The Promise of NEES Research

Application of the George E. Brown, Jr. Network for Earthquake Engineering Simulation in Collaborative Research

Steven L. McCabe

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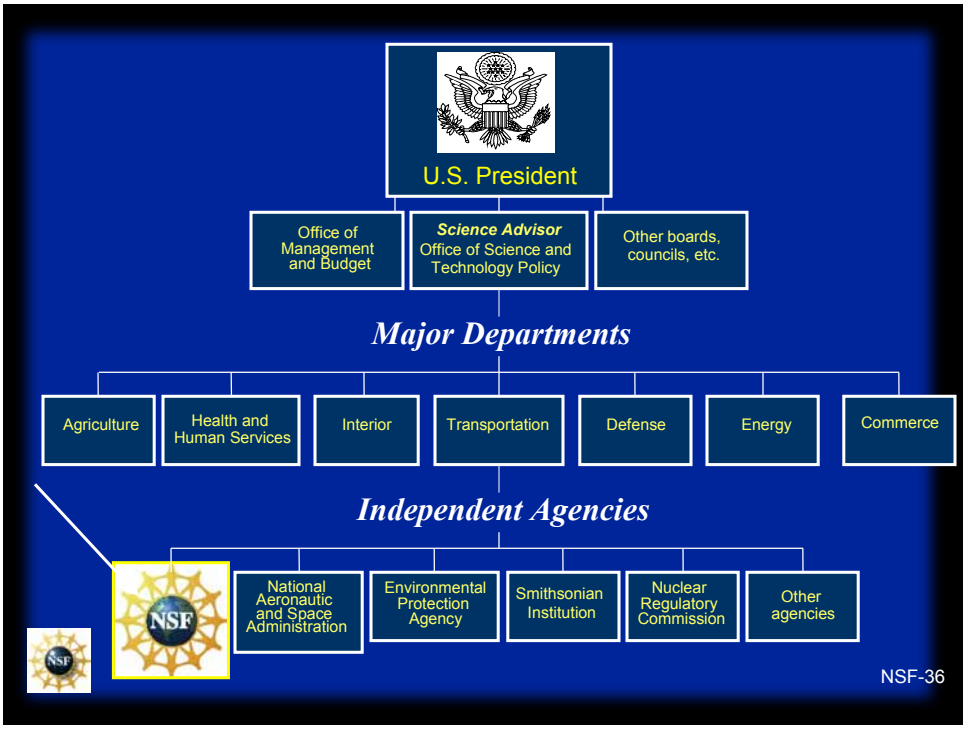
Civil and Mechanical Systems

National Science Foundation

Arlington ,VA


U.S. President
Office of Management and Budget
Science Advisor
Office of Science and Technology Policy
Other boards, councils, etc.
Major Departments
Agriculture
Health and Human Services
Interior
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Defense
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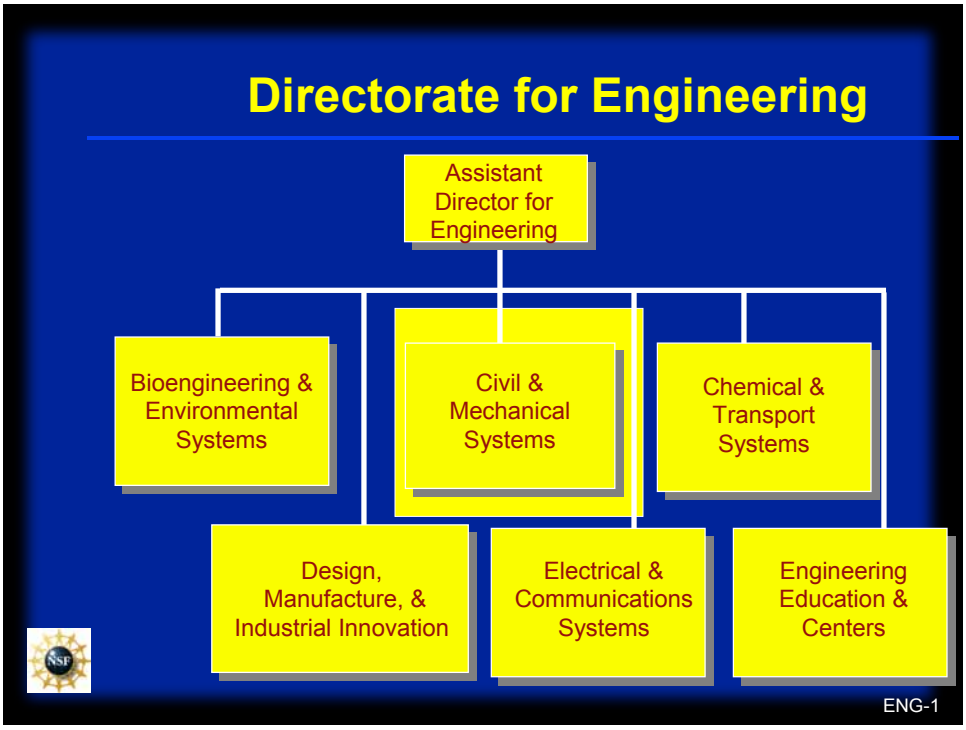
Independent Agencies
NSF
National Aeronautic and Space Administration
Environmental Protection Agency
Smithsonian Institution
Nuclear Regulatory Commission
Other agencies
NSF-36


