

Planning Meeting for NEES/E-Defense Collaboration

RESOLUTIONS

The U.S.-Japan Joint High Level Committee (JHLC) on Science and Technology emphasized, in the Joint Communiqué of the Ninth Meeting, that the two countries should cooperate on multiple aspects of earthquake-related research. During the first Japan-U.S. Workshop on Science and Technology for a Secure and Safe Society (held in February 2004), the Japan Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the US National Science Foundation (NSF) agreed to discuss opportunities for cooperative activities related to earthquake research, citing NEES/E-Defense collaboration as a specific example of such cooperation.

A Planning Meeting for NEES/E-Defense Collaboration was held on April 6-8, 2004 at the Shin-Kobe Oriental Hotel, Kobe, Japan. The meeting, organized by NSF and the NEES Consortium, Inc. (NCI) of the U.S. and MEXT and the National Institute for Earth Science and Disaster Prevention (NIED) of Japan, was attended by leading researchers from both countries as well as representatives from NSF, MEXT and other government agencies. The meeting was hosted by NIED.

NEES refers to the “George E. Brown, Jr. Network for Earthquake Engineering Simulation” being constructed by NSF in the U.S. The NEES program includes the construction of 15 major shared-use facilities for experimentation at universities throughout the U.S. and the development of an advanced cyberinfrastructure to support research and collaboration on earthquake engineering. Upon completion in October 2004, the NEES resources will enable the earthquake engineering community carryout a wide range of cutting-edge research leading to effective and economical means for reducing the potentially catastrophic effects of earthquakes. To carryout the 10-year long NEES research program planned by NSF, NEES resources will be managed and operated by NCI.

E-Defense refers to the “Three-Dimensional Full-Scale Earthquake Testing Facility” currently under construction in Japan by MEXT and NIED. Upon completion in early 2005, E-Defense will be the largest earthquake simulator in the world, capable of subjecting large structures, such as buildings, industrial facilities and bridges, to the full range of seismic behavior expected during damaging earthquakes, up to and including the point of fracture and collapse. Using this facility, effective methods for assessing and increasing the seismic safety of structures can be identified. E-Defense will be managed and operated by NIED.

The NEES/E-Defense Collaboration Planning Meeting was attended by 13 participants from the US and 39 participants from Japan. The current state-of-the-art and -practice in many fields of earthquake engineering were discussed by the participants. Participants discussed engineering research efforts needed to fill critical gaps in knowledge and hasten progress in reducing the catastrophic consequences of damaging earthquakes. Specific research needs were discussed related to:

- A) Wooden Buildings
- B) Foundation and Earth Structures
- C) Reinforced Concrete Structures
- D) Steel Buildings
- E) Bridge Structures
- F) Smart and Protective Structures
- G) Innovative Structures
- H) Non-structural Components

Experimental and analytical research is already underway in Japan utilizing E-Defense on Items A, B and C from the above list. These efforts are part of the Dai-Dai-Toku Program that covers the initial construction and commissioning of the E-Defense Facility.

In addition to these research topics, the participants discussed the need for overarching activities related to high-performance frameworks for computer simulation of seismic response and robust IT infrastructures to facilitate US-Japan research and collaboration. Mechanisms for the planning and scheduling of future joint collaborative research activities were also discussed.

In general, the participants believe that collaboration between researchers in the U.S. and Japan across a broad range of fundamental and applied problems in earthquake engineering is highly desirable, and provides an extraordinary opportunity to accelerate discovery of knowledge needed to reduce the vulnerability of the constructed environment to earthquakes. Various frameworks enabling synergistic, broad-based collaboration should be encouraged at the highest levels.

In particular, the participants found that NEES/E-Defense Collaboration provides an unusually effective opportunity to accelerate discovery and innovation related to reducing the threat of earthquakes. Upon careful consideration and thorough discussion, the participants identified several specific high-priority research topics of common interest to the US and Japan that would effectively utilize the unique capabilities being introduced by E-Defense and NEES.

Based on the presentations, discussions and deliberations, the participants of the Planning Meeting for NEES/E-Defense Collaboration formulated and unanimously adopted the following specific resolutions:

A. Desirability of a NEES/E-Defense Collaborative Research Program

A collaborative US-Japan research program should be established as soon as practicable to utilize the E-Defense and NEES facilities under the framework of “Agreement between Japan and the United States on Cooperation in Research and Development in Science and Technology.”

