Claire M. Johnson, Editor

COSMOS Newsletter

No. 23, November 2016

Consortium of Organizations for Strong-Motion Observation Systems

COSMOS AND THE FUTURE OF STRONG-MOTION MONITORING

W. D. Iwan, President

In spite of the noteworthy progress that has been made in earthquake science and engineering, the world continues to experience devastating earthquakes. The most recent earthquakes have had significant impacts on both people and institutions around the globe. Efforts are being undertaken to minimize these impacts through better disaster planning and management, improved construction, and early warning systems. However, these efforts cannot fully succeed without a thorough understanding of the ground motions that are generated by earthquakes.

The Consortium of Strong Motion Observation Systems (COSMOS) is dedicated to achieving this understanding by advocating the establishment of strong-motion measurement systems, promoting development and adoption of verifiable, internationally-ranked standards for the acquisition and processing of earthquake strong-motion measurements, and promoting the global application of strong-motion measurements by design professionals.

Key participants in COSMOS include the major earthquake monitoring and archiving organizations in the United States, and some foreign organizations. COSMOS has developed standards and guidelines for the selection of strong-motion instruments, and procedures for the deployment of instruments and the analysis of strong-motion data. COSMOS also provides leadership in the archiving of strong-motion data and making this data accessible globally. The organization consists of a Board of Directors, a small but effective staff, and a number of member-led committees that are actively involved in supporting the efforts of the organization.

COSMOS has continued to promote the expansion of its international base by expanding its Board of Directors and reaching out to interested organizations worldwide. Board membership has been opened to foreign members and we continue to organize strong-motion forums at significant international conferences. We will work with any organization to provide an open and easily accessible archive of worldwide strong-motion data and to refine the procedures used in the selection and deployment of strong-motion instruments. In that regard, we welcome suggestions from any organization or individual as to how we might expand and improve our cooperation and coordination efforts. We continually work to establish new partnerships with active strong-motion programs throughout the world.

This year, as a result of our strategic planning exercise, we have made some adjustments in the way we interact with our Core member institutions. We are also examining our staff

COSMOS
c/o PEER, Bldg. 454, Rm. 121
1301 South 46th St.
Richmond, CA 94804-4698

Tel: (510) 665-3437
Fax: (510) 665-3456
Email: cosmos@berkeley.edu
Website: http://www.cosmos-eq.org

structure as we look to our future needs. As we move ahead, we believe we are on a solid footing to remain at the cutting edge of ground-motion research and application. As I mentioned last year, I invite all of you to join with us. We would appreciate your comments and suggestions which can be given to any member of the Board of Directors or to our office.

Report from the Director of Engineering Applications

Bob Bachman, S.E.

The 2015 Annual Meeting and Technical Session took place at the Crown Plaza Hotel San Francisco Airport in Burlingame, California, on Friday, November 13th. The COSMOS Annual Meeting took place 12:15 pm and adjourned at 12:45 pm. The Technical Session was developed by Norm Abrahamson and myself, and was co-sponsored by the Pacific Earthquake Engineering Research Center (PEER) and the California Geological Survey (CGS). The primary subject of the 2015 Technical Session was *Current Ground Motion Design Value Maps – Issues and Proposed Solutions*. We had about 100 attendees at the Technical Session, and it was very well received.

This year's Annual Meeting and Technical Session will again be held at the Crown Plaza Hotel San Francisco Airport in Burlingame, California, on Friday, November 18th. The primary subject of the 2016 Technical Session is *Moving Toward Site- Specific Ground Motions*. Details regarding the Technical Session and full program are provided elsewhere in this newsletter. This year's Technical Session is being sponsored by CGS and co-sponsored by PEER and the Applied Technology Council (ATC). In addition, this year we are having enhanced breakfast, lunch, breaks, and cocktail hour sponsored by Lettis, I.C., Sage, Hart-Crowser, RE Bachman Consulting SE and Fugro. We are grateful for the support of all our sponsors.

COSMOS has been moving forward with several activities during the past year including:

1. Developing Consensus-Based International Guideline Requirements for Strong-Motion Data and Associated Meta-Data utilizing the COSMOS Wiki Page and Bulletin Board completed last year.

2. Expand International Participation in COSMOS Activities through the formation of a Joint International Association for Engineering(IAEE)/COSMOS Working Group

3. COSMOS Web-based Converter Tool that assists in converting measured raw ground motion data into graphical data (more information provided elsewhere in this newsletter).

4. COSMOS International Workshop and Guidelines on determining V_{s30} using non-evasive methods (more information provided elsewhere in this newsletter).

