Independent Administrative Institution
National Research Institute for Earth science and Disaster prevention

E-Defense Inauguration Symposium

2005.1.16

Sponsored by

Hyogo Earthquake Engineering Research Center

This symposium is held as a part of the project of MEXT,
”Special Coordination Funds Promoting Science and Technology”.

Welcome to E-Defense Inauguration Symposium

Over the last ten years, the National Research Institute for Earth Science and Disaster prevention(NIED) has been constructing the world's largest shaking table facility, known as E-Defense. NIED is glad report that E-Defense is nearly completed. The Hyogo Earthquake Engineering Research Center was established on October 1, 2004, to manage research projects using E-Defense and to operate and maintain the facility.

Notable lessons from the damage to buildings and urban infrastructures observed in the 1995 Hyogoken-Nanbu (Kobe) earthquake include.

(1) Cities and towns throughout Japan have large stocks of old buildings and infrastructural systems whose seismic capacity is insufficient. To prepare for future large earthquakes, it is crucial to accurately evaluate their existing seismic capacities and then to retrofit and rehabilitate accordingly.

(2) Much larger shaking than that contemplated in current seismic design is known to be possible Evaluation of the reserve seismic capacity of existing buildings and infrastructural systems, development of design and construction technologies to enhance the seismic capacity, and implementation of these technologies for real design and construction are critical.

Much research has been conducted along these lines. Experimentation plays a very important role in the assessment of accuracies of damage and collapse predictions, validation of the effectiveness of retrofit techniques, and verification of new design and construction methods for enhanced capacity. E-Defense has the unique capacity to experiment with life-size buildings and infrastructural systems in real earthquake conditions, and stands as a tool of ultimate verification. With this feature, E-Defense should help expedite the transfer of various research outputs into the practice of earthquake disaster mitigation.

We are currently working on a series of preliminary tests to validate the various functions of the facility. Afterward, another series of tests with real mass and mock structures are planned for final checks and to familiarize with operation and measurement, and the first experimental projects will start from the fall 2005. Three large-scale tests for timber houses, an RC building, and soils and foundations are scheduled for the fiscal year of 2005.

Because of its unique function as a tool of ultimate verification, many countries and regions that also have strong missions of earthquake disaster mitigation have expressed great interest in E-Defense, and various types of collaborative efforts are being discussed. In particular, the Japanese Ministry of Construction, Sports, Culture, Science, and Technologies (MEXT) and the National Science Foundation (NSF) of the United States of America are negotiating an overall agreement on research collaboration between the earthquake engineering communities in the two countries. Under this scope, NIED and the NEES Consortium, an organization that operates the integrated facilities on earthquake engineering in the United States, are discussing an agreement on solid and long-term research collaboration and a new U.S.-Japan program jointly using E-Defense and NEES facilities.

Nearly ten years have passed since the planning of E-Defense began, and we have finally reached the stage of near completion. On behalf of NIED, I wish to convey our sincere gratitude to all who contributed to the realization of E-Defense. Much tax money has been invested in E-Defense, and this was made possible only by the continuous support of our society and people. We shall do our best to make notable contributions to the great enhancement of earthquake disaster mitigation, with the belieUUf that this is the only way to return the investment to the society and people. To fulfill the mission, we also need enthusiastic support from various sectors, and hereby we would like to ask for continuous guidance and support from the research communities, government and local authorities, and industry that play important roles on earthquake disaster mitigation.

January 16, 2005

Masayoshi Nakashima

Director of Hyogo Earthquake Engineering Center

National Research Institute for Earth Science and Disaster prevention (NIED)

Program

9:00～ 【 Registration 】

【 Symposium 】

Chair *Toru.Hayama* (*Exective Director of NIED*)

10:00～10:20 **Welcome**

Masayosh .Nakashima (*Director of Hyogo Earthquake Engineering Research Center*)
Takayuki Nakamura (*Ministry of Education, Culture, Sports, Science and Technology*)

10:20～11:40 ①Introduction of E-Defense and outline of demonstration shaking table test
②Technical tour of E-Defense （including a shaking test of a wooden house）

Masayoshi Nakashima (*Director of Hyogo Earthquake Engineering Research Center*)
Masayoshi Sato (*Deputy Director of Hyogo Earthquake Engineering Research Center*)

