Future Vision of Seismic Safety

Robert Reitherman
Executive Director
Consortium of Universities for Research in Earthquake Engineering

“Think Big”

- Charge from Ed Dean:
  - “a 21st century vision”
  - “unbridle ourselves”
  - “new concepts”
  - “role played by constituent organizations”
  - “think big”


“Big” = $200+ million proposal

NEES

Network for Earthquake Engineering Simulation

What is the Network for Earthquake Engineering Simulation?

- 2000-2004 construction period (NSF, $82 million)
  - "Equipment Sites"
  - "System Integration"
  - "Consortium Development"
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What is the Network for Earthquake Engineering Simulation?

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  • “System Integration” = IT = Information Technology
  • “Consortium Development” = organization
2004-2014 initial operation plan

- Triple current CMS EQ Eng. annual research budget
- Large “grand challenge” projects, as well as smaller ones
- “Shared use” of the Equipment Sites
- Experimentation plus simulation
- Educational goals for civil engineering
- Curated Data Repository

NEES Consortium Development Project

- Major Deliverables
  - Establish NEES Consortium
    - Jan. 22, 2003: incorporated
    - May 1, 2003: elected Board
    - May 21-22, 2003: 1st Annual Meeting
  - Submit successful 10-year operation proposal to NSF
    - Management, Operations, & Maintenance
    - Budgeting, negotiations for 15 Equipment Site and IT services underway
    - Approx. $20 million/yr.
    - Research budget at equal or larger level
Consortium of Universities for Research in Earthquake Engineering (30 University Members; 369 individual professor members)

George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES)

Project Assessment:
- Thomas Finholt
  University of Michigan

Organizational Development Consultant:
- Andrew Holdich
  The Sago Group

Consortium of Universities for Research in Earthquake Engineering:
- Cherri Pancake, Co-PI
  Oregon State University
- Thomas Finholt
  University of Michigan
- Sharon Wood, Co-PI
  University of Texas, Austin
- Stephen Mahin, Co-PI
  UC Berkeley
- Robert Nigbor, Co-PI
  University of Southern California
- Catherine French
  University of Minnesota
- Anke Kamrath
  San Diego Supercomputer Center
- Jeremy Isenberg
  Weidlinger Associates, Inc.
- William Holmes
  Rutherford & Chekene
- Thalia Angosian
  San Jose State University
- Harvey Bernstein
  Convergent Technologies
- Susan Tubbesing
  EERI
- Gene Whitney
  Office of Science & Technology Policy

Facilities & Information Technology:
- Eunice Pancake, Co-PI
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- Catherine Francis
  University of Minnesota
- Faith Kurniati
  San Diego Supercomputer Center
- Simon Francis
  Louisiana State University
- M. M. Khan-Hussain
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Community Development:
- Shane Wood, Co-PI
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- Susan Tubbesing
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- Gene Whitney
  Office of Science & Technology Policy

NEES Collaboratory Research:
- Stephen Mahin, Co-PI
  UC Berkeley
- Jeremy Isenberg
  Weidlinger Associates, Inc.
- Philip Liu
  Cornell University

Consortium Organization:
- Robert Mahler, Co-PI
  University of Southern California
- William Holmes
  Rutherford & Chekene
- Susan Tubbesing
  EERI
- Gene Whitney
  Office of Science & Technology Policy

NSF Cooperative Agreement
- CMS 0126366

Joy Pauschke
NEES Program Manager
National Science Foundation
Equipment Sites (Laboratories)

- 2 high-performance, shake tables (6 DOF)
- Real-Time Dynamic Hybrid Testing (RTDHT)
- Capacity up to 100 metric tons (120 ft long)
- Networked Tele-Experimentation
- Expanded testing area to 13,000 square feet

Shake Tables

Testing of full-scale structure on dual shake tables

Michel Bruneau, PI
University at Buffalo, SUNY
Shake Tables

- 3 – 450 kN shake tables
- MTS servo-controlled (static & fatigue-rated)
- Upgraded to 3 biaxial motion tables
- Host specimens up to 1.35 MN
- Telecapable for remote participation

Schematic representation of the Multiple Shake Table Facility

Ian Buckle, PI
University at Nevada-Reno

Shake Tables

- Shake table designed to reproduce near source ground motions
- Accommodate 20 MN vertical payload
- Adjacent soil pits and laminar soil box

Camp Elliott Development – Outdoor Shake Table

Frieder Seible, PI
University of California, San Diego
Geotechnical Centrifuge

UC Davis Geotechnical Centrifuge

• Multiple degree-of-freedom gantry robot
• Hundreds of wireless networked sensors
• Advance telecollaboration capabilities
• In-flight geophysical testing and tomography
• On-board biaxial shaker

