

2010 TECHNICAL PROGRAM

Program

In conjunction with the meeting theme of the **2010 Annual Meeting**, “*Appalachians to the Atlantic...Landslides, Earthquakes and Hurricanes, Oh My!*,” the technical program will focus on a variety of landslides, seismic, coastal and other hazards, as well as classic engineering geology, environmental geology, and groundwater topics. The 2010 Annual Meeting Planning Committee has technical sessions, special symposia, short courses, and a teachers’ workshop that we believe will provide an outstanding opportunity for geologists and other professionals to share in the state-of-the-art and practices.

The Planning Committee hopes the 2010 Annual Meeting will be remembered as another of the outstanding meetings for which the Association of Environmental & Engineering Geologists is known.

Full meeting activities will begin at 8:30am Wednesday morning, September 22, 2010 in the Carolina Ballroom with the Welcoming Session, our Keynote Speakers, Kenneth Taylor and Jon Boettcher, and a Plenary Session talk on the 1886 Charleston Earthquake by Pradeep Talwani.

The presentation of AEG's *Outstanding Environmental & Engineering Geologic Project Award* by AEG President Duane Kreuger will be presented on Thursday morning, September 23, 2010. After the presentation of the *Outstanding Environmental & Engineering Geologic Project Award*, the 2010 Richard H. Jahns Distinguished Lecturer in Engineering Geology Award Recipient, Paul Marinos, will present his lecture.

Technical Program sponsors:

- Opening Session on Wednesday, September 23 is sponsored by Gannett Fleming
- Afternoon Session on Wednesday, September 23 is sponsored by the AEG Intermountain Section
- Morning Session on Thursday, September 24 is sponsored by ExoTech
- Technical Session Breaks are sponsored by Charles W. Welby, Parratt-Wolff, Inc, ENCO Labs, Enviro-Equipment Inc, Environmental Test Products, major Drilling, QROS, AEG St. Louis Section, A&D Environmental
- The annual meeting’s registration giveaways are sponsored by Zonge Geosciences (Beer Glass) and AEG KC/Ohio Section (Aluminum Water Bottle). Other registration packet giveaways are sponsored by Rite-in-the-Rain Notebooks (J.L. Darling Corporation), MINERS Incorporated, and Beta Analytic.

A Speakers’ Preparation Room (Rutledge) will be open from 7:00am to 5:00pm on September 21 through 23 (Tuesday through Thursday) and from 7:00am to 2:00pm on September 24. A computer will be provided so that you may practice your PowerPoint presentation.

AEG provides an open forum for the presentation of varying opinions and positions. However, opinions expressed by speakers do not necessarily represent the views or policies of AEG.

OPENING SESSION – WEDNESDAY, SEPTEMBER 22, 2010

Kenneth B. Taylor, PhD, PG, will be the first Keynote Speaker for the 2010 annual meeting.

Dr. Taylor has over 15 years experience in state government as an emergency manager and geologist with extensive experience in emergency planning & disaster response, hazard mitigation, risk assessment, loss estimation and geohazard analysis. He graduated with a B.S. in geology from University of North Carolina at Chapel Hill in 1979, a M.S. in geology from the University of South Carolina in 1981 and a Ph.D. in geophysics and seismology from Saint Louis University in Saint Louis, Missouri in 1991. Dr. Taylor was the 1991-1992 Geological Society of America Congressional Science Fellow where he served as a professional staff member in the U.S. Senate. He is currently the Assistant State Geologist and Chief of the N.C. Geological Survey in the N.C. Department of Environment and Natural Resources (NCDENR).

He has authored more than 50 abstracts, reports and professional papers and serves as the senior technical specialist/advisor to the North Carolina State Emergency Response Team on earthquakes. Since 2003, he has been a Commissioner on the State Emergency Response Commission (SERC) which oversees the allocation of U.S. Department of Homeland Security funding in the state. During disasters, he is the NCDENR Disaster Response and Recovery Coordinator.

He will speak about the need for geoscientists to assist local and state governments in the planning, response and mitigation of disasters.

Abstract:
Geohazards and a Proposed Role for Private, Academic and Government Geoscientists

Storm surge, landslides, earthquakes and sinkholes, these are but a few of the natural geologic hazards. Local, state and national emergency managers are starved for intelligence every time a disaster strikes. This next year, the U.S. Department of Homeland Security's National Scale Exercise (NSE), previously called TOPOFF [for top officials] will utilize a New Madrid earthquake scenario. Geoscientists from both public and private sectors have worked with emergency management planners to prepare for the response. The scale of the exercise is immense with the participation of three FEMA Regions, seven states and hundreds of county governments. There will be significant structural damage, aftershocks and liquefaction of river banks.