11:40～12:40 【 Lunch 】

【 Invitation Lecture 】

Chair *Masayoshi Nakashima*
(*Director of Hyogo Earthquake Engineering Research Center*)

12:40～13:00 EARTHQUAKE ENGINEERING AND RISK REDUCTION AROUND THE WORLD

Luis Esteva （*Professor emeritus of National University of Mexico*）

13:00～13:20 THE SHAKING TABLE IN EARTHQUAKE RISK MITIGATION

Polat Gülkan (*Professor of Middle East Technical University*)

13:20～13:40 LONG-TERM VIRSION FOR THE UNITED STATES GEORGE E. BROWN, Jr. NETWORK FOR EARTHQUAKE ENGINEERING SIMULATION

Joy Pauschke (*Proguram Director of National Science Foundation*)

13:40～14:00 【 Coffee break 】

14:00～14:20 E-Defense and NEES: TWO MILESTPNES IN THE ADVANCEMENT OF EARTHQUAKE ENGINEERING RESEARCH

Ian Buckle (*Professor of University of Nevada Reno*)

14:20～14:40 DEVELOPMENT OF SHAKING TABLE TESTS IN CHINA

Zifa Wang (*Director of Institute of Engineering Mechanics*)

14:40～15:00 IMPORTANCE OF COLLAPSE TESTS IN EARTHQUAKE DISASTER MITIGATION

Tsuneo Katayama (*President of NIED*)

15:00～15:05 Closing remarks *Toru Hayama* (*Exective Director of NIED*)

Abstract of Invitation Lecture

【Lecture1】

EARTHQUAKE ENGINEERING AND RISK REDUCTION AROUND THE WORLD

Luis Esteva （***Professor emeritus of National University of Mexico***）

【Lecture 2】

THE SHAKING TABLE IN EARTHQUAKE RISK MITIGATION

Polat Gülkan (***Professor of Middle East Technical University***)

【Lecture 3】

LONG-TERM VIRSION FOR THE UNITED STATES GEORGE E. BROWN, Jr. NETWORK FOR EARTHQUAKE ENGINEERING SIMULATION

Joy Pauschke (***Proguram Director of National Science Foundation***)

【Lecture 4】

E-Defense and NEES: TWO MILESTPNES IN THE ADVANCEMENT OF EARTHQUAKE ENGINEERING RESEARCH

Ian Buckle (***Professor of University of Nevada Reno***)

【Lecture 5】

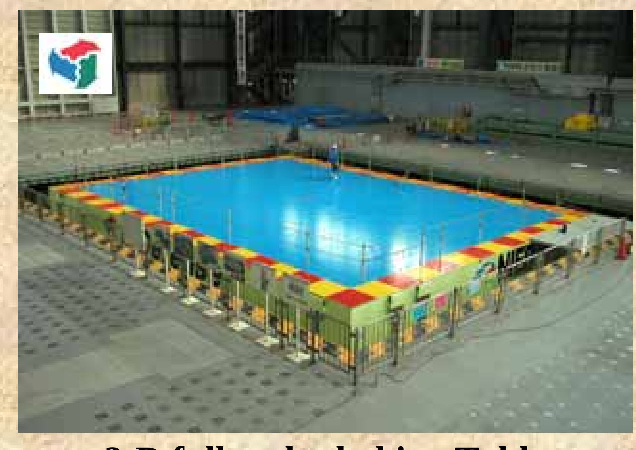
DEVELOPMENT OF SHAKING TABLE TESTS IN CHINA

Zifa Wang (***Director of Institute of Engineering Mechanics***)

【Lecture 6】

IMPORTANCE OF COLLAPSE TESTS IN EARTHQUAKE DISASTER MITIGATION

Tsuneo Katayama (***President of NIED***)



3-D full scale shaking Table

【Lecture 1】

EARTHQUAKE ENGINEERING AND RISK REDUCTION AROUND THE WORLD

Luis Esteva

Professor Emeritus

National University of Mexico, United Mexican States

(*President, IAEE*)

ABSTRACT

A brief review is presented of some current Earthquake Engineering challenges for the assessment and reduction of seismic risk around the world. Lessons learned during the last years are discussed, together with their impact on code evolution and needed research programs. Special comments are devoted to the capabilities offered by the E-Defense Facility for the understanding of many aspects of the response of complex structures under the action of high-intensity ground motion. Mechanisms are proposed to enhance the possibilities of international cooperation in the actions needed to face the main technical challenges. Problems related to socio-economic conditions and non-engineered constructions are examined. Emphasis is laid on the past and expected future roles of the International Association for Earthquake Engineering for the promotion of international cooperation within this framework.

