CONSORTIUM OF ORGANIZATIONS FOR STRONG MOTION OBSERVATION SYSTEMS

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ABSTRACT

Development of COSMOS is continuing with a number of activities and initiatives. A workshop on "Instrumental Systems for Diagnostics of Seismic Response of Bridges and Dams" was successfully held and "Recommended Guidelines" were published. The COSMOS Strong Motion Programs Board completed the guideline "Guidelines for Advanced National Seismic System Strong Motion Station Installation" with funding provided by the U. S. Geological Survey. Development of the COSMOS Strong Motion Virtual Data Center (VDC) is continuing on four fronts: improvement of the user interface to make data more accessible for users; the COSMOS strong motion data format has been approved as a standard; data being held directly in the VDC continue to be expanded; and work is being initiated to develop a mirror sites. Two workshops are in planning: "Archiving and Web Dissemination of Geotechnical Data" is scheduled to be held on October 4 and 5, 2001; and, "Strong Motion Instrumentation of Buildings" is scheduled to be held on November 14 and 15, 2001. In an effort to expand strong motion recording in earthquake prone areas of the world that have few or no current strong motion stations, COSMOS and the World Seismic Safety Initiative (WSSI) have entered into an agreement to facilitate deployment of surplus instruments.

INTRODUCTION

COSMOS was formed in 1999 with the overarching purposes of providing mechanisms for ongoing coordination of strong motion programs in the United States and a forum for the Programs to receive coordinated, systematic user input and feedback on data acquisition and dissemination. Supporting these overarching purposes are other important purposes: 1) to further innovative ideas and policies to improve strong motion measurements and their application in practice, 2) to develop infrastructure for coordinated electronic dissemination of strong motion data, 3) to develop consensus standards for data processing and formatting, 4) to promote expansion of strong motion measurements in urbanized areas with high earthquake risk, and 5) to expand support for strong motion measurements. To foster these purposes COSMOS is pursuing a broad program of activities and is supporting the development and implementation of the Advanced National Seismic System (ANSS), which was authorized by the Congress in 1999 (USGS, 1999). Already, important advances have been made in developing guidelines for strong motion instrument installation, strong motion instrumentation of bridges and dams, standardization of data dissemination formats, and web-based dissemination of strong motion data through the COSMOS VDC. Ongoing efforts

support development of guidelines for strong motion instrumentation of buildings, particularly those located in urbanized areas that have high earthquake risk and the expansion of the COSMOS strong motion data base by incorporating recordings from important earthquakes such as the Chi-Chi Taiwan and Kocaeli Turkey earthquakes. Planned activities will significantly advance web dissemination of strong motion data with the objective of making the COSMOS VDC an effective practical resource for earthquake practitioners.

The structure of COSMOS provides for participation of strong motion program members as well as users of strong motion data at several levels. The Consortium is governed by a Board of Directors constituted of representatives of Strong Motion Program members and strong motion data users. The Strong Motion Programs Board develops and implements the Consortium's technical program. A Senior Advisory Council provides broad high level advice with respect opportunities and activities for advancing strong motion programs to serve the Nation's need for strong motion data to protect public safety in earthquakes. Members may actively participate at any of these levels as well as at the Annual Meeting of the Consortium.

GUIDELINES

COSMOS has recently completed two important guidelines: "Instrumental Systems for Diagnostics of Seismic Response of Bridges and Dams: Recommended Guidelines" (Bolt, et al., 2001), and "Guidelines for Advanced National Seismic System Strong Motion Station Installation" (COSMOS, 2001).

Major dams and bridges are elements of the Nation's infrastructure system that are critically important for economic as well as for public safety reasons. Because of their importance, it has been recognized for many years that strong motion recordings on and around these structures are critically important. Consequently, the importance of placing strong motion instrumentation in such structures is recognized. Owners and operators require recordings of the structures' responses to strong ground shaking to determine actions to be taken during and immediately following an earthquake, to assess the extent of damage, and to determine whether in the long term retrofit or replacement is required. Increasingly, important and critical dams or bridges are required to be instrumented in consideration of public safety.

