Calendar

SMIP2000, Sacramento Convention Center, Sacramento, California, 14 September 2000.

Annual Membership Meeting, 15 September 2000 at PEER: 9:30 AM

Board Meeting: 15 September 2000, at PEER: 3:00 PM

Invited Workshop on Instrumental Diagnostics of Seismic Response of Bridges and Dams: 26 & 27 October 2000.

Editor: Claire M. Johnson

COSMOS Newsletter

No. 3, August 2000

Consortium of Organizations for Strong-Motion Observation Systems

Highlights

Bruce A. Bolt, President

Significant progress has occurred since the first Annual Meeting of COSMOS on 16 September 1999. The demands and activities over the last year more than justified the need for an umbrella organization representing strong-motion networks in the United States.

• A major step was the debut of the Virtual Data Center (VDC) (http://www.cosmos-eq.org) through the dedicated work of Professor Ralph G. Archuleta. Liaison was established between the COSMOS VDC and the specialized database of particular engineering interest recently released by PEER. Bruce Bolt will meet with N. Ambraseys and P. Smit (Imperial College of Science, Technology and Medicine, London) in late August to discuss linking the European Strong-Motion Data Base (see COSMOS Newsletter No. 2) into the COSMOS VDC.

• COSMOS officers participated in developing actions to implement the Advanced National Seismic System (ANSS). Continuing regular contact has been maintained with Dr. John Filson, U.S. Geological Survey (USGS). Executive Director J. Carl Stepp, who represents COSMOS as a member of the ANSS Interim National Steering Committee (INSC), and COSMOS Director and Vice-President James F. Davis, also a member of the INSC, participated in two meetings of the Committee, which were held on 29 February and 13-14 July 2000. COSMOS Director and Secretary W.U. Savage is a member of the ANSS Technical Integration Committee.

• COSMOS received a grant from the USGS entitled "The Development of Guidelines for Strong-Motion Station Installation for the Advanced National Seismic System." This grant will develop guidelines for the siting, construction, and site characteristics for strong-motion station installation. COSMOS will present the draft guidelines in a workshop involving ANSS representatives. The Principal Investigator on this grant is J. Carl Stepp, Executive Director, and Dr. Robert L. Nigbor, University of Southern California, is Key Investigator (see page 3).

• A contract was signed with the California Strong-Motion Instrumentation Program entitled "Enhanced Strong-Motion Measurements and Utilization," with B.A. Bolt and J.P. Moehle as Co-Principal Investigators. Under this proposal, work continues towards the purposes and goals as set

continued page 2

Attention COSMOS Members

The Annual Meeting of COSMOS Members will take place at 9:30 AM, 15 September 2000, PEER, Richmond, California, following SMIP2000.

See page 7.

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out in the Charter of COSMOS and agreed to by the core members and other representatives of strong-motion programs in the United States. In addition, this contract provides key financial support for the COSMOS Workshop in October (see page 7)

• A key future activity is the workshop in October entitled "Invited Workshop on Instrumental Diagnostics of Seismic Response of Bridges and Dams," to be held on 26-27 October 2000 at 9:00 AM, at PEER, Richmond, California (see page 7)