Research interests

- Earthquake hazard and risk
- earthquake engineering
- structural reliability

【Lecture2】

THE SHAKING TABLE IN EARTHQUAKE RISK MITIGATION

Polat Gülkan

Professor

Department of Civil Engineering, Disaster Management Research Center,

Middle East Technical University, Republic of Turkey

ABSTRACT

The first operational shaking tables in the world were inaugurated some 35 years ago, and these curious instruments enabled engineers to observe visually and record the dynamic response of structural subassemblies and systems under controlled circumstances. The early tables were a product of the technology that then existed: the payloads were limited, as were the size of the platforms or flat beds where they were placed. The types of motion that could be generated were mostly uniaxial, and its stroke short. Yet, primitive as these systems were by current standards, they permitted ground-breaking developments in understanding how real, or near-real, systems responded to random platform motions, and how well our computational tools were able to predict them. The early shaking tables have now been mostly phased out because of changed technology, much in the same way as early computers have become forgotten relics. Current earthquake simulation systems are larger, can generate artificial motions with better fidelity, and usually display enough degrees of freedom to qualify as true earthquake motions. They are also horrendously more expensive to build and maintain.

In my early career, I was lucky to conduct shaking table experiments at two different universities in the US. This experience was part of a worldwide, mostly independently conducted research utilizing the shaking table. In reviewing the global picture that has arisen from this experience I conclude that considerable objectives have been achieved in earthquake safety from results of that research. Understanding earthquake response of simple systems subjected to motions generated in the laboratory has given us the ability to design safely and economically much more involved systems that meet our real-life requirements. Those societies that funded their engineers and scientists to develop these experimental tools were served well in the form of safer built environments. My presentation will draw from my personal experience in this area, and emphasize how test results were interpreted for concrete design recommendations for safe practices.

Research interests

- Earthquake Engineering and Structural Dynamics
- Disaster Mitigation Policies

Publications

- E. Kalkan and P. Gülkan (2004): “Site-Dependent Spectra Derived from Ground Motion Records in Turkey,” EERI Earthquake Spectra, 20(4): November.
- Gülkan, P. (2004): “Regional Reconstruction in Turkey without Effective Risk Mitigatory Measures: The Missing Link,” in press, Natural Hazards.

【Lecture3】

LONG-TERM VIRSION FOR THE UNITED STATES GEORGE E. BROWN, Jr. NETWORK FOR EARTHQUAKE ENGINEERING SIMULATION

Joy Pauschke

Program Director

National Science Foundation, Division of Civil and Mechanical Systems,

Directorate for Engineering, United States of America

ABSTRACT

After completing a five-year construction period funded by the National Science Foundation (NSF), the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) opened for operations on October 1, 2004, as a world class, shared national resource consisting of 15 earthquake engineering experimental facilities located at academic institutions around the United States. These facilities include shake tables, reaction wall and strong floor laboratories with unique testing equipment and capabilities, geotechnical centrifuges, a tsunami wave basin, and mobile and permanently installed field-testing equipment. These facilities are networked by high-speed Internet connections and protocols through the NEESgrid cyberinfrastructure, which includes a centralized data repository and collaborative, simulation, telepresence, telecontrol, and visualization tools. NEES Consortium, Inc. (NEESinc), through a NSF cooperative agreement, will operate NEES from October 2004 through September 2014. Further information about NEES resources and operations is available at the NEESinc web site at www.nees.org. To help guide NEES through the next decade, a panel organized by the National Research Council (NRC) of the National Academies developed *Preventing Earthquake Disasters: The Grand Challenge in Earthquake Engineering* (NRC, 2003), a long-term agenda for the earthquake engineering research community. This plan identifies important research needs that are well suited to the investigative techniques made possible by NEES experimental facilities. NSF has implemented a research program to utilize the NEES infrastructure to develop new knowledge, methodologies, and technologies for earthquake loss reduction. The 2004 research competition resulted in 10 research awards made for about $10 million. A second (2005) competition is currently underway.