The United States Geological Survey is completing their plans to provide technical specialists to FEMA but the states and local governments need their own expertise. Engineers in the region are already organized to provide post earthquake safety inspections of buildings, but consider a state dam safety program with dozens of dams to inspect to make sure "all is well" or "there is an immediate danger." All will be needed and all can help in some way. The planning must start now. If interested contact state emergency management or local emergency management to volunteer your talents. State and

local EMA are interested in working with associations rather than individuals, since the organizations vet the personnel with identification, credentialing, training, equipping and exercising.

Dr. Pradeep Talwani will be the Plenary Session Speaker for the 2010 Annual Meeting.

Pradeep Talwani, who has been studying the Charleston earthquakes for more than three decades, is a Distinguished Professor Emeritus of Geophysics in the Department of Earth and Ocean Sciences, University of South Carolina (USC). He earned his M.Sc. in Applied Geophysics at the Indian School of Mines, in 1962, and M.S. and Ph.D. in Geophysics from Stanford University in 1971, and 1973 respectively. He was the Director of the South Carolina Seismic Network from its inception to his retirement in 2009. He worked in oil exploration in India from 1962 to 1968, and has been at USC since 1973. His current and past research activities include the study of prehistoric and current seismic activity and seismic hazard analysis in South Carolina; the 1886 Charleston earthquake—its history, causes, mechanisms, seismotectonics, the works! His other research interests include the study of intraplate earthquakes; reservoir induced seismicity, fluid pressure flow in fractures, the study of paleoliquefaction features to obtain the recurrence time of prehistoric earthquakes, and the measurement of geodetic strain in the Charleston area. Together with his students, he has given more than 400 technical talks and published more than 100 research papers. Among his professional honors are being elected as a Fellow of the Geological Society of America, the Seismological Society of America's Eastern Section JSA Award for Contributions to Observational Seismology, and the 2008 Richard Russell Research Award for Science, Mathematics and Engineering, the highest research award given at USC. His current and past professional affiliations include the American Geophysical Union, Seismological Society of America, Earthquake Engineering Research Institute, Geological Society of America, and the United States Committee on Large Dams, among others.

Abstract:

The Charleston Earthquakes--Then and Now.

The most destructive earthquake in Eastern United States, with an estimated magnitude of 7.3, struck Charleston on August 31, 1886. The Charleston region continues to be seismically active and a recurrence of a similar earthquake there drives the assessment of seismic hazards in the region. In my talk I will trace the earliest studies that followed this earthquake in the 1880s, to our current understanding of the seismotectonics of the region. These include multi-disciplinary studies to obtain the seismotectonic framework responsible for the observed seismicity, estimates of the recurrence rates for large earthquakes obtained from a study of paleoliquefaction features in the South Carolina Coastal Plain, insights of maximum magnitudes obtained from an analyses of in situ geotechnical data, and geodetic strain rates obtained from repeat GPS observations.

AEG's
Outstanding Environmental & Engineering Geologic Project

The Association of Environmental & Engineering Geologists is pleased to recognize the **George Washington Memorial Parkway, Arlington, Virginia: Innovative Rock Slope Stabilization** as the 2010 AEG *Outstanding Environmental and Engineering Geologic Project*.

INTRODUCTION

An innovative rock slope stabilization design along the George Washington Memorial Parkway (GW Parkway) provided a cost-effective way to achieve the client's and owner's dual objective – protect the traveling public from rockfall while preserving the aesthetics of this scenic federal highway. The project resulted in a truly innovative approach to rock slope stabilization with a promising future.

National Significance of the Project

The natural beauty of the parkway is an extremely important cultural resource, and maintaining the aesthetics of the landscape along the highway is a major priority for the Eastern Federal Lands Highway Division (EFLHD) and the National Park Service (NPS). A desirable slope stabilization design would mitigate the rockfall hazard using methods and hardware that would minimize the visual impact to the existing slope. Given that traditional rock slope stabilization elements, such as slope layback, rockfall netting, rock anchors and rockfall control barriers, dramatically alter the visual appearance of rock slopes, an innovative solution was needed to achieve project performance objectives.