5. Becoming the Webhost for the Center for Engineering Strong Motion Data.

If you are interested in learning more or are interested in participating in any of these activities, please feel free to contact me or any of the COSMOS Board of Directors.

2016 COSMOS Technical Session

Bob Bachman, Director of Engineering Applications

The Consortium of Organization for Strong Motion Observation Systems (COSMOS) will be holding its Annual Meeting and Technical Session at the Crowne Plaza Hotel San Francisco Airport in Burlingame, California, on Friday, November 18th. The Crowne Plaza SFO is conveniently located at 1177 Airport Boulevard one block east of the 101 Freeway. The Crowne Plaza has a complimentary shuttle , which runs every 30 minutes)from San Francisco Airport. For those coming by BART, the shuttle stop is located in front of the International Terminal upper level adjacent to the SFO BART Station. The airport shuttle schedule is available on their website. This year's Technical Session is being sponsored by the California Geological Survey (CGS) and co-sponsored by the Pacific Earthquake Engineering Center (PEER) and the Applied Technology

Council (ATC). Registration for the Technical Session will begin at 7:30 am (with a hot breakfast available at that time). The Technical Session will begin promptly at 8:30 am and with a hot lunch break at noon. The COSMOS Annual meeting will start at 12:30 pm and adjourn at 1:00 pm. The Technical Session will then reconvene and end at 5:00 pm. It will then be followed by partially hosted cocktail hour (one drink ticket) with tasty appetizers.

This year's technical session has the theme: *Moving Toward Site-Specific Ground-Motion Hazard*. The morning session will provide presentations on COSMOS/USGS/CGS joint activities, the updated ANSS strategic plan, new available datasets from South America, and PEER, important new changes to ASCE 7-16 requiring more site-specific ground motions and new limitations on their development, and updates on the Project 17 and the PEER PSHA Validation Project. The afternoon presentations will feature presentations on the PEER Directivity Project and recommendations on performing hazard analysis with directivity, integrating ground motion recordings into Site-Specific Amplification functions, use of 3D simulations in developing design ground-motion hazards, and trade-offs between Aleatory and Epistemic Uncertainty. Speakers will include Alan Yong, Hamid Haddadi, Brad Aagard, Ruben Boroschek, Silvia Mazzoni, Charlie Kircher, Ron Hamburger, Christie Hale, Yousef Bozorgnia, Jennifer Donahue, Kioumars Afshari, Christine Goulet, Morgan Moschetti, and Nick Gregor.

This year's technical session was planned by COSMOS' new Technical Session Planning Committee chaired by Christine Goulet. Other members of the planning committee are Nico Luco, Silvia Mazzoni, Nick Gregor, and C.B. Crouse. Norm Abrahamson and Bob Bachman served as advisors to the committee.

Registration fees are $240 for COSMOS, PEER and ATC members and $280 for nonmembers that includes a hot breakfast and lunch, refreshments, and a great cocktail hour with wonderful appetizers and partially hosted bar. There is also a special reduced student rate of $60. This year, attendees will be able to earn 0.6 Continuing Education Credits (CEUs) or 6 Profession Development Hours (PDUs) by attending. Program details for the COSMOS Annual Meeting and Technical Session are available at the COSMOS website at **www.cosmos-eq.org**.

Board of Directors Update and Election

Bob Bachman, Director of Engineering Applications

The election for the COSMOS Board of Director is underway by electronic ballot, which are due by November 14th. The new COSMOS Board of Directors will begin their term office the day before the 2016 Annual Meeting and Technical Session. The 2016 COSMOS Annual Business Meeting will be held in conjunction with the COSMOS Technical Session, which is being held at the Crowne Plaza Hotel San Francisco Airport in Burlingame, California, on Friday, November 18, 2016.

The COSMOS Board of Directors currently consists of 2 core representative members (who are not elected) and 9 members who are elected by the membership including one International Board Member. The newly elected members will have 3-year terms of office. The 9 elected members have staggered terms so that each year no more than four members are elected in any given year. The candidates were chosen by a nominating committee consisting of John Parrish, Marcia McLaren, C.B. Crouse and Bob Bachman (*Ex-Officio*) and the nominations were confirmed by the current COSMOS Board of Directors. The candidates for this year are current Board Members Jon Heintz and Donald Wells, whose terms are expiring. Returning elected board members are Bill Iwan, Bob Nigbor, Marcia McLaren, C.B. Crouse, Alan Yong, Ruben Boroschek, and Jamie Steidl. Returning Core representative Board Members are John Parrish representing CGS and Woody Savage representing USGS.

