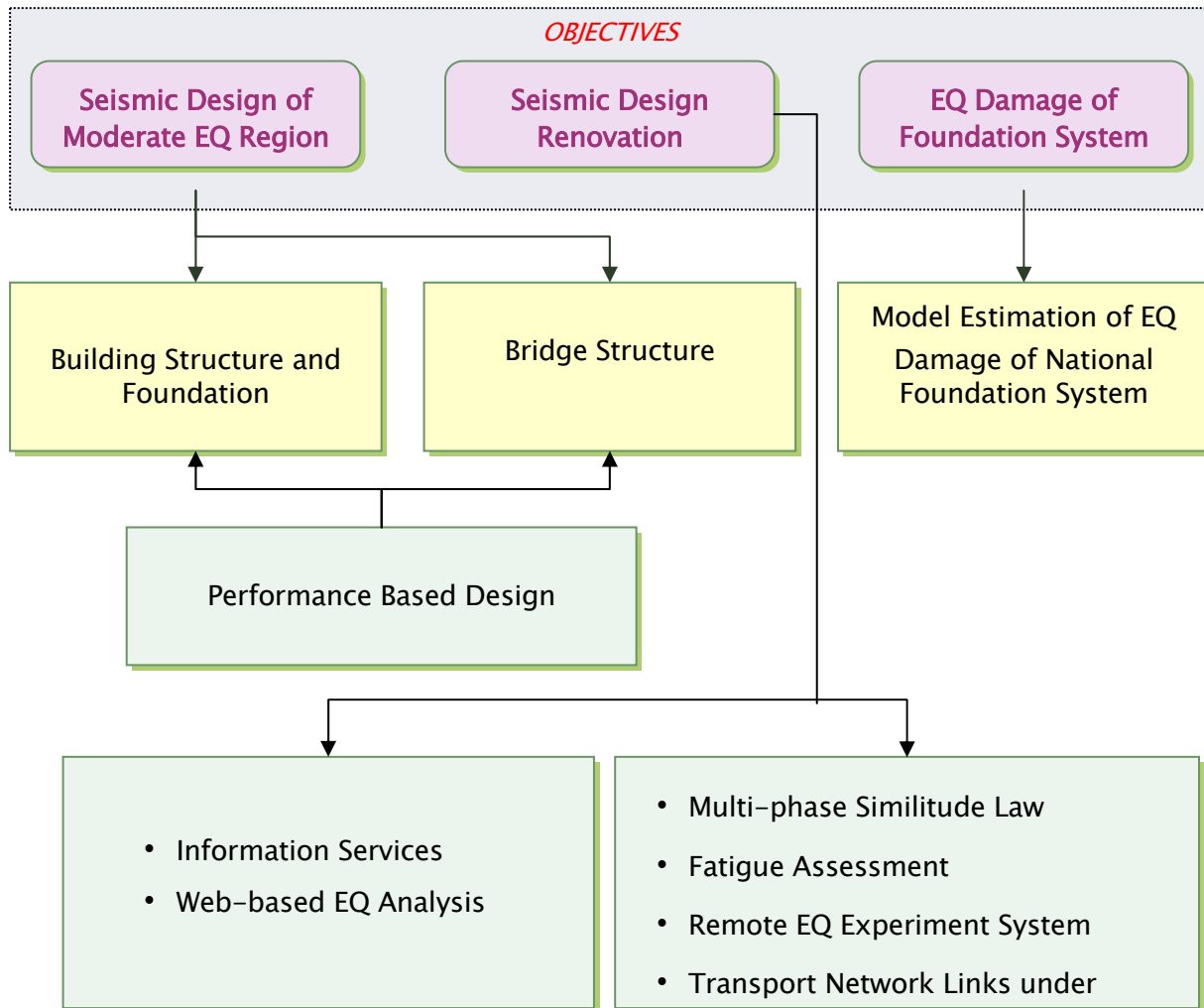


Figure 1. Relations between research areas of KEERC

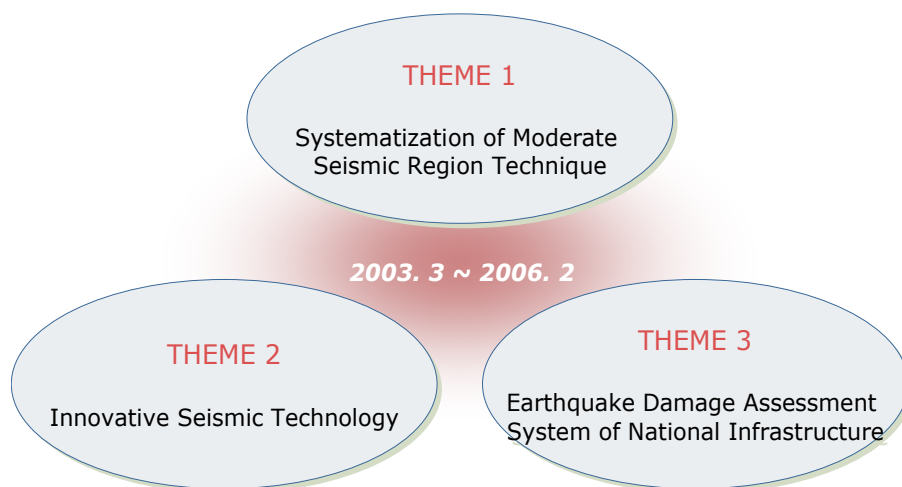


Figure 2. Research programs during Stage III (Year 2003 through Year 2005)

### **Research Theme I**

*Development and transfer of seismic design methods for the building structures and foundation in the moderate earthquake region*

