» TUESDAY, MAY 8, 2018

21ST ANNUAL SOWERS SYMPOSIUM

Georgia Tech

A CONTINUING TRIBUTE

For 50 years, Professor Emeritus George F. Sowers served a unique and dual role as a faculty member at the Georgia Institute of Technology and as a senior consultant at Law Engineering, Inc. (the predecessor to MACTEC, Inc. and Amec Foster Wheeler). A civil engineer and geologist, he consulted worldwide on substantial civil projects in the United States and Europe, large earth- and rock-fill dam construction in Asia, and deep permafrost conditions in northern Greenland. Truly, he was "world class." A master of anecdotes, his vivid recollection of case studies and his elegant approach to engineering captivated students and professionals alike. His Terzaghi Lecture at the 1979 annual convention of the American Society of Civil Engineers (ASCE) was "There Were Giants on the Earth in Those Days," and it brought to life stories of ancient earthwork and massive construction projects completed several thousand years ago by native Americans.

Professor Sowers was active in numerous professional societies at the local, national and international level. He held offices in several of these groups, including ASCE, the International Society for Soil Mechanics and Foundation Engineering (ISSMFE), the American Society for Testing and Materials (ASTM), the U.S. Committee on Large Dams, the Seismological Society of America, and the Association of Engineering Geologists.

He was the author and co-author of eight books, including the classic textbook *Introductory Soil Mechanics and Foundations: Geotechnical Engineering*, which enjoyed four English editions as well as versions in Spanish and Mandarin Chinese. His last book, *Building on Sinkholes: Design and Construction of Foundations in Karst Terrain*, was published in 1996 by ASCE. Professor Sowers authored more than 140 technical papers and received many prestigious awards, including the Georgia Tech Teacher of the Year award (1971), the Georgia Society of Professional Engineers Engineer of the Year award (1973), the Herschel Prize from the Boston Society of Civil Engineers (1976), the Middlebrooks Award (1977 and 1994), the ASCE Martin Kapp Lecture (1985), the ASCE Brooks Award (1990), the ASCE Forensic Engineer of the Year award (1994), and the Terzaghi Award (1995). In 1994, Professor Sowers was elected to the National Academy of Engineering.

SOWERS IN INDONESIA, 1986. PHOTOS COURTESY MRS. GEORGE F. SOWERS AND LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

AGENDA

2:45 PM
Arrival and Registration

3:30 PM
State of the Art
Mature Fine Tailings: Observations on the Behavior of a Unique Geomaterial
Marika Santagata, Ph.D.
Associate Professor of Civil Engineering
Purdue University
West Lafayette, Indiana

4:15 PM
State of the Practice
Geosynthetic-Stabilized Roads: From Mechanisms to Design
Jie Han, Ph.D., P.E., F.ASCE
Glenn L. Parker Professor of Geotechnical Engineering
The University of Kansas
Lawrence, Kansas

5 PM
Reception and Exhibits

6 PM
Dinner

7 PM
Acknowledgments and Awards

7:20 PM
Remembering George F. Sowers
Tom Billings
U.S. Army Corps of Engineers, Retired
Atlanta, Georgia

7:40 PM
Sowers Lecture
Performance-Based Design in Geotechnics
Malcolm Bolton, Ph.D., FREng
Emeritus Professor
University of Cambridge
Cambridge, United Kingdom

8:40 PM
Adjourn

GEORGE F. SOWERS, PORT OF SAVANNAH FIELD TRIP

G-I ASCE GEO-INSTITUTE Georgia Chapter

Georgia Tech School of Civil and Environmental Engineering
College of Engineering

STATE OF THE ART

Mature Fine Tailings: Observations on the Behavior of a Unique Geomaterial Estimated at a total of ~10^9 m^3, the accumulation of mature fine tailings (MFTs) in tailing ponds is one of the key challenges facing the oil sands industry. MFTs are soft, gel-like materials with intrinsically low hydraulic conductivity, low shear strength, and exceptionally slow consolidation rates that greatly limit their reclamation. These materials "trap" large amounts of process water, some residual bitumen, process chemicals, and in some cases, a gas phase deriving from bacterial activity — resulting in a chemically and mechanically complex and highly variable geomaterial. The ultrafine fraction formed by sub-micron clay particles dispersed during bitumen extraction plays a critical role in governing the colloidal properties and thus the management of the MFTs. Mineralogy and surface chemistry of the clay fraction (as well as pore fluid chemistry and the organics present) also control the effectiveness of high molecular weight anionic polymers used for dewatering MFTs.

The lecture will discuss some of the approaches used for the laboratory characterization of these materials and present findings of a recent investigation of untreated and polymer-treated MFTs, highlighting the unique nature of the geomaterial created as a result of the treatment and the link between molecular and particle level interactions and expected large-scale performance.

