nees@UCLA

The George E. Brown, Jr. Network for Earthquake Engineering Simulation

Proposal Writing Guide

August 28, 2012

1 Introduction

The University of California, Los Angeles George E. Brown, Jr. Network for Earthquake Engineering Simulation (nees@UCLA) Site was established to enable field vibration testing and monitoring of structural and geotechnicalsystems. The major equipment components of the site include the following:

- **Eccentric mass shakers** that can apply harmonic excitation across a wide frequency range in one or two horizontal directions. These shakers can induce weak to strong forced vibration of structures. For small structures, excitation into the nonlinear range is possible when the shakers are operated near their maximum force capacity. The shakers can be operated in a wired or wireless mode.

- **Linear inertial shaker** that can apply broadband excitation at low force levels. These shakers can be programmed to approximately reproduce the seismic structural response that would have occurred for any specified base-level acceleration time history (assuming the properties of the structure are known). The shaker can be controlled in a wired or wireless mode.Above-ground sensors that can be installed at the ground surface or on a building, bridge, or geo-structures to record acceleration or deformation responses. Accelerations are recorded with uni-directional or triaxial accelerometers. Deformations (i.e., relative displacements between two points) are recorded with LVDTs or using fiber-optic sensors.

- Retrievable subsurface accelerometers (RSAs) that can be deployed below- ground to record ground vibrations. The sensors and their housing are specially designed to be retrievable upon the completion of testing.

- Wireless field data acquisition system that efficiently transmits data in wireless mode from the tested structure to the high performance mobile network (see following item).

- High performance mobile network that (a) receives and locally stores data at a mobile command center deployed near the test site; (b) transmits selected data in near real time via satellite to the UCLA global backbone; and (c) broadcasts data via the NEESpop server into the NEESgrid for teleobservation of experiments.

A typical application of the equipment would have shakers installed on or within a structure, a dense array of sensors throughout the structure and RSAs deployed below the ground surface. Data from the building sensors and RSAs are transmitted wireless via field data loggers to the mobile command center where all data are locally stored. Selected data channels and video streams could be transmitted via satellite to the UCLA global backbone for subsequent dissemination via NEESpop for teleobservation of the experiment.

One point that should be emphasized is that the nees@UCLA equipment can be utilized with several types of vibration sources. In addition to the eccentric mass shakers and linear inertial shaker, the equipment is also ideally suited for seismic monitoring of structural or geo-systems (i.e., aftershock or microtremor sources).

2 Applications of nees@UCLA

We anticipate several general categories of application for the nees@UCLA equipment site, which are described briefly in the following paragraphs:

2.1. Building or bridge structural response/performance studies. The equipment can be used to identify the modal responses of buildings (i.e., vibration periods, damping ratios, mode shapes), to evaluate the performance of non- structural elements within tested structures (i.e., HVAC, partition walls, equipment, etc.), and to evaluate the detailed response of structural components (e.g., beam-column connections, column-slab connections, etc.). Experiments can be performed at low levels of excitation from ambient vibration, micro-tremors, or over a range of excitation levels using the various shaker systems. For structures of small to modest size, eccentric mass shakers can be utilized to excite structures into the nonlinear range. Dense instrumentation arrays can be deployed to provide detailed insights into structural and non-structural response and performance characteristics. Structures well suited for forced-vibration studies include existing structures slated for demolition and full-to-moderate scale structures or sub-systems constructed specifically for testing. The sensors and data acquisition systems can be deployed for seismic monitoring of any structures of interest.

2.2. Soil-foundation-structure interaction (SFSI) studies. The equipment can be used to apply forces and moments to foundation components, the response of which can be measured with acceleration and/or displacement sensors to evaluate SFSI effects. Load application to foundations is a natural consequence of vibration testing of buildings and bridges, so SFSI studies could be a component of any such experiment. Moreover, shakers can be directly installed on model foundations or simple structures mounted on model foundations to generate cyclic responses. Instrumentation would typically include an accelerometer array to record foundation motions and ground surface motions near the foundation, as well as RSAs below the ground surface. Specific research objectives of such work could include the evaluation of frequency-dependent stiffness and damping terms for foundation systems, as well as foundation-soil-foundation interaction effects.