- Direct Inelastic Earthquake Design using Secant Stiffness by Park, Hong-Gun
- The Shear Strength of RC Coupling Beams with Plastic Deformations by Hong, Sung-Gul
- Efficient Analysis of Floor Vibrations in a Shear Wall Building Structure by Lee, Dong-Guen
- Seismic Design of Bolted Web Connection in Reduced Beam Section (RBS) Steel Moment Connections by Lee, Cheol-Ho
- Effect of Flexibility of Shallow Foundation on Seismic Behavior of Bridge Columns by Kim, Myoung-Mo

### **Research Theme II**

*Development and transfer of seismic design methods for the bridge structures in the moderate earthquake region*

- Fundamental Studies to Develop the Reliability-based Seismic Design Methods for Bridges by Koh, Hyun-Moo
- Development of Seismic Design Procedure of Bridges in Moderate Seismic Region by Kim, Jae-Kwan
- Evaluation of Seismic Performance for Reinforced Concrete Bridge Piers under Earthquake Loading by Lee, Jae-Hoon
- Development of Seismic Performance Evaluation Software of Concrete Bridges for the Moderate Seismicity Regions by Shin, Hyun-Mock
- Seismic Response of Circular Column-bent Piers under Bidirectional Repeated Loadings by Chung, Young-Soo
- An Evaluation of Seismic Capacity of Cable Supported Bridges in Moderate Seismic Zone by Chang, Sung-Pil

### **Research Theme III**

*Development and transfer of estimation model for the seismic damage of the national foundation systems*

- Estimation of the Site-Dependent Spectral Decay Parameter for Strong Motion Simulation in Southern Korea by Baag, Chang-Eob
- An Efficient Finite-Difference Method for Simulating Seismic Response of Localized Basin Structures by Baag, Chang-Eob
- Analysis of Tide-Gauge Records of the 1883 Krakatau Tsunami by Choi, Byung-Ho
- Liquefaction Resistance From Triaxial Tests under Earthquake Motions in Moderate Earthquake Region by Kim, Soo-Il
- Development of Seismic Loss Estimation Model for Lifeline System by Lim, YunMook
- Development of an Estimation Model for the Seismic Damage of Road Networks by Lee, Sang-Ho
- Monitoring System Considerations for Structural Assessment after Earthquake by Kim, Sungkon

- System Identification in Time domain for Structural Damage Assessment Using L1-Regularization and Time Windowing Technique by Lee, Hae-Sung

### **Special Project**

*In accordance with performance-based design and information technology advancement*

- Management of KEERC Information Service by Chang, Sung-Pil
- Equivalent Multi-phase Similitude Law for Pseudodynamic Test on Small-scale RC Models by Chang, Sung-Pil
- Development of Remote Earthquake Experiment System through the Internet by Kim, Jae-Kwan
- Development of Web-based Platform for Earthquake Analysis and Design by Shin, Soobong
- Fatigue Assessment of Steel-Composite High-Speed Railway bridges using a Reliability-based Approach by Koh, Hyun-Moo
- Retrofit Priority of Transport Network Links under an Earthquake by Sohn, Jungyul

Table 1 provides the detailed and contact information about KEERC researchers who are carrying the above research projects.

### **KEERC INFORMATION SERVICES (KEERCIS)**

An information system for earthquake engineering in Korea is available through KEERC Information Service. All the research projects of KEERC have been continuously centered to the Knowledge Base System and synthesized into an integrated knowledge base system. It is thereby expected that the research results be implemented effectively and transferred easily to cross-disciplinary researchers, industry, government, and the public. Additionally, since the KEERC has a central position in Korea in collecting and sharing the earthquake engineering related information, this service level project covers various levels of research domains and research classes. The KEERC plays a major role in exchanging research information among Korea and international countries.

### **FACILITIES**

The research laboratory of KEERC is located at Seoul National University. These dedicated research spaces are designed to have open laboratories, which allow KEERC researchers in various fields to easily share information and facilities and engage in experimental research. The experimental facility includes structural testing system (MTS, 50ton), horizontal vibration and control system, and many other measuring systems (Figure 3). This facility will be linked through network systems to other institutions. Also, KEERC's consortium brings experimental facilities to provide various opportunities for study of seismic design technologies for buildings, bridges, and lifelines, and seismic hazards.



Figure 3. KEERC Testing Laboratory

## CLOSURE

The KEERC has directed many fundamental and applied researches in earthquake engineering for the past several years in accordance with Korea's research demands. KEERC's initial focus was to solidify and broaden earthquake engineering research in Korea. As a result, some progress has been made from previous stages which can be summarized as follows:

- Identification of key issues to develop techniques for the analysis and design of new structures, and for retrofit of existing structures that are applicable in low to moderate seismic region.
- Development of KEERC's industry partnerships to both support and benefit from earthquake technology improvements.
- Establishment of cooperative relationships with national and international institutions.
- Dissemination of findings to the academic community, design professionals, government officials, and the public.

Currently the KEERC is in the middle of the 3<sup>rd</sup> stage (i.e., in Year 8 of its nine-year research plan funded by KOSEF). To develop a fully integrated framework for earthquake engineering in low to moderate seismic region, the KEERC research members consider the following issues deeply:

- Fostering the technology transfer into design and construction practices
- Expanding the KEERC's industry partnerships continuously
- Providing university students and professionals with better training system to meet the requirements of the new technology construction industry for earthquake engineering

The experiences and opinions of collaborative partners of ANCER could help to address the above issues effectively. The KEERC research members have been fortunate to obtain several big

research project awards related to earthquake engineering. The KEERC's research will be continuously undertaken through the newly starting research projects. KEERC would keep the position of leading role in seismic hazard mitigation in Korea beyond the last period of financial support of KOSEF.

Table 1. List of KEERC research members

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