Developments in the Advanced National Seismic System

J. Carl Stepp, Executive Director

Significant progress has been made toward implementing the Advanced National Seismic System (ANSS), which is described in COSMOS Newsletter No. 2, April 2000. The ANSS was inaugurated in FY2000 with the installation of 80 strong-motion stations in high earthquake risk urban areas: 40 stations in the San Francisco Bay urban area and 20 each in the Seattle and Salt Lake City urban areas. The first meeting of the ANSS Interim National Steering Committee (INSC), which was formed to plan implementation of the system, was held on 29 February 2000. The INSC adopted a regional network structure as the overall framework and structure for implementing the ANSS. Following the adoption of the regional structure, self-organized regional meetings were held in California, the Pacific Northwest, the Intermountain West, and the Central United States to define the geographic boundaries of the regions, identify participating institutions and organizations, and develop a regional management structure. Other regional organizing meetings will be held in the near future. The regional meeting results and recommendations were reviewed by the INSC in its second meeting held on 13-14 July 2000. The Committee adopted a structure so that each region will have two implementation components: a network management structure and an oversight committee. Regional network operators reporting to the ANSS Program Manager, Dr. Harley Benz, will provide network planning and management. Regional ANSS Oversight Committees, whose members will be users of earthquake data and information, will provide review and oversight of network implementation. The Regional Oversight Committees reporting to the ANSS National Steering Committee will provide review and guidance on all aspects of network planning and implementation. The National Steering Committee is currently being formed and is expected to hold its inaugural meeting in the fall of 2000.

All public agencies, federal, state, and local, and an increasing number of private organizations need and use seismic information. The ANSS concept recognizes that meeting the nation's needs for seismic information requires a twofold effort. First, bold initiatives must be developed to implement common, integrated earthquake monitoring systems that are networked together. Second, interagency and public-private agencies must collaborate for dissemination and use of seismic information. The ANSS web site (http://pasadena.wr.usgs.gov/eqhaz/anss) provides current information about implementation of the system.

COSMOS Display at the EERI Annual Meeting, St. Louis

J. Carl Stepp, Executive Director

The Earthquake Engineering Research Institute generously provided a display booth for COSMOS at the Institute's Annual Meeting in St. Louis, Missouri, 31 May through 3 June. The COSMOS brochure, copies of newsletters, and other materials were displayed at the booth and distributed to interested visitors. Importantly, the booth provided the opportunity to display and demonstrate the COSMOS Virtual Data Center (VDC) (see page 4) to the large number of meeting attendees who visited the display. Professor Ralph G. Archuleta, University of California Santa Barbara, Principal Investigator for development of the COSMOS VDC, demonstrated how the VDC can be accessed and searched with user-provided parameters.

The objective of the VDC is to provide a single resource that the average practicing earthquake engineer or earthquake scientist can access and obtain with minimum effort and within a reasonable time strong-motion data that meet the needs of a particular project or study (see page 4). With one stop at the COSMOS VDC— which can be accessed through the COSMOS web site (http://www.cosmos-eq.org)— the user will be able to obtain data that satisfy the user-provided search parameters from any participating strong-motion program's database. The data will be available in an easy to understand, standard format that does not require additional user formatting. Initially the VDC links databases of strong-motion programs in the United States, but the vision is to extend the links internationally. COSMOS plans to continue development of the VDC over the next two years and to improve, expand the scope of participation, and maintain the Center into the foreseeable future.

USGS National Strong-Motion Program: Toward a Digital Network

Ron Porcella, U.S. Geological Survey

The U.S. Geological Survey's (USGS) National Strong-Motion Program (NSMP) set an ambitious goal in Fiscal Year (FY) 1996: to upgrade all permanent USGS-owned analog free-field strong-motion stations to digital recording within 10 years. At that time the NSMP network was more than 90% analog. This modernization effort is currently ahead of schedule, and the NSMP expects to complete the upgrade of virtually all USGS-owned free-field stations by the end of FY 2003. The substantially more costly instrumentation of large structures is also being upgraded as rapidly as possible. Nationwide, more than one-third of the 40 USGS instrumented structural systems (comprising 12-72 data channels) have been upgraded to digital.

In California the approximately 150-station USGS-owned free-field strong-motion network is now more than 95% digital. Currently nearly 100 stations are either monitored in real time in cooperation with regional seismic networks, or are configured to call-in over standard telephone lines to the "network management system," which is operated by the NSMP Data Center in Menlo Park, California. These "dial-up" stations call-in to the Data Center (1) on a daily basis with a field status report, (2) when detecting ground motion above a present trigger threshold, and (3) when detecting an alarm condition for any of several user-selected maintenance parameters (low voltage, loss of GPS time, etc.) The near-real time (triggered) parametric data, including peak ground acceleration and velocity, is then made available to the regional seismic network operation center within a matter of minutes to supplement real-time data for generation or refinement of ground shaking maps, so-called "shake maps."