B. Frameworks and Procedures Needed to Enable NEES/E-Defense Collaboration

Because of the important scientific and societal impacts of the likely research to be undertaken through NEES/E-Defense Collaboration and the rapidly approaching completion of the E-Defense and NEES facilities, NSF and MEXT should draft a fundamental framework enabling this collaboration in earthquake engineering by August 2004, if possible, and formalize an implementing arrangement by December 2004.

Similarly, NCI and NIED should complete by March 2005, if possible, a Memorandum of Understanding encompassing the arrangements needed to carryout the collaborative research utilizing the E-Defense and NEES research facilities.

C. General Characteristics of Collaboration

Efforts should be made by all parties to encourage wide-ranging participation from the US and Japan in the NEES/E-Defense Collaboration, with special efforts to ensure strong involvement by young researchers and students in earthquake engineering, as well as by specialists with expertise in allied fields such as information technology, sensors, computational simulation, construction, disaster preparedness, economics, and so on. Participation by design professionals, government officials and representatives from industry, business, and the public should be encouraged where possible. NCI and NIED should alert members of the earthquake engineering community of existing opportunities offered by NSF, JSPS, MEXT and others for bilateral exchange of personnel between the US and Japan and for cooperative research. New funding channels should be sought where possible to expand participation in NEES/E-Defense Collaboration.

While the unique and complementary characteristics of the E-Defense facility may provide the primary impetus for the specific activities recommended for NEES/E-Defense Collaboration, it is desirable for Japanese investigators to work collaboratively with US investigators on NEES research projects being undertaken in the US.

To the extent possible, emphasis should be given to collaborative research activities involving the direct interaction of US and Japanese investigators on common projects.

In general, NEES/E-Defense Collaborative research activities are expected to involve strong components associated with:

- Non-structural components and contents – to understand and assess the important impact of nonstructural components and contents elements on seismic response, damage and losses, such elements should be incorporated in experiments and analyses, where appropriate and to the extent possible;
- Health monitoring and condition assessment -- to advance sensor technologies and algorithms for system identification, and to assure that data of high quality is obtained, systematic efforts are needed related to structural monitoring and condition assessment;
- Data and metadata curation -- to build rich datasets upon which NEES/E-Defense research can be conducted, consistent, robust and secure IT protocols and services are needed for acquiring, processing, storing, mining and disseminating information, data and metadata of various types;
- Numerical simulation and visualization (numerical shaking table) -- to model and interpret complex nonlinear dynamic phenomena such as those to be studied as part of NEES/E-Defense Collaboration, and to validate computer-based techniques for predicting seismic response, integrated efforts are needed to improve computational frameworks;
- IT-enabled tools for collaboration – to facilitate interaction of researchers and others with data, resources and colleagues in the US and Japan, various IT-enabled tools and capabilities, including ones for telepresence and teleconferencing, are needed; and
- Education – to promote the synthesis and dissemination of knowledge gained through NEES/E-Defense Collaboration; a broad spectrum of educational activities is desired.

As such, special attention needs to be paid to opportunities for “payload” type investigations, where instrumentation, response control mechanisms, non-structural elements, and so on can be added to planned experiments, or where supplemental experiments or computer simulations can substantially enhance the value of the investigations to be undertaken using the E-Defense facility.

D. Specific Near-term Research Priorities

Based on extensive and thorough deliberations, efforts should be made by NSF and MEXT to secure funding to enable US participation in research activities currently planned as part of the Japanese Dai-Dai-Toku Program for the E-Defense facility. As noted above, these activities relate to:

- (A) Wooden Buildings
- (B) Foundation and Earth Structures

(C) Reinforced Concrete Structures

Planning for these studies (along with preparatory experiments and analyses) have already begun, and the experiments to be undertaken using the E-Defense Shaking Table are expected to be completed by March 2007. As noted in the *Plenary Session on Research Priorities*, this timing constraint may limit US participation to smaller “payload” type activities that take advantage of the experimental setups being utilized by Japanese investigators and that investigate supplementary topics while minimizing additional cost and time. Due to the time needed to plan these research activities, and secure funding, it is likely that these preliminary aspects of NEES/E-Defense Collaboration will not progress to the experimental phase until summer of 2006.