2.3. Response/performance studies for geo-structures or soil deposits. As with building or bridge structures, geo-structures such as dams, embankments, and retaining wall systems can be tested though forced vibration or seismic monitoring. Such studies would typically be performed to evaluate seismic response characteristics (i.e., vibration periods, damping ratios, topographic amplification effects). Excitation at amplitudes that could induce soil shear failure is expected to not generally be possible. RSAs would enable measurements of internal response and deformations of geo-structures. Seismic monitoring of soil deposits is also possible with the RSAs and surface instrumentation.

3 Key Questions to Address

The following describes various questions that need to be addressed in order to use the nees@UCLA Site.

Vibration source

- What is the vibration source? (eccentric mass shakers, linear inertial shaker, ambient or other)

- If the nees@UCLA eccentric mass shakers will be utilized:
    - At what level of the test structure will the shakers be mounted, and how will the shakers be lifted/transported to that location?
    - What is the approximate fundamental period of the structure?
    - How will the shakers be anchored?
    - Will the test structure be subject to uni-directional or omni-directional excitation?
    - If uni-directional shaking is desired, are both the MK-15 shakers needed? If yes, will they need to be synchronized?
    - What is the desired frequency range?
    - What is the maximum force output?
    - Approximately how many different tests are needed?

- If the nees@UCLA linear inertial shaker will be utilized:
    - At what level of the test structure will the shaker be mounted, and how will the shaker be lifted/transported to that location?
    - What is the fundamental period of the structure?
    - How will the shaker be anchored?
    - What is the excitation type? (harmonic, earthquake record, white noise, other)
    - Should the excitation applied to the structure be displacement or force controlled?
    - What is the desired frequency range?
    - What is the maximum force output?

- Are utilities (480V three-phase power) and ancillary equipment (i.e., forklift, crane, gantry) available at the project site? If not, be sure to budget for shipping/rental/fuel costs for these equipment.

Instrumentation

- Which nees@UCLA data loggers will be utilized (Kinemetrics seismic monitoring system and/or the National Instruments system)?
- Is GPS time synchronization needed? If yes, is there direct line of sight from the data loggers to the sky?
- Do you plan on using wireless telemetry?
- Include a preliminary instrumentation plan.
- How many channels are needed?
- How long will the data acquisition system be deployed?
- Will the data loggers be continuously monitoring throughout the life of the deployment?
- Which nees@UCLA sensors will be utilized (accelerometers, retrievable subsurface accelerometers, displacement gauges, strain gauges)?
- Will non-nees@UCLA sensors be used? If yes, have you budgeted sufficient funds to design and fabricate additional cables?

Cone Penetration Testing

- How many CPT soundings are required and at what locations?
- Are downhole measurements of in situ shear wave velocity needed?
- Are pore pressure dissipation tests needed?
- Are the retrievable subsurface accelerometers to be deployed? If yes, how many?
- Applications utilizing the retrievable subsurface accelerometers should budget cable replacement costs.
- Have transportation/travel costs for the CPT truck and operator been budgeted?

General

- Has a project plan and schedule been developed?
- Does the proposed activity meet the NEES Inc. and nees@UCLA safety standards?

- Have sufficient funds been budgeted for leasing costs, environmental health surveys/monitoring, portable storage, and portable toilets?
- Have sufficient funds been budgeted for travel and shipping?
- How much broadband (1.54 Mbps) satellite time will be needed?
- What telepresence activities are planned?
- Have sufficient funds been budgeted for web dissemination, data quality control and transfer to the NEES data repository?
- What security measures will be taken to safeguard nees@UCLA equipment against theft, vandalism, fire, rain, etc.?
- Have nees@UCLA Site personnel been contacted to discuss in general terms the project feasibility, technical performance specifications, budget, etc.?