Presently, more than 50 new NSMP real- and near-real time digital strong-motion stations are being installed in California; 21 in the San Francisco Bay Area are real-time stations established as part of the new Advanced National Seismic System (ANSS). With these stations, the USGS-owned strong-motion network in California will contain more than 200 digital free-field stations by the end of FY 2000. By the end of FY 2003, the USGS-owned California network is expected to contain about 250 digital free-field stations. Virtually all of these stations will be either monitored in real time by the California Regional Seismic Network or will send data to the NSMP Data Center in near-real time when triggered.

The more than 150-station, USGS-owned free-field strong-motion network located outside of California is now about 35% digital; approximately 40 of these stations currently dial in to the NSMP Data Center. The numbers of USGS-owned digital stations are listed below, by region, with the total numbers of stations shown in parentheses:

Pacific Northwest = 18 (25);
Nevada = 12 (14);
Utah = 6 (20);
New Madrid = 5 (26);
Alaska = 2 (27);
Hawaii = 5 (31);
Charleston = 2 (3);
Puerto Rico = 2 (3); and
Other = 0 (5).

The remaining 100 USGS-owned analog stations—located primarily in Hawaii, Alaska, Utah, and New Madrid— will be upgraded to digital recording over the next 3 years. As in California, all stations will be either monitored in real time by a cooperating regional seismic network or will send data to the NSMP Data Center in near-real time.

The USGS National Strong-Motion Program is working in close cooperation with regional seismic networks that are being established under the ANSS to explore opportunities for sharing hardware and data dissemination facilities at existing or planned NSMP strong-motion stations. Please contact Ron Porcella (porcella@usgs.gov) with any comments or questions.

Guidelines for Urban Strong-Motion Stations Taking Shape

Robert L. Nigbor, University of Southern California

Recorded strong-motion data are affected by the site conditions, the proximity of man-made structures, and sometimes even by the configuration of the accelerograph foundation. Although some strong-motion programs have internal standards for free-field station design, there is no uniformity between programs. This non-uniformity is further evident in the installation of ground motion reference sites in urban areas where true free-field conditions are not available. As the Advanced National Seismic System (ANSS) develops into a truly national, coordinated network for strong-motion observation, standards for siting, construction, and site characterization—for both new and existing stations—are critical. Especially needed are uniform definitions of "free-field" and "urban reference" stations.

COSMOS is working in conjunction with the U.S. Geological Survey (USGS) and its ANSS partners to develop such standards. Led by Dr. J. Carl Stepp, COSMOS, and Professor Robert L. Nigbor, University of Southern California, and with oversight and review from the

continued page 4

COSMOS Strong-Motion Program Board, a document entitled "Guidelines for ANSS Strong Motion Station Installation" is in progress. These guidelines will cover site selection, station construction (focusing on free-field slab/enclosure design), and geotechnical site characterization.

It is anticipated that a draft version of the guidelines will be available prior to the COSMOS Annual Meeting, and that final publication (through COSMOS' web page and on-request paper copies) will occur in October.

For further information about this project or to contribute any ideas or information, please contact Bob Nigbor at nigbor@usc.edu.

Figure 1. Typical free-field station design

COSMOS Virtual Data Center

R.G. Archuleta, University of California, Santa Barbara

The COSMOS Virtual Data Center (VDC), http//:db.cosmos-eq.org or http://www.cosmos-eq.org, is a web accessible relational database for strong motion data. This database was designed to make it simple for a user to retrieve strong-motion data that are most relevant to the needs of the user. At the same time it gives primary responsibility for quality control of the original data to the agencies that collected and processed the data.