In 2002, the failure of a 35-ft high, 240-ft long rock cut slope along the GW Parkway in Arlington, Virginia, released several large rock blocks onto the shoulder and into the travel lanes. The rockfall damaged curb and pavement sections and disrupted busy commuter traffic. The Federal Highway Administration (FHWA) and EFLHD contracted with Schnabel Engineering (Schnabel) to provide geotechnical and geostructural engineering design services to:

- investigate the cause of the 2002 slope failure;
- assess the future rockfall hazard potential of the entire slope;
- develop conceptual slope stabilization design alternatives and comparative cost estimates; and
- prepare final design plans and specifications for the selected concept design.

Rock Gluing: An Innovative Application of an Existing Technique

Schnabel extended the use of an existing technique, polyurethane resin grouting, to highway rock slope stabilization. Schnabel's innovation helped EFLHD and NPS achieve their goal of improving slope stability while preserving the highway landscape.

At the start of the project, a new technique for rock slope stabilization, called rock gluing, was just starting to be investigated by FHWA Central Federal Lands Highway

Division (CFLHD). Rock gluing is the method of injecting polyurethane resin (PUR) grout into a rock mass to bond individual blocks into a bigger, more stable, continuous mass. The PUR "rock glue" is injected under pressure and forced into rock mass discontinuities where it hardens and adheres to the rock. The hardened glue increases the shear strength of the discontinuities and thereby reduces the risk of sliding along those discontinuities. The excess rock glue that reaches the surface of the slope can be cleaned off leaving little trace. The result is a natural-looking rock slope in which the structural integrity and slope stability of the rock mass is improved internally with little surface expression.

PUR grouting has been used for tunneling, mining and dam projects since the 1960s, primarily to control water seepage into underground spaces and to stabilize tunnel crowns; however, rock gluing for above-ground rock slope stabilization for highway projects is new. The technique was used successfully in 2005 and 2006 by CFLHD on two test projects aimed at better understanding the applicability of rock gluing for highway slopes. However, there were no design standards upon which to base our design.

Schnabel applied the rock gluing technique to the GW Parkway Project based on the results of the CFLHD test projects. However, it was the first designed use of the rock gluing technique after the two test studies; and the first ever use by EFLHD. The major innovation for this project is that Schnabel developed a new method to quantify slope stability improvements providing a basis for design where none existed before. This allowed Schnabel to use rock gluing as the primary method of mechanical stabilization in lieu of traditional slope stabilization hardware, such as patterned rock anchors and rock netting, which would have dramatically altered the natural slope aesthetics.

Rock Gluing Design and Construction

Schnabel personnel collected geologic rock structure mapping data in the field, and used the data to perform kinematic and limit equilibrium slope stability analyses to evaluate and characterize the rock slope hazards as a basis for developing the mitigation design concepts. Two concept alternatives with engineering cost estimates were developed comparing a traditional mitigation design involving patterned rock anchors with a rock gluing solution. Both design concepts included initial scaling to remove the most critically unstable rock blocks and installation of drains within the rock mass to relieve potential groundwater uplift pressures that would contribute to slope failure. The difference between the two concept designs is the use of either rock anchors or rock glue as the primary reinforcement mechanism.

The glue injection holes were spaced 10 ft apart on center (vertical and horizontal) and were drilled 15 ft deep behind the rock face. The spacing and depth were determined based on the character and spacing of rock mass discontinuities, and expected rockfall block size.

To analyze the effectiveness of rock glue for slope stabilization, Schnabel Engineering calculated the total resisting force (i.e., sum of tensile and cohesive strength contributed by the rock glue) required to raise the factor of safety (FS) above 1.5. It was assumed that the rock glue would effectively cover at least 50% of discontinuity and tension crack surfaces in the rock mass. The results indicate that a minimum grout tensile strength and cohesion value of 5 psi and 6 psi, respectively, are required to obtain a FS of 1.5 for the potential planar sliding and toppling conditions. These strength values are easily achieved since tensile strength and cohesion for PUR grout reported by the manufacturer vary from 150 psi to 5,000 psi.

The rock gluing solution has two distinct advantages over the rock anchor design. First, the anchor design does not support the rock mass at the surface of the slope between the anchors, whereas it is expected that the rock glue would improve the entire slope face. Therefore, there would be a greater potential for localized rockfall and raveling between anchors than there would be for a slope treated with rock glue. Second, the rock anchor plates can not be easily hidden without additional work to hide them.

The rock gluing solution was chosen by EFLHD and NPS as a cost-effective way to increase the stability of the slope while preserving slope aesthetics. Schnabel's cost estimates showed that rock gluing would be only slightly more expensive than rock anchoring. Schnabel prepared design plans and specifications that were used for construction.