Based on additional discussions and careful consideration, very high priority is assigned to starting the planning for the next major phase NEES/E-Defense Collaboration. The *Plenary Session on Research Priorities* identified two major, high-priority initial research areas: Steel Buildings and Bridges (Items D and E, above). Each project is expected to require major funding, involve multiple payload and ancillary efforts, and to entail three phases lasting several years. Each phase would take turns utilizing the E-Defense Facility, ideally occupying the table periodically from mid-2007 through 2009. Both projects are expected to have a significant scientific and societal impact. Because of the major investment involved, and the high impacts expected, carefully planning is required. It is expected that planning for the steel buildings and bridge efforts will consider appropriate opportunities to incorporate concepts related to Protective Structures (Item F) and Innovative Structures (Item G). Additionally, planning related to Steel Buildings should incorporate opportunities to assess the effects of Nonstructural Elements (Item H) on earthquake response and losses, whereas research on Bridges should include opportunities to explore effects of soil-structure-interaction (Item B)

Thus, planning for the following two areas should be given highest priority.

- Steel buildings – studies focusing on moment-resisting frames, innovative methods for retrofitting vulnerable existing steel buildings, and pioneering concepts for enhancing the performance of new steel structures, incorporating aspects related to nonstructural elements, protective systems, and innovative structural systems.
- Bridges – studies focusing on various bridges systems and bridge-foundation-soil interaction, incorporating aspects related to protective systems and innovative structures.

E. Near-term Planning Efforts Needed

Sustained and systematic efforts are needed to plan the details of the NEES/E-Defense Collaboration. It is clear that detailed plans are required to develop sound scientific goals and research plans, accurate budgets and realistic schedules. To this end, NSF and MEXT should support and fund joint US-Japan activities to:

- Establish a Joint NEES/E-Defense Working Group to facilitate near- and long-term aspects of NEES/E-Defense Collaboration;
- Establish Joint Technical Planning Groups related to the near-term research priorities identified in Item D above; i.e.,
 - Steel buildings
 - Bridges
- Establish other Joint Technical Planning Groups as needed; e.g., related to Wooden Buildings, Foundations and Earth Structures, Reinforced Concrete Structures, and IT; and
- Convene workshops or undertake other exploratory efforts to identify suitable topics for future NEES/E-Defense Collaboration.

F. Near-term Implementation Efforts Needed

Near-term efforts are needed, and should be supported by appropriate funding agencies, to put in place policies, the IT infrastructure and simulation tools necessary to carry out NEES/E-Defense Collaboration. These activities are needed immediately so that items will be ready by the start of the proposed NEES/E-Defense Collaboration in the summer of 2006. These efforts would focus on activities related to simulation and IT, and include at a minimum activities to:

- Define policies, procedures and protocols necessary for documenting data and metadata, and implement secure network-enabled services for capturing and curating data and metadata;
- Develop policies and secure network-enabled services related to sharing of information, software, data and metadata, including relevant agreements regarding intellectual property rights;
- Implement network-enabled collaboration tools for interaction with data, resources and people, including but not limited to capabilities for data visualization, telepresence and teleconferencing; and
- Discuss the feasibility of establishing shared tools for exchange of computer models and for numerical simulation and visualization of earthquake response, and implement these tools where possible.

G. Sustained Planning and Outreach Activities Required

NSF and MEXT are encouraged to fund, at least annually, a NEES/E-Defense Symposium to discuss progress and accomplishments as well as opportunities for future collaborative research. Meetings should be held at a location to be mutually agreed upon by NCI and NIED. The next meeting should be held in approximately one year.

The Joint NEES/E-Defense Working Group described in Item E above should meet periodically to assess progress and identify opportunities for future research activities as well as for other activities related to education, outreach and the development of methods for designing, evaluating, constructing or retrofitting structures for improved seismic resistance. Participants at this first Planning Meeting express willingness to serve along with others on such a Working Group, as the continuity and diversity of ideas developed at this meeting are believed to be important source of direction for future NEES/E-Defense Collaboration.

NCI and NIED should promote awareness of the NEES/E-Defense Collaboration by the broad earthquake engineering community, government officials, and the public.

H. Closure

The participants believe that the Planning Meeting was highly successful, and that NSF and MEXT should be congratulated for providing the earthquake engineering community with cutting-edge tools that will substantially accelerate progress towards the important goals of earthquake loss reduction. The attendees agree that the cordial and harmonious atmosphere at the meeting, and the candid and thoroughgoing discussions, signal an outstanding future for NEES/E-Defense Collaboration. The participants also appreciate and heartily thank NIED for its efforts in convening this successful meeting.