The virtual data center was organized with a typical www shopping cart approach. Based on a wide range of search parameters, the user can specify criteria that will be used to select the appropriate strong motion acceleration time histories. Once selected the user can preview the records and their relevant attributes, such as peak acceleration, closest distance to the fault, geological conditions at the site, etc. If the records are acceptable, the user puts them into his/her shopping bin. Multiple searches can be done. When all the searches are finished, the user can download the data directly from the agency that collected the data. This download is completely transparent to the user.

The database has fields in seven parameter tables related to the earthquake: station, local geology, region, instrument, owner, network, and acceleration time histories. This allows the user to search for records based on many different combinations of criteria. In addition to the general search on basic parameters, the user can use an advanced search or a point-and-click search using a map of the earthquake and recording stations. There is also a bibliography associated with the parameters so that a user can find the reference for a magnitude or for the processing of the data—a useful feature when writing papers or reports.

At present the VDC has information on 95 earthquakes, 3180 accelerograms, and 572 station descriptions. For each earthquake the VDC has tried to include all the available accelerograms. The VDC will soon expand to 159 earthquakes, 5287 accelerograms, and 1387 station descriptions.

In the near future it will also have the ability to search for acceleration records that have response spectral ordinates at particular periods, e.g., 0.1, 0.3, 1.0, 3.0s. Currently the data are downloaded in the format determined by the agency that collected the data. In the future, there will be a standard format for all the strong motion data that are downloaded.

SMIP2000 Seminar on Utilization of Strong-Motion Data

A. Shakal, California Division of Mines and Geology

The California Strong Motion Instrumentation Program (CSMIP) in the Division of Mines and Geology of the California Department of Conservation is pleased to announce a one-day seminar entitled "Utilization of Strong-Motion Data." The purpose of the seminar is to increase the utilization of strong-motion data in improving post-earthquake response, seismic design provisions, and practices. The seminar will be held on Thursday, 14 September 2000, at the Convention Center in downtown Sacramento. The seminar program will include presentations by investigators funded by CSMIP to perform data interpretation studies during the past year and invited experts who have utilized strong-motion data in specific studies. Topics will cover several areas, including the following:

continued page 5

- Evaluation of site amplification factors from strong-motion records
- Recent data recorded from downhole geotechnical arrays
- Validation of evaluation methods and acceptance criteria in performance-based seismic codes
- Implications of near-fault ground motion data recorded in the 1999 Taiwan Earthquake
- Seismic performance evaluations of transportation structures
- Development of refined design procedures for estimating the vibration characteristics of bridges
- COSMOS Virtual Strong-Motion Data Center
- TriNet Engineering Strong-Motion Data Center

In addition, there will be an update presentation on the Consortium of Organizations for Strong-Motion Observation Systems (COSMOS).

For further information, please call Shirley Rowley of CSMIP at 916/322-3105.

Taiwan Strong-Motion Instrumentation Program and the 1999 Chi-Chi Earthquake

W.H.K. Lee, U.S. Geological Survey
T.C. Shin, Central Weather Bureau, Taiwan

The Seismology Center of the Central Weather Bureau (CWB) of Taiwan is officially responsible for monitoring earthquakes in and near Taiwan. Taiwan is a small island, 35,000 kilometers square, with most of the population centered in the northern and western plains and along the Longitudinal Valley between the Central Mountain Ranges and the Coastal Ranges in the east.

The CWB began an extensive seismic instrumentation program in 1991, specially targeting urban areas of Taiwan. On 21 September 1999 at 1:47 am local time, a major earthquake (M_W =7.6) occurred near the town of Chi-Chi in Nantou county, central Taiwan (Shin et al., 2000). There were 3000 deaths, 10,000 people were injured, and over 100,000 rendered homeless. The modern digital data recordings obtained from this earthquake has provided a wealth of information for seismologists and earthquake engineers to reduce seismic hazard in urban areas.