In order to fully review current practice and define the scope of instrumentation needed to capture the response of major dams and bridges, COSMOS held an invited workshop on October 26 – 27, 2000. Invitations were extended to forty-four persons who were known to have active professional interest in instrumentation of large critical structures. Short discussion papers addressed the wide range of relevant topics. The papers together with recorded comments and discussion following each paper formed the basis for recommended guidelines. The product of the workshop is an archival quality proceedings (Bolt, et al., 2001)

With funding support by the U. S. Geological Survey, COSMOS has completed "Guidelines for Advanced National Seismic System Strong Motion Station Installation" (COSMOS, 2001). The purpose of earthquake strong motion measurements within the Advanced National Seismic System (ANSS) is to quantitatively document large-amplitude earthquake ground shaking for use in various alerting, assessment, and research applications. The Guideline, which was drafted by Robert Nigbor and prepared with oversight of the COSMOS Strong Motion Programs Board (SMPB), provides specific guidance for the installation of ANSS strong motion stations to be considered as urban reference stations. The goal of urban reference stations is to accurately record the combined effects of earthquake source, propagation path, and site effects within the range of amplitudes (.001 - 2g) and frequencies (0 – 50 Hz) needed for the various public safety, engineering, and scientific applications. In urban areas, the broader goal is to measure ground motions that are representative of the ground shaking experienced by the built environment - buildings, other structures, infrastructure. The most useful urban strong motion reference stations are those installed at ground surface locations in the free field with minimum contamination of ground motions by soil-structure interaction effects. Useful reference stations may be installed within small buildings, however. Both types of installations can provide valuable information for many public safety, engineering, and scientific applications.

The Guideline provides detailed information regarding strong motion reference station siting, construction, site characterization, and documentation. The ANSS management within the USGS has reviewed and accepted the document and it is now being used by ANSS Region Managers to implement installation of urban reference strong motion stations. Although it is directed primarily to guide installation of ANSS urban reference stations, the document is broadly useful to other strong motion measurement programs.

The Guideline currently is undergoing final approval review by the COSMOS SMPB and is expected to be available on the COSMOS web (www.cosmos-eq.org) within a few weeks. Following approval the Guideline will be published as an archival quality report.

DEVELOPMENT OF THE COSMOS STRONG MOTION VIRTUAL DATA CENTER

Evolution of the COSMOS Virtual Data Center (VDC) is continuing with current developments in four activities: development of VDC server to improve access to data by users, development of a mirror site at the USGS National Strong Motion Program (NSMP) (www.nsmp.wr.usgs.gov), incorporation of important data directly into the VDC (see M. Squibb, COSMOS Newsletter No. 5), and release of the COSMOS data format standard.

The VDC user interface continues to be improved as part of the normal evolution of the database and with feedback from users. Users have been able to download earthquake parameters as an ASCII file for some time. Recently completed modifications and improved instructions on the VDC home page (www.db.cosmos-

eq.org) facilitate downloading these parameters as TAB-delimited data in a spreadsheet program. Improvements in the user interface that facilitate data access is a continuing primary goal. The ultimate goal is to provide a resource that practitioners can incorporate into their every-day practices. In order to keep current with developing technology the VDC server has been upgraded to Windows2000.

Work is currently being initiated to develop a mirror site at the USGS in Menlo Park, CA and it is expected that work will be initiated later this year to develop a mirror site at the California Division of Mines and Geology (CDMG) in Sacramento, CA. When completed these mirror sites will improve performance and ensure uninterrupted user access. To provide additional assurance of uninterrupted user access, an uninterrupted power source has been installed.

Important data, especially data that are not held in either the CDMG or USGS NSMP databases, which are virtual sites of the VDC, continue to be added directly to the VDC server as such data become available. A growing number of strong motion observation programs are generously cooperating in this effort.

Strong motion recordings of the Nisqually, Washington earthquake of 28 February 2001 were added to the VDC server immediately following the earthquake (see Stepp, et al., COSMOS Newsletter No. 4, and H. Benz, COSMOS Newsletter No. 5). The M6.8 Nisqually earthquake recordings are particularly important for earthquake engineers and strong motion seismologists in the Pacific Northwest because it appears to have been a repeat of damaging earthquakes that occurred at essentially the same location in 1949 and 1965. A few strong motion recordings were obtained from both of these earthquakes. With the very active deployment of strong motion stations in recent years however, the Nisqually earthquake was recorded at 73 strong motion station sites resulting in 277 strong motion recordings. Recordings were obtained on a range of site geology and in a significant number of structures. Fifty-four channels of motion were recorded at eight instrumented dams, four U. S. Army Corp of Engineers (COE) dams, and two U. S. Bureau of Reclamation (BOR) dams as well as dams owned by Tacoma Public Utilities and Seattle Light and Power. Six channels of strong motion were recorded in waterways structures. Twenty-six channels were recorded in instrumented high-rise buildings and 21 channels were recorded in lifeline facilities. With the productive cooperation of the Pacific Northwest Seismic Network (PNSN) (www.geophys.washington.edu/SEIS/PNSN/SMO/), the NSMP (www.nsmp.wr.usgs.gov), the COE (www.geoscience.wes.army.mil), and the BOR, a significant subset of these data were incorporated into the VDC server shortly following the earthquake and the recordings were available to practitioners in the region for more informed consultation with clients.