COSMOS has four officers. These are the President, Vice President, Secretary, and Treasurer. These officers are elected by the Board of Directors. Our current officers are Bill Iwan – President, Jon Heintz – Vice

continued page 3

President, Jamie Steidl – Secretary, and Donald Wells – Treasurer

We welcome your continued support and have greatly appreciated your full participation in these elections.

2016 Bolt Medal Awarded to Roger Borcherdt

W. U. Savage, COSMOS

Roger D. Borcherdt, scientist emeritus at the U.S. Geological Survey and past Shimizu Visiting Professor and consulting professor at Stanford University, is the 2016 recipient of the Bruce A. Bolt Medal. The annual award is presented jointly by the Consortium of Strong Motion Observations Systems (COSMOS), Earthquake Engineering Research Institute (EERI), and the Seismological Society of America (SSA). The Medal recognizes individuals worldwide whose accomplishments involve the promotion and use of strong-motion earthquake data and whose leadership in the transfer of scientific and engineering knowledge into practice or policy has led to improved seismic safety.

Dr. Borcherdt's career is marked with "exceptional scientific contributions in the fields of seismology and engineering seismology, extraordinarily broad in scope," as noted on the Presidential Distinguished Service Award he received in 2010 as the highest honor of the U.S. Department of Interior. His contributions, evident in 200 publications, include pioneering site-response studies resulting in V_{s30} site-response characterization procedures adopted worldwide in building codes and seismic-hazard mitigation maps; theoretical solutions of fundamental wave propagation problems in seismology that extend the mathematical framework for seismology to all linear anelastic media as presented in his graduate-level textbook, *Viscoelastic Waves in* Layered *Media*; "scientific leadership in engineering seismology," as noted on his U.S. Department of Interior Meritorious Service Award (1993); and participation on several building code committees and advisory panels.

Borcherdt is a foremost authority on use of strong-motion data to characterize site response for use in building codes and seismic hazard evaluations. His initial pioneering work provided the first compelling evidence of site resonances on soft soils in the U.S., as published in the Bulletin of the Seismological Society of America in 1970. Subsequent comparative strong ground-motion and shear-wave velocity measurement studies in the San Francisco and Los Angeles regions under his leadership led to his introduction of the now-famous "V_{s30}" as a metric to distinguish site response characteristics of near-surface geologic deposits. His seminal paper on "Estimates of Site-Specific Response Spectra for Use in Earthquake Resistant Design," for which he received an "outstanding Paper Award" from *Earthquake Spectra* in 1994 provided the initial V_{s30} definitions of site classes and corresponding strong-motion site coefficients that were adopted in consultation with many colleagues and applied to building codes that continue to be used throughout the world.

Borcherdt's 2009 graduate textbook, *Viscoelastic Waves in Layered Media*, provides general mathematical solutions for fundamental wave propagation problems in seismology that are valid for any layered media with a linear response, elastic or anelastic, regardless of the amount of intrinsic material absorption. These more general solutions, derived by the author, reveal new physical characteristics of *P*- and *S*-body waves and Rayleigh- and Love-Type surface waves in multi-layered anelastic earth models not predicted by previous theory. These more general solutions were termed at a recent workshop as a stepping stone to a new era in seismology, not only because they explain changes in amplitude, wave speed, and particle-motion characteristics along seismic ray paths that were previously unexplained, but also because they provide exact closed-form theoretical solutions for wave-propagation problems in an infinite number of types of anelastic media. The general solu-

continued page 4

tions provide the basis to improve anelastic wave prediction and inversion models for a variety of problems in engineering, seismology, exploration geophysics, and solid mechanics.

Borcherdt's leadership as chief of various USGS projects and branches at the federal NSF-USGS National Strong-Motion Program resulted in the following accomplishments:

- His coordination of the first USGS multi-disciplinary seismic zonation effort (MF-709), resulting in maps used extensively in required California City and County Seismic Safety Elements and as prototypes for maps required by California Seismic Hazard Mapping Law AB-3897
- His design with colleagues of the first microprocessor controlled wide-dynamic range (180dB) digital strong-motion recording system (GEOS, patent #4,603,486), as a prototype for commercial instrumentation
- Numerous (>30) portable GEOS strong-motion aftershock studies in the U.S., Mexico, Chili, Canada, Armenia, South Africa, and Turkey, yielding new insights on earthquake-source, crustal-structure, and site-response characteristics
- Installation of several permanent strong-motion arrays throughout the U.S., including integrated borehole soil-response arrays in San Francisco and the notable Parkfield, California, GEOS array with its unprecedented high resolution recordings of the 2004 **M**6 earthquake showing no discernible near-field precursory strain or displacement at sensitivities of 10-11 strain and $5x10^{-8}$ meters.