There is strong interest around the world to better coordinate international earthquake engineering experimental research. A workshop is being planned by NEESinc for May 2005 to organize an International Steering Committee to facilitate international earthquake engineering collaboration, including developing protocols for shared cyberinfrastructure. The NEES experimental facilities and the 3-D full-scale earthquake testing shake table facility (E-Defense) built by the Japanese National Research Institute for Earth Science and Disaster Prevention (NIED) offer complementary earthquake engineering experimental facilities for large/full scale testing. Preliminary meetings have been held in 2004, and will continue in 2005, between researchers in the United States and Japan to develop collaborative research strategies for investigation of the seismic performance of steel structures and bridges that require coordinated use of the NEES and E-Defense facilities and the NEESgrid/NIED cyberinfrastructure. Summaries of these meetings are available at the NEESinc web site.

Research experience

Dr. Joy Pauschke is responsible for overseeing the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES). This includes oversight of the operations of NEES through NEES Consortium, Inc., as well as coordinating the NEES research program. She also has oversight responsibility for one Engineering Research Center and one Earthquake Engineering Reseach Center.

【Lecture4】

E-Defense and NEES: TWO MILESTPNES IN THE ADVANCEMENT OF EARTHQUAKE ENGINEERING RESEARCH

Ian Buckle

Professor

University of Nevada Reno, Department of Civil and Environmental Engineering,

United States of America

ABSTRACT

It has long been recognized that our ability to experimentally model the seismic response of the built environment has fallen behind our ability to numerically simulate the same response on a computer. Yet without these experimental tools the validity of our numerical simulations cannot be confirmed and the reliability of our computer codes is uncertain. Nevertheless we continue to design and build structures in seismic zones around the world based on these simulations and perhaps, unwittingly, place people at risk.

The seismic behavior of many structures involves complex phenomena that are poorly understood, and numerical models are considered to be simplified approximations of the true response. In the absence of rational theories and/or laboratory experimentation, earthquake reconnaissance has become the primary means of validating and improving design methods. Unfortunately this has proven to be a slow process and lacks the quantitative aspects needed to improve engineering tools and judgment. Unlike laboratory experiments, actual earthquakes are events of uncontrollable intensity, frequency content, duration and location.

But the reason for the lack of experimental facilities is two fold. First, small-scale experiments have very limited value when trying to understand structural collapse because they cannot capture dynamic nonlinearities with accuracy. To be meaningful these experiments need to be conducted at full- or almost full-scale, and this means the laboratories in which the experiments are to be conducted, are themselves very large. The logistics of conducting such experiments can quickly become overwhelming. Second, the forces involved when working at large scale are enormous and until very recently the hydraulic and control technologies necessary to develop these forces, and apply them with care and precision, have been lacking. It follows that the construction cost of these facilities is high and the cost of just one experiment (on a full-scale specimen) can exceed the annual budget of many research-funding agencies.

Nevertheless the return on such a financial investment can be very high, in terms of lives saved and reduced economic losses. It is therefore of major significance that the governments of Japan and the United States have recently taken up this challenge and constructed the E-defense facility at Miki and the network of large-scale experimental facilities (NEES) in the U.S.

Construction of the E-Defense facility by NIED and the NEES facilities by NSF, has recently been completed and both are currently moving from construction to operation. This lecture explores opportunities for research using these milestone facilities that were once impossible to pursue but are now feasible. Given the sophistication, size, and diversity of these facilities, advancements in earthquake engineering may be confidently expected at an unprecedented rate. A safer world for all of us, and particularly our children, will be the outcome.

Research Interests

- Seismic performance of bridges, lifelines and buildings; design and retrofit criteria for bridges
- earthquake protective systems for structures including theory, hardware, and engineering applications of seismic isolations
- non-seismic bridge performance for extreme loads such as thermal effects and overloads
- linear and nonlinear analytical techniques for structures subject to dynamic loads.