Recently, the VDC has added uncorrected free-field strong motion recordings of the 20 September 1999 Chi-Chi, Taiwan main earthquake. With the corporation and support of the California Strong Motion Instrumentation Program (CSMIP), the participation of the Central National University of Taiwan, and the Taiwan Central Weather Bureau, processing of over 400 recordings of the Chi-Chi earthquake main

shock and three major aftershocks is being carried out at CSMIP following to CSMIP standards. Full processing will be carried out to velocity, displacement and response spectra (see B. A. Bolt, COSMOS Newsletter No. 5). The processed data will be shortly available on the VDC or directly on the CSMIP server as part of the VDC, in the COSMOS standard data format (see A. F. Shakal, COSMOS Newsletter No. 5). The format can be viewed on the COSMOS web site (www.cosmos-eq.org/cosmos_format_01.pdf).

Though the generous assistance of Mustafa Erdik and the Kandilli Observatory and Earthquake Research Institute (KOERI) and Erdal Safak of the USGS, uncorrected recordings of the August 2000 Kocaeli, Turkey earthquake and 15 aftershocks are being added currently to the VDC. We anticipate adding additional recordings of the Kocaeli earthquake and aftershocks obtained by other strong motion networks in Turkey as they become available. The KOERI strong motion recordings have been converted to the COSMOS standard data format.

The VDC continues to receive strong motion recordings from observation networks in both the United States and other countries. Recently, through the generous cooperation of the Centro de Investigaciones Geotecnicas and the Universidad Centroamericana, Structural Mechanics Department uncorrected strong motion recordings of the 13 January 2001, 13 February 2001, and 17 February 2001 El Salvador earthquakes have been added to the VDC. Strong motion recordings of 10 recent earthquakes generously provided by the Kik-Net in Japan, have been added in 2001 together with recordings of 10 February 2001 Big Bear Lake, California, the 10 June, 2001 Satsop, Washington, and the 29 November 2000 Central Alaska earthquakes.

SCHEDULED WORKSHOPS

COSMOS has scheduled two invited workshops: Archiving and Web Dissemination of Geotechnical Data, and Strong Motion Instrumentation of Buildings (see J. C. Stepp and J. Swift, COSMOS Newsletter No. 5 and A. F. Shakal, J. C. Stepp, and R. L. Nigbor, COSMOS Newsletter No. 5). The first of these, supported by the PEER Center Lifelines Program, is scheduled to be held on 4-5 October, 2001; the second, supported by National Science Foundation, COSMOS, and ANSS funding, is scheduled to be held on 14-15 November, 2001.

The first of these workshops was motivated by the recognized need to make the various different types of valuable geotechnical data available in the most cost efficient way to a broad user community. Geotechnical investigations are routinely required for design and to obtain approval to construct all critical structures and significant buildings as well as for a wide range of specific research purposes. Large quantities of data are consequently generated, much of them of interest and significant value to the broad geotechnical engineering and construction community as well as for university research. While the data are generally collected following current professional practices, consistent

standards and quality practices are not generally implemented. The data that have been collected over the years typically reside in the archives of local, state, and federal agencies and private sector organizations. Organizations such as Caltrans and the transportation agencies of other states, the Federal Highway Administration, the California Division of Mines and Geology, the geological surveys of other states, the U. S. Geological Survey, Army Corp of Engineers, Bureau of Reclamation, and other federal agencies, private sector companies such as Pacific Gas and Electric, and national research-focused activities such as the National Geotechnical Experimental Sites, university-government-private sector cooperative projects such as GEOINFO-ROSRINE, and the PEER Center Lifelines Program collect important data sets. A number of efforts aimed at developing databases for archiving and web dissemination of geotechnical data are now in progress. These important efforts together with the data collection absorb large resources and there are significant barriers to broadly accessing the data because common data format standards are lacking and optimally compatible data archiving and dissemination methods are not in place.