Borcherdt is an honorary member of EERI and has served as editor of Earthquake Spectra, EERI Vice President, and Honors Committee Chair. He is an active member of SSA and charter founding member of COSMOS. He currently chairs the Engineering Criteria Review Board for the San Francisco Bay Conservation and Development Commission and is a past member of several advisory committees, including Federal Emergency Management Agency's Working Group for Development of HAZUS, its Provision Update Committee for NEHRP Recommended Building Code Provisions, and its ATC-58 committee for development of provisions to include advancements in performance based design.

Borcherdt received his B.A. (1963) and M.A. (1965) degrees in theoretical mathematics from Universities of Colorado and Wisconsin, and M.S. (1970) and Ph.D (1971) degrees in engineering geoscience from the University of California, Berkeley.

Dr. Borcherdt received his award at the SSA Annual Meeting in April 2016 in Reno, Nevada.

Update: Site Characterization Project

Alan Yong, USGS

The following are (1) updates and (2) announcements about the activities of the COSMOS International Guidelines for Applying Noninvasive Geophysical Methods to Characterize Seismic Site Conditions Project from the previous year, and (3) a memorial note.

(1) Past events, accomplishments and next steps:

With funding support from COSMOS, PG&E and SCE, the Table of Content (ToC) and leading/contributing authors of each section for the COSMOS Noninvasive Site Characterization Guidelines were established. To acquire acceptance of the ToC and authorship from the community, Guidelines Workshops were held around (or within) the schedules of the 2015 American Geophysical Union (AGU; San Francisco, California USA), 2016 Seismological Society of America (SSA) Annual Meeting (Reno, Nevada USA), and 2016 European Seismic Commission (ESC) 35th General Assembly (Trieste, Italy). In-person attendees range from 7 to 36 participants and remote participants from 12 to 26 during any given Workshop. To foster discourse with the community about the Guidelines effort, the Guidelines Facilitation Committee also convened a series of special sessions entitled *Advances in Noninvasive Approaches to Characterizing Seismic Site Conditions* at both SSA and ESC meetings—the third and final session in this series with the same title is scheduled in

continued page 5

2017 16th World Conference on Earthquake Engineering (WCEE) [see (2.3)] and a coordinated COSMOS Workshop has also been planned (date/time yet to be determined by the WCEE).

At the most recent Workshop (ESC, Trieste, Italy), the range of topics discussed during the open session primarily focused on debate about the intended user(s) of the Guidelines. It was clear that there remain concerns about how the framework of the Guidelines should be designed with respect to the intended user(s) despite the establishment of the ToC (at the 2016 SSA-Reno 23 April Workshop). It was also clear that there was still disagreement with respect to the type of intended users of the Guidelines. The range of users considered in the discussion spans from students (various levels, beginners) to professional practitioners, as well as researchers (experts)—clients of practitioners were also included. Some notable concerns about the unintended use of the Guidelines were also discussed, e.g., exclusive use of the Guidelines in lieu of direct experience, the Guidelines as a Cookbook, and the Guidelines as an unintended measure to deny acceptance of manuscripts submitted for journal-based peer-review processes or similar types of evaluations.

Based on these and earlier discussions, the consensus is that debates about the aforementioned concerns have the potential to continue in perpetuity. Despite the merits of discourse, any further actions that do not directly yield a preliminary collection of products will potentially contribute to the premature termination of the Guidelines Project. In the interest of progress, Committee Chair Alan Yong temporarily delayed addressing the concern about the types of intended users and began developing a collection of modules (with other contributors) that can be subsequently modified to address the information necessary for an agreed upon set of intended users at a later time. The modules are, thus, intended as templates intended to serve as a guide for authors to draft their respective method based sections. The template modules in development describe the Multi-Channel Analysis of Surface Wave Method.

A website (**http://www.cosmos-eq.org/organization/sitecharacterization.html**) for the Guidelines project has been created and information are expected to be updated.

With regret, Oz Yilmaz has voluntarily withdrawn his participation (personal decision) as a co-representative of Turkey—Aysegul Askan, however, remains as the representative of Turkey. In July, Hiroshi Kawase and Rubén Boroschek accepted the Project's invitations to join the Committee as representatives of Japan and South America, respectively. A brief dedicated note about the passing of Committee Member Marco Mucciarelli, representative for Italy, is given at the end (3) of this article.