Directorate for Engineering
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ENG-1

Earthquake Engineering program

Lies within CMS

- Structural Systems and Hazard Mitigation
- Geotechnical Engineering
- Emergency Response studies

Funding Levels at > $10 million per year with traditional individual investigator awards (IIA)

National Science Foundation

NEES Research: NEESR

– *Major* shift in *funding levels and approach* being launched this year to utilize NEES

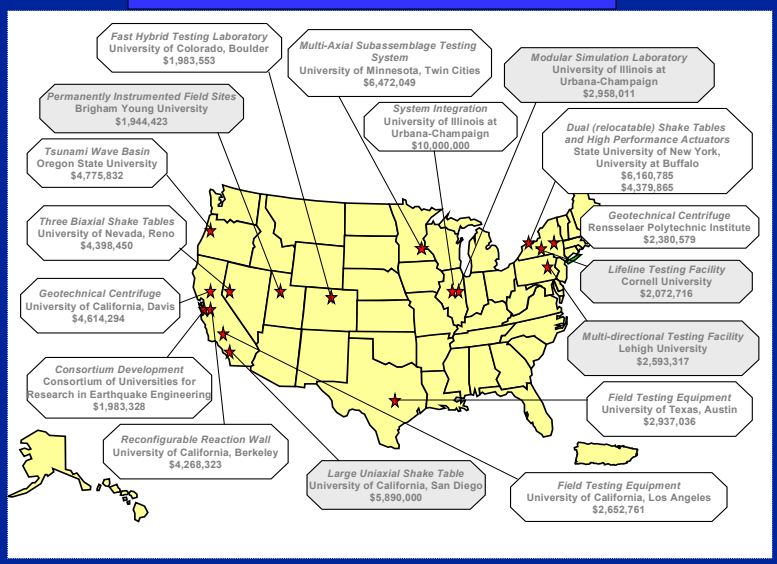
– Initiating a three tiered plan for research

- Grand Challenge Research Initiatives
- Multiple Investigator teams
- IIA

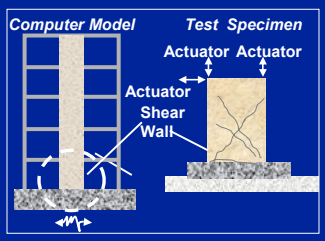
Goal of NEES: National Shared Use Resources

- Experimental Sites funded by NSF (ES)
- Experimental Data Repository
  - Grid facilitates replication of results remotely or locally
- Computational Simulation Results Repository
  - Digital content for use in R&D, practice, education, outreach
- Simulation Software Tools Archive
  - Browsable and searchable library of community codes
- Collaborative technologies
- Capabilities (e.g., HPC sites for numeric simulation)
  - Grid facilitates ubiquitous access to computing resources, including high-performance parallel supercomputers

NEES Award Portfolio



NEES Resources: Equipment Sites



Fast Hybrid Structural Testing
University of Colorado, Boulder

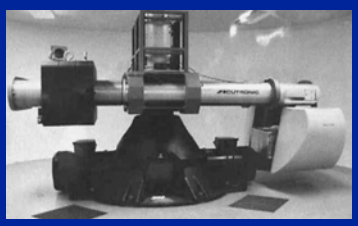
Structural and Geotechnical Field Testing
University of California, Los Angeles

Geotechnical Field Testing
University of Texas, Austin

Two Permanently Instrumented Field Sites in CA
Brigham Young University

NEES Resources: Equipment Sites

Geotechnical Centrifuge
University of California, Davis



Geotechnical Centrifuge
Rensselaer Polytechnic Institute

Tsunami Wave Basin
Oregon State University

Reconfigurable Reaction Wall
University of California, Berkeley

Compelling Technical Issues – what questions will NEES Research answer?