The accelerometer sensors used have a flat response from DC to 50 Hz. Signals are digitized at 200 samples per second or higher and at 16-bit or higher resolution. Most accelerometer sensors are ± 2g full scale. These digital accelerographs at the free-field sites are operated in trigger mode, with a 20-second pre-event memory, and are usually set to record an extra 5 seconds after the signal drops below a preset threshold. About half of these digital accelerographs are capable of outputting a continuous digital data stream, making telemetry very easy. All digital accelerographs are capable of being dialed in via telephone modem.

At the time of the earthquake, the Taiwan Rapid Earthquake Information Release System (RTD) automatically determined the location and magnitude for the mainshock and prepared a shake map within 102 seconds after the earthquake's origin time. This information was then sent out by a pager-telephone system, by an e-mail server, and by fax (Wu et al., 2000). Government officials and media found such timely information very useful. The rapid earthquake information release system and real-time strong-motion array systems are based on a simple hardware/software design first introduced by Lee et al. (1989). These systems were subsequently improved and refined (Lee, 1994; Lee et al., 1996; Wu et al., 1997).

At present, the following instruments are in operation:

- A real-time, digitally telemetered seismic network of 80 three-component, short-period stations
- A rapid earthquake information release system based on 61 real-time, telemetered digital accelerographs (which also record onsite in trigger mode)
- 650 modern digital accelerographs in free-field sites, see Fig. 1 (all record in trigger mode; 61 sites are continuously telemetered to CWB headquarters in Taipei [see above] and some sites have more than one accelerograph)
- 56 real-time strong-motion arrays in buildings and bridges (up to 60 uniaxial accelerometers in each array, including one 3-component accelerometer outside the structure whenever possible)

With the above instrumentation, CWB operates the densest network of digital strong-motion instruments in the world.

By November 1999, over 400 records from the Chi-Chi main shock were retrieved from free-field accelerographs. Along the northern end of the surface rupture, very simple waveforms were observed. Large amplitudes were recorded at some stations to the east of the surface ruptures (the hanging wall). With a few exceptions, stations to the west of the surface rupture recorded lower amplitudes. Of the 55 strong-motion arrays (with 30-60 uniaxial accelerometers) in operation in buildings and bridges, 35 of these arrays recorded the mainshock. The free-field strong-motion data from the Chi-Chi main shock was compiled onto a CD by the CWB (Lee et al., 1999). It is the most complete recorded dataset for a major earthquake since strong-motion instruments were first deployed in the 1930s.

continued page 6

During the first week of the Chi-Chi earthquake, 11 aftershocks with local magnitude greater than 6 were recorded; two of these aftershocks had moment magnitudes similar to those recorded during the 1994 Northridge, California, mainshock (M_W=6.7). Aftershocks (down to magnitude 4) were also recorded by many digital accelerographs in free-field sites. As a result, over 10,000 digital 3-component, strong-motion accelerograms were recorded in the 4 weeks after the earthquake.

Originally proposed by Dr. Y.-B. Tsai in 1990, the total cost of this extensive instrumentation program by CWB was about $40 million (U.S.) over a 10-year period and included costs for equipment, installation, maintenance, operation costs, and staff salaries.

To date, the lessons learned from this program are as follows:

- Strong-motion instrumentation is essential to obtain on-scale records for determining relevant seismological parameters, especially for earthquake engineering applications
- A real-time monitoring system based on telemetered accelerographs provided accurate information during the mainshock and aftershocks. The system's success is based its simple design and a redundancy built-in to all its components (Wu et al., 2000)
- Careful planning involving both seismologists and earthquake engineers is necessary to obtain financial funding to achieve the desired goals
- An advisory committee, including international experts, was effective in assisting CWB in planning and implementing this extensive instrumentation program
- Equipment cost was roughly 25% of the total cost over a 10-year period. It is critical that a large portion of available funding be budgeted for maintenance and operation costs
- All instruments must be carefully evaluated and tested prior to purchase

References

Lee, W.H.K. et al. (1989). *Design and Implementation of a PC-based Seismic Data Acquisition, Processing and Analysis System*, IASPEI Software Library, 1:21-46, Seism. Soc. Am., El Cerrito, CA.