The objective of the workshop is to develop consensus recommendations for classifying, archiving, and web dissemination of the various types of geotechnical data. The final product is intended to be a road map of developmental and infrastructure needs. A workshop agenda, which can be viewed on the COSMOS web site (http://www.cosmos-eq.org), has been structured to facilitate better understanding of the common features and issues that have been identified by the various ongoing database development efforts and to address long-term infrastructure and funding requirements. The important principal deliverable of the workshop will be consensus recommendations that describe a clear path forward for implementing archiving and web dissemination of geotechnical data to meet user needs. Workshop presentations and consensus recommendations will be published in an archival quality proceedings.

The second of these workshop is an activity of the COSMOS SMPB. The workshop is motivated by the need to obtain broad input of earthquake engineering professionals for the purpose of defining strategic needs that can be used to guide the development of guidelines for strong motion instrumentation of buildings. With the authorization of the ANSS (see H. Benz, COSMOS Newsletter, No. 2, April, 2000; R. Page, COSMOS Newsletter No. 5) it is anticipated that at least 6,000 strong motion instruments will be placed in buildings during the next five years. The placement of the instruments in order to maximize the usefulness of the anticipated recordings for the purpose of advancing public safety in earthquakes is critically important.

The main objectives of the workshop are to document current practice for strong motion instrumentation of buildings, to identify the types of building that should be instrumented, and to define the types of response measurements needed to meet expanding uses of strong motion data in earthquake engineering research and practice, emergency response practice, and building health evaluation. Other important objectives are to document developing instrumentation technologies, communication technologies, and monitoring system. The workshop is being organized around four principal topics: current building instrumentation programs and guidelines, future needs for strong motion

measurements in buildings, instrumentation technologies, and strategies for selecting buildings for strong motion instrumentation. The last of these topics will address national and regional priorities, priorities for selection of buildings, and mechanisms to encourage expansion of private participation in a coordinated national building instrumentation effort.

Discussion papers within these topics are being invited and will be distributed to workshop participants in advance. The discussion papers together with consensus recommendations of the workshop will be published in an archival quality proceedings. It is intended that the proceedings will serve as a technical information base for separate development of guidelines for strong motion instrumentation of buildings.

Organizations supporting this workshop include the National Science Foundation supported U. S. Committee for Advancement of Strong Motion Programs, the U. S. Geological Survey Advanced National Seismic System, COSMOS, and PEER.

SAFER CITIES INITIATIVE

COSMOS and the World Seismic Safety Initiative (WSSI) have concluded an agreement to jointly promote and facilitate deployment of surplus strong motion instruments in earthquake prone regions of the world that currently have few or no strong motion stations. Strong motion instrumentation is normally replaced by monitoring programs as instrument technology improves and the replaced instruments become surplus. The instrumentation that is replaced often in is good working order, but no longer meets the requirements of the monitoring program. In recognition that these instruments can be beneficially deployed in many areas of the world, COSMOS and WSSI have developed a project, entitled *"SAFER Cities (Strong-Motion Accelerographs For Earthquake Loss Reduction in Cities)"*. The project is intended to accomplish the redistribution of surplus instruments.

Surplus instruments provided by monitoring programs in the United States will be primarily those of the four COSMOS Core Strong Motion Program members: the ACOE, the BOR, the CSMIP, and the NSMP as well as other Strong Motion Program members. Additional instruments may be provided by monitoring programs in other parts of the world that are affiliated with or support the WSSI. Recipients of the instruments must be non-profit organizations and agencies that would otherwise have little or no means of recording the next damaging earthquake in urbanized areas of the world that have high earthquake risk exposure. Objectives of the initiative, responsibilities of the various agencies and organizations, and procedures for redistribution of unused instrumentation can be viewed on the COSMOS web page (www.cosmos-eq.org).

CONCLUDING REMARKS

COSMOS is dedicated to improving public safety in earthquakes by facilitating advancements in strong motion monitoring and the broad use of strong motion data. The

Consortium functions on the premise that public safety can be best achieved through coordinated, broad participation of strong motion monitoring programs and public and private users of strong motion data. To this end an important objective is to generate a spirit of participation through the COSMOS membership, which is open to all professionals who are interested in earthquake safety.

REFERENCES

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