- Issues of scale
  - Testing of models has been to reduced scale
  - Questions exists as to how the scaling affects the true nature of performance involving nonlinear response
  - Material properties, time scale do not scale exactly
    - e.g. fracture in concrete is a function of absolute size
  - NEES will enable full or near full scale testing of com0plete structures and components

Compelling Technical Issues…

- Issues of complexity
  - Component test of individual components separated by geography and/or time are not the same as testing of a complete system
  - Typical pseudo-dynamic tests or static tests have been extensively used but do not represent a true dynamic environment
  - NEES will enable distributed tests to be conducted together with tests at other sites merging into large components or systems
  - NEES will enable faster pseudo-dynamic tests that approach a true dynamic environment

Compelling Technical Issues…

- Issues of completeness
  - Soil-foundation-structure tests have not been possible because of the different tests required to test the soil, foundation, soil-foundation interface and the structure
  - NEES will enable true complete systems to be evaluated in dynamic or pseudo-dynamic tests for the first time

Compelling Technical Issues…

- Issues with ground motion
  - Recorded earthquake ground motions, primarily from recent events, have exhibited accelerations, velocities and displacements that far exceed existing experimental capabilities
    - Kobe
    - Northridge
  - Using actual ground motions as test inputs for shaking table experiments is essential for developing improved understanding of response and damage mechanisms
  - NEES will enable dynamic tests that will exhibit the true ground motion characteristics

Japan also is developing a new modern testing environment

- Kobe earthquake revealed problems with existing data and decisions based on this data
- Japan independently recognized that scale issues are very important and have resulted in test results that are not as reliable as needed
- Tests of complete systems are needed to examine actual performance to develop better design codes
- Japan is developing the E-Defense shake table at Miki City to conduct full or near full-scale tests
  - $450 million
  - One facility with limited throughput and participation
  - Agencies (BRI, NIED and PWRI) are running the show with limited university participation

Examples of NEESR projects starting in FY2004

NEES Experimental Project for Verifying Full-Scale Semiactive Control of Nonlinear Structures

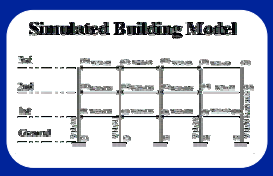
Advancing the state of knowledge and acceptance of ***semiactive damping technology***

PI: Richard Christenson
Assistant Professor
Division of Engineering
Colorado School of Mines, Golden, CO

Amount: $196,811 ($223,823 w/ cost sharing)
Duration: 36 months
Starting Date: 09/15/03
NEES site: UC Boulder Fast Hybrid Test System

Colorado School of Mines Network for Earthquake Engineering Simulation

Experimental Verification of Semiactive Control Applied to Full-Scale Structures Exhibiting Nonlinear Material Behavior



More efficient and cost-effective than testing a physical structure. NEES provides equipment and facilities otherwise not available to the PI at the Colorado School of Mines.

Collaborative Research: Testing and analyses of nonrectangular walls under multi-directional loads

Catherine French
Department of Civil Engineering
University of Minnesota, Minneapolis, Minnesota

Sri Sritharan
Department of Civil Engineering
Iowa State University, Ames, IA

Ricardo Lopez
University of Puerto Rico Mayaguez
Mayaguez, Puerto Rico

Suzanne Nakaki Dow
Nakaki-Bashaw Group, Inc.

NSF George E. Brown Jr. NEES Program

Multi-Axial Subassemblage Testing System (MAST)

Innovative Bracing Systems

- R. Leon and R. DesRoches – Georgia Tech
- M. Bruneau and A. Reinhorn – U. at Buffalo
- B. Shing – U. of Colorado
- B. Stojadinovic and J. Moehle – UC-Berkeley
- M. Abdollah – Florida A&M
- A. Elgahzouli – Imperial College (London)

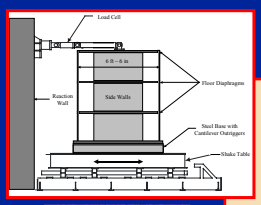
  - Test at different loading rates (static, pseudo-dynamic, shake table)
  - Tests at different structural scales (full-scale, subassemblies, members)
  - Three NEES facilities linked in real time to conduct tests

Development of a Precast Floor Diaphragm Seismic Design Methodology (DSDM)

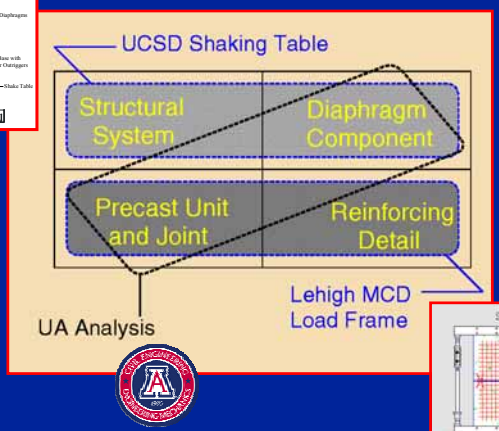
Robert Fleischman, University of Arizona
Clay Naito and Richard Sause, Lehigh University
Jose Restrepo and Andre Filiatrault, UC-San Diego
S.K. Ghosh, S.K. Ghosh Associates, Inc.