(2) Upcoming COSMOS Guidelines Project related events:

(2.1) 2016 COSMOS Annual Technical Session: Moving Toward Site-specific Ground-motion Hazards: *COSMOS Site Characterization Guidelines* (INVITED) by Alan Yong and the COSMOS Guidelines Facilitation Committee

(**http://www.cosmos-eq.org/organization/sitecharacterization.html**)

Date: 18 November 2016
Time: 8:30 am to 6:00 pm
Location: Crowne Plaza Hotel San Francisco Airport, Burlingame, California

(2.2) 2016 American Geophysical Union: Capturing the Complexity of Site Amplification II (S43E): A progress report on the development of the COSMOS International Guidelines for Applying Noninvasive Geophysical Techniques to Characterize Seismic Site Conditions (INVITED, S43E-05) by Alan Yong and the COSMOS Guidelines Facilitation Committee

Date: 15 December 2016
Time: 2:45 pm-3:05 pm
Location: Moscone South, 307, San Francisco, California

(2.3) 2017 16th World Conference on Earthquake Engineering (WCEE): *Advances in Noninvasive Approaches to Characterizing Seismic Site Conditions*

continued page 6

(107SS in **http://www.16wcee.com/index.php/scientificarea/special-sessions.html**)

Date: TBA
Time: TBA
Location: TBA

Fifteen abstracts (8 invited and 7 contributed) were approved for our 16th WCEE special session (see link above), which is the final conference-related special session in a series of similar sessions relating to our COSMOS Guidelines Project as convened at the recent 2016 SSA (**https://www.seismosoc.org/meetings/ssa2016/sessions/**) and 2016 ESC-GA (**http://meetingorganizer.copernicus.org/esc2016/sessionprogramme**) sessions. As at the previous meeting/assembly, a follow-up COSMOS Workshop, focused on furthering the progress on the development of the Guidelines document, is planned. At this time, the date and location of this coordinated COSMOS-WCEE Workshop are under development with Rubén Boroschek, COSMOS Facilitation Committee Member and WCEE Scientific Committee Co-chair.

(2.4) 2017 Seismological Society of America (SSA) Annual Meeting: Geophysical Applications in Integrated Site Characterization

This SSA special session was recently proposed to the SSA local organizing committee on 30 September 2016 by COSMOS Guidelines Participants Jamey Turner and Daniel O'Connell as:

Geophysical surveys are essential for characterizing seismic and variable subsurface site conditions beneath critical high-hazard aging structures, such as levees and embankment dams, along linear alignments for pipelines, and over large foundation footprints of LNG facilities and nuclear facilities. This session encompasses the broad range of geophysical approaches used to achieve site characterization objectives. Topics of interest include, but are not limited to: HVSR, SPAC, SASW, MAM, MASW, IMASW, ReMi, down hole and cross hole seismic, etc; as applied to seismic site characterization, to estimate seismic velocities, site responses, structural responses, soil-structure interactions, fault characterization, marine paleoseismology, IBC Site Class, liquefaction susceptibility, and identifying voids associated with karsting and mining. Advances in passive and active seismic sourcing and acquisition approaches are of interest. Also invited are updates on the Consortium of Organizations of Strong Motion Observation Systems (COSMOS) and the Development of the International Guidelines for the Application of Noninvasive Geophysical Techniques to Characterize Seismic Site Conditions. Discussion of the challenges of meeting end-user expectations and objectives is encouraged.

(3) Memorial:

Lastly, it is with much sadness to report that Marco Mucciarelli passed on 7 November. Marco was not only a key contributor to our current efforts—he was a reliable colleague, and of all, a good friend. He will truly be missed. On behalf of the COSMOS community, our deepest condolences are sent forth to his wife Maria and family. Please find the INGV link memorializing Marco: **https://ingvterremoti.wordpress.com/2016/11/07/vogliamo-ricordare-marco-mucciarelli-sismologo-e-divulgatore-appassionato/**

continued page 6

Board of Directors

President: W. D. Iwan*
Vice-President: Jon Heintz
Secretary: Jamison Steidl
Treasurer: Donald Wells
Ruben Boroschek
C.B. Crouse
Marcia McLaren
Robert L. Nigbor
John Parrish
W. U. Savage
Alan Yong

*Chair of General Membership

Director of Engineering Applications: Robert E. Bachman

COSMOS
Bldg. 454, Rm. 121
1301 South 46th Street
Richmond, CA 94804-4698
Tel: 1-510-665-3437
Fax: 1-510-665-3456
Email: cosmos@berkeley.edu
http://www.cosmos-eq.org