Lee, W.H.K. (Ed.) (1994). *Realtime Seismic Data Acquisition and Processing*, IASPEI Software Library, Vol. 1, 285 pp. (2nd ed.), Seism. Soc. Am., El Cerrito, CA.

Lee, W.H.K. et al. (1996). Design and implementation of earthquake early warning systems in Taiwan, *Proc.*, 11th World Conf. Earthq. Eng., Paper No. 2133.

Lee, W.HK. et al. (2000). *CWB Free-Field Strong-Motion Data from the 921 Chi-Chi Earthquake: Vol. 1. Digital Acceleration Data, Technical Report*, Central Weather Bureau, Taipei, Taiwan, in preparation. (Note: A Pre-Publication CD containing the digital acceleration data was released on December 15, 1999).

Shin, T.C. et al. (2000). A preliminary report on the 1999 Chi-Chi (Taiwan) earthquake, *Seism. Res. Letters*, 71(1):24-30.

Wu, Y.M., et al. (1997). Taiwan rapid earthquake information release system, *Seism. Res. Letters*, 68:931-943.

Wu, Y.M. et al. (2000). Performance of the Taiwan Rapid Earthquake Information Release System (RTD) during the 1999 Chi-Chi (Taiwan) earthquake, *Seism. Res. Letters*, 71(3):338-343.

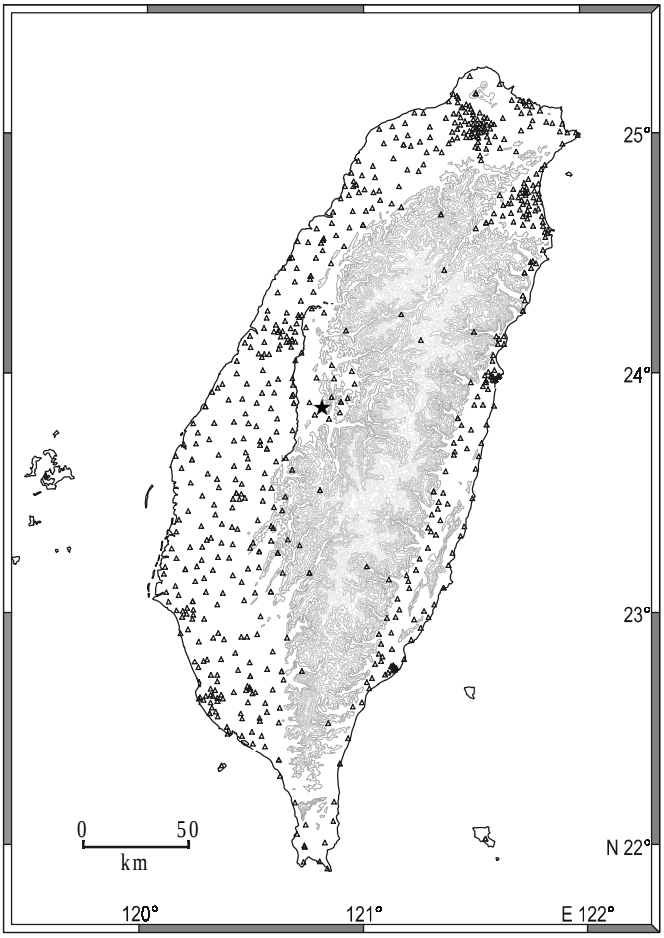

Figure 1. Locations of the CWB free-field, 3-component, digital accelerograph stations.The "star" indicates the location of the main shock. Surface ruptures extending about 80 km north-south are shown to the left of the main shock.