Future Value

The value of using the rock gluing technique for the GW Parkway rock slope stabilization project extends well beyond the immediate and local benefits of protecting the traveling public from rockfall at the project site. The future value to the engineering geology profession stems from the new analytical method Schnabel developed and the experience with success gained on the project. This new approach provides a basis for design in the rock gluing technique. This groundbreaking approach can be used for other projects. In fact, EFLHD has already used rock gluing as a practical solution for three such projects, and is actively looking for future opportunities to implement the new technique. For these reasons, this project represents a significant advancement for the engineering geology profession, and promotes a positive public image of engineering geology.

Social, Economic, and Sustainable Design Considerations

The travelling public benefits from the results of this project every day in multiple ways. Commuters and tourists alike rely on the GW Parkway as a main transportation route through the region. Many people use the GW Parkway daily for their commute to and from work. These drivers and passengers

expect to be safe from slope failures and rockfall. They also value the natural appearance of this scenic federal highway and expect it to be maintained. The innovative use of the rock gluing technique provided a cost-effective way to sustain the natural aesthetic of the highway without requiring the use of unattractive rock slope stabilization hardware as the main component in the design.

**The 2010 GSA/AEG Richard H. Jahns
Distinguished Lecturer in
Engineering Geology**

The Richard H. Jahns Distinguished Lecturer in Engineering Geology Award was established in 1988 by the Association of Environmental & Engineering Geologists in co-sponsorship with the Engineering Geology Division of the Geological Society of America. The purpose is to provide funding annually for a distinguished engineering geologist to present a lecture at a number of academic institutions to increase awareness of students about careers in engineering geology. The Distinguished Lectureship is named in honor of Dr. Richard H. Jahns (1915-1983), an engineering geologist who had a diverse and distinguished career in academia, consulting, and government.

Dr. Paul Marinos has been named the 2010 Jahns Distinguished Lecturer in Engineering Geology. Dr. Paul Marinos received a Mining Engineering degree from the School of Mines of the National Technical University of Athens, Greece in 1966, a postgraduate degree in Applied Geology from the University of Grenoble, France, and his Doctorate in Engineering Geology from the same University in 1969. He worked for French and Greek design and construction companies until 1977 and then was elected as Professor at Democritus University in Northern Greece. Since 1988 Dr. Marinos has been Professor of Engineering Geology in the School of Civil Engineering in the National Technical University of Athens and has served as head of the Geotechnical Section of the School for several years. From 2001 to 2004 and from 2006 to 2008 he was the Director of a Graduate Course in Tunneling and Underground Construction. He was a visiting Professor in the Geology Department of the University of Grenoble (1987) and of the School of Mines in Paris (2003).

Dr. Marinos is a member of AEG and GSA and fellow of the Geological Society of London. He is a past President of the International Association of Engineering Geology and the Environment (IAEG), immediate past president of the Geological Society of Greece and honorary member of the International Association of Hydrogeologists (IAH).

Dr. Paul Marinos has received several awards, including the Hans Cloos medal of IAEG, and the Andre Dumont medal of the Geological Society of Belgium. He was selected for the presentation of named lectures, including the 6th Glossop Lecture in London (2002), the 19th Rocha Lecture in Lisbon (2002), the 33rd Cross Canada Lectures Tour (2005), and the Rock Mechanics annual Lecture in Madrid (2006).

Dr. Marinos and his team conduct research on a variety of applications of geology to engineering, mainly rock mass characterization, weak rock properties and behavior, with special emphasis to tunnel design. His work also covers landslides, dam geology, and engineering in karstic terrain. His other significant interest is the protection of historic monuments and archeological sites. Dr. Marinos has authored or co-authored over 300 papers in journals or major conference proceedings. He was a key or invited lecturer in more than 40 conferences or special events. He has given lectures to University Courses or Workshops, among them the Federal Technical University (EPFL) in Lausanne, Switzerland, the Polytechnico of Turin, Italy, the University of Durham, U.K., the University of Coimbra, Portugal, the University of Kobe, Japan, the Black Sea University Romania, the Aristotle University of Thessalonica, Greece, and the Griffiths University, Australia. He has edited proceedings published by international publishers. Dr Marinos is a member of the Editorial Board of a number of prominent journals as "Engineering Geology", "Bulletin of the International Association of Geology", "Landslides", "Environmental Geology", "Rock Mechanics" and from 2009 "Environmental and Engineering Geosciences".

Dr. Paul Marinos has extensive industrial experience having served as consultant, independent reviewer and member of consulting boards or panel of experts on major civil engineering projects in Greece, France, India, Iran, Jordan, Morocco, Portugal, Saudi Arabia, South East Asia, Spain, Sweden, and Turkey.