Short courses conducted in bridge engineering, seismic retrofitting, and isolation of highway bridges.

【Lecture5】

DEVELOPMENT OF SHAKING TABLE TESTS IN CHINA

Zifa Wang

Director

Institute of Engineering Mechanics, China Seismological Bureau, People's Republic of China

ABSTRACT

This article started with the description of the three stages of the development of shaking table tests in China. The first stage was in 1960s, when only harmonic seismic input was simulated in the test. The second stage was in 1980s, when small size electro-fluid servo shaking tables were developed to simulate one or two-dimensional seismic inputs. The third stage was in 1980s, when multi-dimensional large-size shaking tables were developed. The application of shaking table tests in engineering practice in China was also reviewed. Special attention was delivered to the similarity laws for the shaking table tests. Different models of simulation in shaking table tests were compared and summarized. A comparison of shaking tables in China with those in other countries was also included in the article for the purpose of providing help on future developments of shaking table tests in China. Finally, the paper discussed the recent mega projects in China and the importance of utilizing large-scale shaking tables. The potential usage of the E-Defense project in future large engineering endeavors in China is also discussed for better seismic safety within the country.

Research experience

As the director of IEM in China, his major responsibilities include planning and directing the research activities within the institute, such as strong motion observation, engineering seismology, structural response, lifeline system earthquake engineering, instrumentation, geotechnical engineering, and information technology. IEM as the major institute working on earthquake engineering has gained international fame through its research activities and the past results.

【Lecture6】

IMPORTANCE OF COLLAPSE TESTS IN EARTHQUAKE DISASTER MITIGATION

Tsuneo Katayama

President, National research Institute for Earth science and Disaster prevention, Japan

ABSTRACT

We learned from the Kobe earthquake that ground motion beyond general estimation occurs in the area near the seismic fault, and such motion may cause severe damage to even modern structures. We realized that limited damage has to be tolerated in structures when subjected to extremely strong shaking. To accept damage in a structure, the mechanism and process of structure's failure should be well understood, and it is necessary for us to estimate earthquake resistance of structures more reliably and to cultivate effective retrofitting methods for them. For this purpose, failure mechanisms and collapse processes should be examined by full-scale collapse tests to eliminate scaling problems which are inherently involved in scale-model tests. 3-D motion is necessary to simulate the processes of destruction under the condition of real earthquake motions.

Based on these understandings, the National Research Institute for Earth Science and Disaster Prevention (NIED) has been constructing a large 3-D shaking table "E-Defense" in Miki city, near Kobe. The table is 20m x 15m in size, and is able to perform dynamic collapse tests of structures with a maximum weight of 1,200 ton-f. E-Defense will contribute to the significant progress of earthquake engineering research, especially to the understanding of structural failure mechanism, and to the advancement of the earthquake resistant design of structures.

Education

- March, 1962 Bachelor of Civil Engineering, University of Tokyo
- March, 1964 Master of Civil Engineering, University of Tokyo
- March, 1968 Ph.D, University of New South Wales, Sydney, Australia

Previous positions

- Associate Professor, Institute of Industrial Science, University of Tokyo (October,1971 - June, 1982)
- Professor, Institute of Industrial Science, University of Tokyo (July, 1982 - August, 1996)
- Director, International Center for Disaster-Mitigation Engineering, Institute of Industrial Science, University of Tokyo (April, 1991 - August, 1996)
- President, National Research Institute for Earth Science and Disaster Prevention (September, 1996 - present)
- Professor emeritus, University of Tokyo (May, 2000 - present)
- Director General, World Seismic Safety Initiative, an Undertaking of IAEE (January, 2003- present)
- Honorary member of IAEE, President-Elect of IAEE (August, 2004-)

Construction of E-Defense

Construction of this facility began in 1999 and will be completed in *2005*. Therefore, this facility will begin to make its contribution ten years after the Hyogoken Nanbu (Kobe) Earthquake.

Construction Site

(January, 2000)

Horizontal & Vertical Actuators

(January, 2003)

Experiment Building Foundation

(April, 2001)

770-ton Table (32 welded blocks)

(May, 2004)

E-Defense Inauguration Symposium

Address and Access map

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