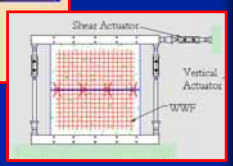
Research Approach:

Integrated Analysis and Experimentation



UCSD





- UA Analyses link UCSD structure level experiments with LU detail level experiments.

LEHIGH University

Demonstration of NEES for Studying Soil-Foundation-Structure Interaction

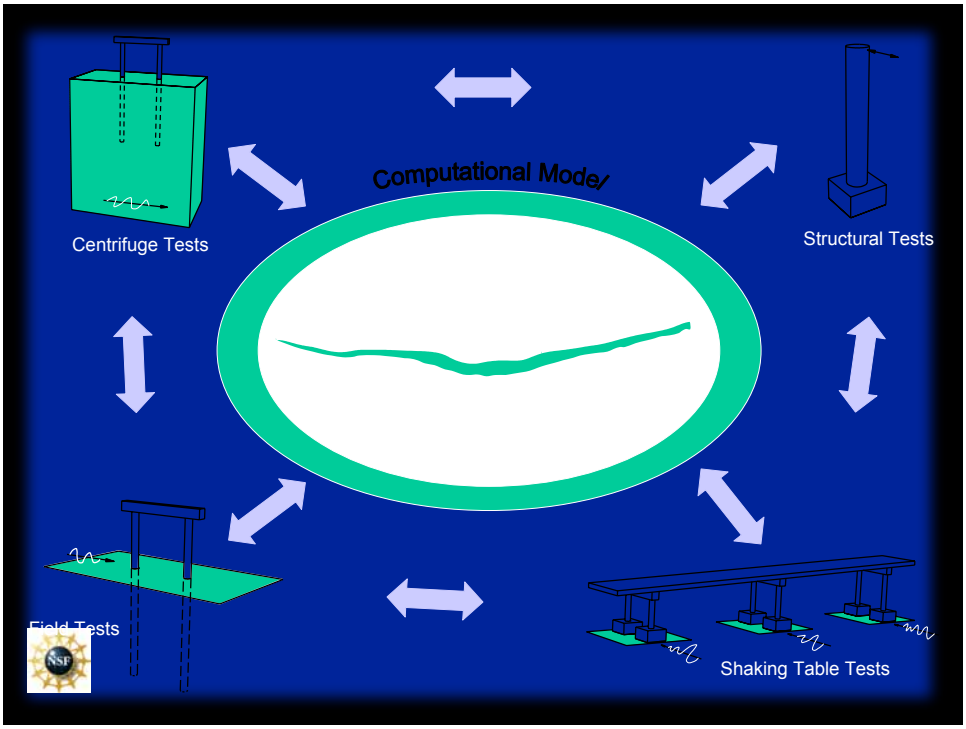
University of Texas: S.L. Wood, E.M. Rathje, K.H. Stokoe
Purdue University : J.A. Ramirez
San Jose State University : T. Anagnos, K.M. McMullin
University of California, Berkeley: G.L. Fenves
University of California, Davis: B. Jeremic, B.L. Kutter, D.W. Wilson
University of Illinois: J.M. Futrelle
University of Kansas: A.B. Matamoros
University of Michigan: T.A. Finholt
University of Nevada, Reno: M. Saiidi, D.H. Sanders
University of Washington: P. Arduino, M.O. Eberhard, S.L. Kramer

Soil-Foundation-Structure Interaction

- Prototype structure – reinforced concrete, continuous bridge on drilled shaft foundations.
- Behavior is influenced by ground motion and nonlinear characteristics of the soil, foundation, and structure.
- Not possible to test a single physical model and reproduce all the key aspects of system performance.

NEES Model for Research

- Four series of complementary models will be tested, each conducted at a different scale and designed to investigate a different aspect of the nonlinear response of the prototype structure.
- Computational simulations will be used to interpret the response of the individual experiments, quantify the limitations of each experiment, and model the response of the prototype system.



NEES is an opportunity

- To improve performance under earthquake excitation
- To conduct research in a new way
- To look at the future of collaborative research