13th World Conference on Earthquake Engineering
Vancouver, B.C., Canada
August 1-6, 2004
Paper No. 1576

IMPLEMENTING THE STRUCTURAL MONITORING PROGRAM OF THE ADVANCED NATIONAL SEISMIC SYSTEM

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SUMMARY

In 1999, the US Congress authorized the construction of the US Geological Survey-led Advanced National Seismic System (ANSS). The ANSS plan [1] called for the installation of 3000 new structural monitoring instruments, 3000 new urban ground response instruments, and more than 1000 instruments to upgrade regional and national seismic networks. During the first four years of limited funding by Congress of the ANSS, focus was placed on installing high-quality free-field and reference strong-motion instruments to measure shaking levels and prepare ShakeMaps in the San Francisco Bay area, Seattle, Anchorage, Reno, and Salt Lake City. Only three structures were instrumented during this period. The focus of ANSS is now shifting to bring structural monitoring into balance with the other components of ANSS. As envisioned, ANSS will enable instrumentation of 200 to 400 structures at 20 to 50 data channels per structure.

Each structure to be instrumented will be selected to assure that: (1) recorded data will address well-defined, high-priority structural engineering needs; (2) the structure is representative of a large number of structures exposed to earthquake hazards; (3) the structure is located in an area that has a high probability of being shaken at a level sufficient to provide the desired structural response data; and (4) there is access to the structure for post-earthquake inspections and analysis. Extensive involvement of practicing and research earthquake engineers and leading organizations such as the NSF Centers and the NEES Consortium will enable identification of priority needs for structural response data, and recommend specific instrumentation projects.

The ANSS Structural Instrumentation Guideline is in preparation, and will provide procedures for nominating candidate structural monitoring projects, and criteria for evaluating and prioritizing projects for funding. The current status of ANSS Structural Monitoring can be found at www.anss.org.

INTRODUCTION

The Advanced National Seismic System (ANSS) is a major initiative led by the US Geological Survey to meet the earthquake data and information needs of the earthquake monitoring, engineering, and research

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communities along with emergency response organizations, local to national governmental agencies, and the general public. ANSS envisions the modernization and linking together of national, regional, and urban monitoring networks to provide timely and accurate information used to reduce loss of life and property from earthquakes, tsunamis, and volcanic eruptions [1]. The implementation plans [1,2] for this modernized seismic monitoring system includes more than 7,000 new digital seismic instruments (Table 1) along with advanced communications networks and data processing, archiving, and distribution facilities. The advanced technology of ANSS makes possible the automatic broadcast of timely and authoritative notifications of earthquake occurrence, source properties, and the distribution of strong ground shaking, along with derived products and information that meet the broadest range of needs.

Table 1. Instrumentation Plan for ANSS

Type	Equipment	Cost (US$)
Monitoring in structures for rapid damage assessment and earthquake engineering	3,000 strong-motion instruments, including communications systems, for 200 to 400 structures at 20 to 50 channels/structure	56M
Urban monitoring at ground sites for warning and rapid damage assessment	3,000 strong-motion recorders, with communications systems	56M
Modernize regional seismic networks	1,000 modern seismographs, including communications systems	31M
Expand national monitoring network to 100 stations	44 additional modern seismographs, including satellite communications	3M
Regional and national network centers	Modernize and standardize hardware and software to manage new data and functions	22M
Portable arrays for aftershocks	2 portable arrays with 25 elements	3M
Total		**171M**

As Table 1 illustrates, the preponderance of instrumentation expansion in ANSS is focused on the built environment. Two thirds of the planned funding is comprised of instrumentation to collect data of critical importance to engineering understanding of earthquakes, both on the ground and in buildings and other structures. Combining this instrumentation with the robust infrastructure of data collection in regional and national seismic networks creates operational cost efficiencies and blurs the traditional separation between seismologists and engineers.

Although ANSS was authorized by Congress in 1999, funding during the past four years has been about one-tenth of that authorized. During this period, ANSS implementation has concentrated on the installation of more than 420 urban strong-motion instruments in relatively high-hazard urban areas. These instruments are operated in real time, making possible the rapid assessment of strong shaking using the product ShakeMap, along with compiling data useful for site response studies and other applications. The urban instrumentation in the San Francisco Bay area, Seattle, Anchorage, Reno, and Salt Lake City are now of a density comparable to that in southern California, where the TriNet system was installed after the Northridge earthquake in 1994 [3]. In the same time period, only three structures (one in Anchorage and two in the San Francisco Bay area) were instrumented.

The focus of ANSS is now shifting to bring structural monitoring into balance with the urban reference stations. Planning for the implementation of structural monitoring began with a workshop in November 2001 conducted by COSMOS [4]. This workshop addressed buildings as the primary class of structure to

be instrumented by ANSS, and was organized around the topics of current building instrumentation, future needs for strong-motion measurements in buildings, instrumentation technologies, and strategies for selecting buildings for instrumentation. Subsequently, ANSS management and its implementation and oversight committees have refined the plans for structural monitoring.

STRUCTURAL MONITORING IMPLEMENTATION

The primary objective for ANSS structural instrumentation is to obtain structural response measurements during earthquakes that can be used to improve general predictive models of representative building types and other typical structures, and thus refine design and retrofit codes and practices and calibrate post-earthquake damage evaluations. Attendant objectives include improving data quality and reducing overall costs for instrumentation, and using real-time monitoring for response and recovery following earthquakes and other hazard events. The data to be collected with these objectives are intended to directly address the needs of earthquake engineering, emergency responders, recovery planners, and others.

Each of the structures to be instrumented by ANSS will be selected to assure that the following priorities are met:

- Recorded data will address one or more well-defined structural engineering needs and issues.
- The structure is representative of a large class of structures exposed to earthquakes.
- The structure is located in an area that has a high probability of being shaken in the near future at a level sufficient to provide the desired structural response data.
- Access to the structure for post-earthquake inspections and analysis is assured.

Close coordination of the ANSS Structural Monitoring Program is needed with other related activities to optimize the effectiveness of ANSS. For example, the Network for Earthquake Engineering Simulation (NEES) being created by NSF is a major, 15-year program of laboratory experimentation and high-performance computer simulation for research and education. ANSS can provide a productive partnership with NEES through instrumentation of structures from which earthquake data would validate and extend the research results from NEES projects. In addition, coordination with other structural monitoring programs in the US and worldwide can most rapidly bring the needed structural data to uses in research and applications.

At present, a committee is being formed with a balance of practicing and research engineers to prepare the ANSS Structural Instrumentation Guideline. This Guideline will transform the objectives and priorities described above into specific procedures and criteria for the identification of suitable candidate structures, and the prioritization of structures for instrumentation with the annual funding that is available. The Guideline is expected to be completed in late 2004, such that ANSS can fund instrumentation projects for completion in 2005.

CONCLUSIONS

The Structural Monitoring Program is a major part of the Advanced National Seismic System. The preparation of procedures to identify candidate structures to instrument, and to prioritize and fund the instrumentation, is in progress. These procedures should assure that the objectives and priorities of ANSS structural monitoring are met. Current information on the status of ANSS Structural Monitoring may be found at www.anss.org.

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