Bruce Kutter, PI
University at California, Davis

Rensselaer’s 100 g-ton Geotechnical Centrifuge

• 2-D In-flight computer controlled earthquake shaker
• In-flight 4 degree-of-freedom robot
• Tele-observation / Tele-operation capability
• 2 high-speed cameras
• Next generation, high-resolution sensors

Ricardo Dobry, PI
Rensselaer Polytechnic Institute
Tsunami Wave Basin

OSU Three-dimensional Wave Basin

- Max. stroke of 2m / max. velocity 2 m/s
- Comprehensive Information Architecture
- Powered by direct digital controlled AC motors
- Complementary 2-D Wave Channel (not shown)
- Excellent intermediate to long wave behavior

Solomon Yim, PI
Oregon State University

Large-Scale Structural Testing

Cable-stayed bridge segment with RTDHT, using two shake tables, reaction walls, and large-scale high-performance actuators

- Dynamic, pseudo-dynamic and hybrid testing
- Real-time Dynamic Hybrid Testing (RTDHT)
- Networked tele-experimentation capabilities
- Test large-scale structures (static/dynamic loading)
- High-resolution digital video and imaging

Michel Bruneau, PI
University at Buffalo, SUNY
Large-Scale Structural Testing

Reconfigurable Reaction Wall-Based Earthquake Simulator Facility examples.

Jack Moehle, PI
University of California, Berkeley

- Multi-substructure hybrid simulation using the pseudo-dynamic test method
- Digital 8-channel servo-control system for hybrid testing
- 128-channel data acquisition system
- 4 fast and an array of slow hydraulic actuators
- Telepresence video and robot avatar systems

Large-Scale Structural Testing

Shear Wall Tests using FHT Method

P. Benson Shing, PI
University of Colorado at Boulder

- Fast Hybrid Test (FHT) system
- Three high-performance dynamic actuators
- Digital servo-control system (w/ 3 control channels)
- High speed testing with seismic waveforms
- 2800 square feet of strong floor
Large-Scale Structural Testing

- Multi-Axial Subassemblage Testing (MAST)
- 6 Degree-of-Freedom (DOF) Control Technology
- Ability to test large-scale structural subassemblies
- Real-time tele-operation of hydraulic equipment

Catherine French, PI
University of Minnesota-Twin Cities

Large-Scale Structural Testing

- Combine real-time testing capabilities with existing multi-directional reaction wall facility
- Large-scale real-time multi-directional testing of structural components and systems
- Soil / structure interaction
- Advanced sensor technology

James Ricles, PI
Lehigh University
Large-Scale Structural Testing

- Three loading / boundary condition boxes with 6 DOF control
- Three types of non contact displacement measurement systems
- Integration of data acquisition, visualization, and analysis

Amr Elnashai, PI
University of Illinois, Urbana-Champaign

Large-Scale Structural Testing

- Large-scale buried pipeline testing facility
- Split box for lifeline experiments at the RPI centrifuge

Harry Stewart, PI
Cornell University
Field Experimentation

John Wallace, PI
University of California, Los Angeles

- Forced vibration testing of structural systems
- Soil-foundation-structural interaction (SF SI) effects
- Aftershock monitoring of full-scale buildings and earth structures
- Characterization of soil / properties / response using CPT & soil probes

UCLA Mobile Field Laboratory Schematic

Large-Scale Structural Testing

Kenneth Stokoe II, PI
University of Texas at Austin

- Large Triaxial Mobile Shaker (Vibroseis)
- Two Electro-Hydraulic Cubical Shakers
- Tele-Presence for remote researcher interaction
- Next-Generation Field Instrumentation
- Wired and Wireless Data Acquisition Systems

Triaxial Vibroseis
Large-Scale Structural Testing

- Enhance instrumentation at two sites in So. California where liquefaction is expected
- Facilities for soil / foundation / structure interaction tests at one site
- Permanently Instrumented Field Sites

Permanently Instrumented Field Sites

Garner Valley Downhole Array (GVDA)

T. Leslie Youd, PI
Brigham Young University

System Integration (Information Technology)

NEESgrid

Daniel A. Reed, PI
NCSA - University of Illinois, Urbana-Champaign
Opportunities for Practitioners and Academicians

- join the NEES Consortium: www.nees.org
- a seat on the Board is intended for a practitioner
- get in the pipeline to receive research results
- be on a research team
- “teleparticipation”
- affect the research agendas of NEES research projects

A research method: Index Buildings
What do you want researched?

- NEES facilities and funding are special, not ordinary
- Get the right answer to a big question, not the quick fix for the next edition of the code
- Academia-practice collaboration is a two-way street.
- Think big.

www.nees.org    www.curee.org

For further information

George E. Brown, Jr.
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