Agenda for Annual General Meeting

W.U. Savage, Secretary

PEER
Richmond, California
15 September 2000
9:30 AM - 2:30 PM

1. President's Report (Bruce A. Bolt)
2. Board Minutes (William U. Savage)
3. Treasurer's Report
4. Executive Director's Report (J. Carl Stepp)
5. Advanced National Seismic System Progress (John R. Filson)
6. Report of Strong-Motion Program Board Activities (Anthony F. Shakal)
7. COSMOS Virtual Data Center (Ralph J. Archuleta)
8. Instrument Installation Guidelines (Robert L. Nigbor)
9. Instrument Standards (W.H.K. Lee)
10. Bridge/Dam Response Workshop, 26-27 October (Bruce A. Bolt)
11. Future Activities
12. Other Business
13. Close

Agenda for Board Meeting

PEER
Richmond, California
15 September 2000
3:00 PM - 5:00 PM

To be Fixed

Below is a list of hotels in the area. All hotels necessitate renting a car; there is no shuttle service to the Richmond Field Station. All hotels have government rates. Please call or email the COSMOS office if you need a map to the Richmond Field Station.

Berkeley Marina Radisson	800/777/7800
4 Points Sheraton Emeryville	510/547-7888
Holiday Inn Emeryville	800/348-8000
Hotel Durant	510/845-8981
Oakland Marriott City Center	510/451-4000

Please RSVP to Claire Johnson (510/231-9436) or email the COSMOS office (cosmos@peer.berkeley.edu) by 8 September 2000 if you plan to attend either the Annual Meeting or the Board Meeting. Also, if you need any help securing accommodations, please call Claire.

Invited Workshop on Instrumental Diagnostics of Seismic Response of Bridges and Dams

B.A. Bolt, President

COSMOS is sponsoring a workshop entitled "Invited Workshop on Instrumental Diagnostics of Seismic Response of Bridges and Dams." This workshop will be held at the Pacific Earthquake Engineering Research Center (PEER), Richmond, California, on 26-27 October 2000.

The main objective of the workshop is to document a technical basis for instrumenting large infrastructure systems, such as major bridges and dams. The premise is that owners and operators of these facilities require information about the benefits of instrumentation for operation, maintenance, and emergency response as input for implementation policies and plans.

The workshop will be organized around (1) invited presentations and (2) focused discussion leading to recommendations. The presentations tentatively scheduled include a description of existing instrumentation programs of large infrastructure facilities, use of instrumentation for evaluating structure and soil/structure demands, and international examples of relevant instrumentation.

Speakers will include M. Celebi (USGS), G. Fenves (UCB), D. Gutierrez (DWR), P. Hipley (Caltrans), K. Kawashima (Tokyo Inst. Tech, Japan), R. Nigbor (USC), A. Shakal (CSMIP), K. Tamura (PWRI, Japan), Y.B. Tsai (NCU, Taiwan), and W. Tseng (ICEC).

Supporting organizations include Caltrans, COSMOS, CSMIP, CUREe, DSOD, Golden Gate Bridge District, PEER, U.S. Army Corps of Engineers, and U.S. Bureau of Reclamation.

If you haven't paid your COSMOS dues for 2000, please remit a check for $50.00 to the COSMOS office: Rm. 121, Bldg. 454, 1301 South 46th St, Richmond, CA 94804, ATTN: Claire Johnson.

Seminar Series to Introduce New Seismic Design Criteria for Steel Moment-Frame Buildings

The SAC Joint Venture will hold a series of 2-day seminars to introduce 4 newly developed sets of recommended seismic design criteria for steel moment-frame buildings. The seminars will be held in September at three separate locations: San Francisco (9/11-12/2000), Los Angeles (9/22-23/2000), and Seattle (9/27-28/2000). For further information, please contact Bernadette Mosby @ 650/595-1542 or visit one of the following websites: www.seaint.org, www.atcouncil.org, or www.curee.org.

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