Marika Santagata is an associate professor in the School of Civil Engineering at Purdue University. She holds a Laurea in Ingegneria Civile from the University of Ancona in Italy, and M.S. and Ph.D. degrees in civil and environmental engineering from MIT. Her research interests and contributions are founded on fundamental studies of the behavior of a broad range of soils and of their interaction with other materials, relying on experimental investigations that probe the materials of interest at different scales. Recent research efforts have focused on earthquake induced soil liquefaction, rheology and microstructure of clay dispersions, mineral surface-water interactions in clay minerals, behavior and improvement of soils with high organic content, stress-strain-strength response of sensitive carbonatic clays, and use of high molecular weight polymeric flocculants to treat mature fine tailings.

Santagata routinely teaches the introductory geotechnical engineering course and graduate courses devoted to the fundamentals of soil behavior and geotechnical testing. She is past chair and a current member of the Committee on Soil Properties and Modeling of the Geo-Institute of ASCE, and serves on the G-I's Awards Committee. She served as an associate editor for ASCE's *Journal of Geotechnical and Geoenvironmental Engineering* between 2005 and 2013.

She received a National Science Foundation CAREER grant in 2007. Her work at Purdue has been recognized with the Outstanding Graduate Student Mentor Award in Civil Engineering, two Chi Epsilon Edmund M. Burke Outstanding Professor Awards, Roy E. & Myrna G. Wansik Excellence in Research and Teaching Awards, the Ross Judson Buck '07 Memorial Award for Undergraduate Counseling, and the Harold Munson Award for Outstanding Teacher in the School of Civil Engineering. Santagata is a registered professional engineer in Italy.

MARIKA SANTAGATA, PH.D.

ASSOCIATE PROFESSOR OF CIVIL ENGINEERING

PURDUE UNIVERSITY

WEST LAFAYETTE, INDIANA

STATE OF THE PRACTICE

Geosynthetic-Stabilized Roads: From Mechanisms to Design In the late 1970s, significant research and applications of geosynthetics for roads followed major developments of geosynthetic products — geotextile, geogrid, and geocell — and established the geosynthetics discipline. Since then, new geosynthetic products have periodically been introduced into the market. Many researchers have investigated possible mechanisms that govern the performance of roads incorporating different geosynthetics and several design methods have been developed. Years of research and application have led to a better understanding of the governing mechanisms involving geosynthetics in roads and, as a result, the existing design methods have improved and new design methods have been proposed.

This lecture will illustrate the differences and relationships between mechanical stabilization and reinforcement by woven geotextile, geogrid, and geocell and highlight the benefits of hydraulic stabilization of roads by wicking geotextile to remove moisture from soil. Experimental and theoretical results will be presented to demonstrate how the mechanisms govern the performance of geosynthetic-stabilized roads and how the geosynthetics improve their performance. This lecture will also present the development of design methods for geosynthetic-stabilized roads, considering the governing mechanisms for their applications and performance. A couple of case studies also will be presented to demonstrate the use of geosynthetics to stabilize roads in real projects.

Jie Han is the Glenn L. Parker Professor of Geotechnical Engineering in the Civil, Environmental, and Architectural Engineering Department at the University of Kansas. He received his Ph.D. degree in civil engineering from Georgia Tech in 1997. He has accumulated extensive teaching, research, and practical experience in geotechnical and pavement engineering, mostly focused on geosynthetics, ground improvement, pile foundations, buried structures, and roadways. Han is the sole author of the Wiley-published book *Principles and Practice of Ground Improvement* and has published more than 300 peer-reviewed journal and conference papers.

Han serves as chair of the Geo-Institute of ASCE's Soil Improvement Committee and is an associate editor for the ASCE *Journal of Geotechnical and Geoenvironmental Engineering* and the ASCE *Journal of Materials in Civil Engineering*. He is an editorial board member for eight international journals and served as technical co-chair for the GeoShanghai International Conference in 2006 and the ASCE/IFAI GeoFrontiers Conference in 2011. Han has delivered international keynote lectures and offered short courses. His numerous awards include two U.S. Transportation Research Board Best Paper Awards, the Shamsher Prakash Prize for Excellence in Practice of Geotechnical Engineering, the International Geosynthetics Society Award, and the ASCE Martin S. Kapp Foundation Engineering Award.

JIE HAN, PH.D., P.E., F.ASCE

GLENN L. PARKER PROFESSOR OF GEOTECHNICAL ENGINEERING

THE UNIVERSITY OF KANSAS

LAWRENCE, KANSAS

SOWERS LECTURE

Performance-Based Design in Geotechnics Engineering design should consist of a sequence of decisions that lead to the creation of an artifact — a geo-structure in this case — that satisfies the client's performance requirements. This lecture argues that any assessment of geotechnical performance must involve two considerations: the risk of collapse (Ultimate Limit State, or ULS) under adverse but foreseeable conditions, and the inevitability of ground displacements that may threaten the serviceability of the facility concerned (Serviceability Limit State). Whether in LSD Eurocodes or North American LRFD codes, the traditional approach of specifying safety factors on soil strength begs the question of which strength to measure — peak or ultimate — and it fails to recognize that both structural unserviceability and structural failure may well precede soil failure. Furthermore, present day textbooks and codes often fail to emphasize that non-linearity of both strength and stiffness is inherent to soil behavior, and also fail to point out that practical non-linear alternatives are readily available. These propositions will be examined in relation to centrifuge modeling of four applications: the seasonal creep and ultimate failure of clay slopes, the ultimate vertical bearing capacity of sands, the non-linear deformability of all clays at moderate strains, and the consequentially non-linear load-settlement behavior of spread foundations on clay. It will be deduced that:

- Most slopes should be designed using the critical state angle of friction, not the peak strength;
- Most foundations should be designed against ULS with a non-linear peak strength envelope;
- Undrained clays in triaxial tests should be expected to show a power-law for stress-strain;
- The design of spread foundations on clay should focus first on undrained embedment, and then on the likelihood of undrained creep, before allowing for consolidation settlement and drained creep.

The lecture will therefore call into question the use of arbitrary safety factors, the linear Mohr-Coulomb envelope with parameters c' and φ', the use of oedometer data rather than triaxial data as the basis of settlement predictions, and the assumption that ULS in foundation engineering corresponds to soil failure.

Malcolm Bolton graduated from Cambridge University in 1967 and earned an MSc in structural engineering before switching to geotechnics and taking up centrifuge testing. He returned to Cambridge in 1980 and is now emeritus professor, having served as a professor of soil mechanics, Director of the Schofield Centre for Geotechnical and Construction Modelling, and Head of the Geotechnical and Environmental Group prior to his 2013 retirement. He is a Fellow of the Royal Academy of Engineering and holds various awards from the U.K. Institutions of Civil and Structural Engineering, the British Geotechnical Association and the Canadian Geotechnical Society. Bolton was founding chairman of the International Society for Soil Mechanics Technical Committee on Geo-Mechanics from Micro to Macro. He has collaborated on piles with GIKEN, LTD for 24 years, and is the founding chairman of the International Press-In Association. He has served on the Slope Stability Technical Review Board for the Hong Kong Government, helped draft *BS-8002 Earth Retaining Structures*, and hopes to see fundamental improvements made to Eurocode 7 (which has subsumed it). He has 250 publications on topics ranging from fundamental soil mechanics to a wide variety of geotechnical engineering applications.

MALCOLM BOLTON, PH.D., FRENG

EMERITUS PROFESSOR

UNIVERSITY OF CAMBRIDGE

CAMBRIDGE, UNITED KINGDOM

OUR HISTORY

The Georgia Geo-Institute Chapter of the American Society of Civil Engineers owes its very existence to George Sowers. Beginning in the mid 1950s, a small group of local geotechnical engineers met to have dinner and talk about current geotechnical engineering activities. The group was chaired by then-professor George Sowers and would meet two or three times a year. Some notables of the six to 10 engineers who typically attended these fledgling geotechnical committee meetings were Clyde Kennedy from Law Engineering, Bob Crisp of the Army Corps of Engineers, and various engineers from the Georgia Highway Department. During the mid to late 1960s, the meetings became less frequent and eventually faded away.

In 1978, Professor Sowers encouraged two former students — Robert J. Stephenson, then Director of the Corps of Engineers Materials Lab in Marietta, Georgia, and Tom Billings, also a Corps employee — to work with him in reactivating the group. The following month, the first meeting of the newly reorganized Geotechnical Committee, with Billings as chairman, met at Oga's Barbeque on Northside Drive, thus creating what has become an avid attachment to barbecue meals for our meetings. George Sowers gave the initial presentation to those in attendance. Meetings continued at Oga's until it went out of business. Then meetings were moved to the Dunphy Hotel until it also went out of business. During the early 1980s, the group struggled to find a suitable meeting place and tried several venues with varying success. In 1986, presentations were taking place in a basement meeting room at the Royal Coach Hotel. In November of that year, Joel Galt, who later served a term as committee chairman, arranged for the Geotechnical Committee to meet at the Georgia Power Company building. This new location had many advantages over our previous meeting places. Fittingly, the first speaker in this new venue was George Sowers. With a recurring meeting place at the Georgia Power building, our programs began to stabilize and grow. Each year since the early 1990s, the committee has strived to have a program at an outdoor venue. These meetings have been catered by various barbecue restaurants, and accompanied by cold liquid refreshments. They are a good time of fellowship for all of our colleagues.

Now in its 21st year, our George F. Sowers Symposium is appropriately built on a partnership between practice and academia that emulates Sowers' career. In 1993, Geotechnical Committee Chairman Mike Turner met with Dr. Jean-Lou Chameau, chair of Georgia Tech's School of Civil Engineering, and members of the School's Geotechnical Engineering Program to initiate an annual event (at that time unnamed) with well recognized individuals to deliver an academic lecture at the School in the afternoon and an applied lecture to practicing geotechnical engineers in the evening. The success of this early joint-lecture series, and the inspiration George Sowers was to all of us, led to the formal establishment of the Sowers Lecture in 1998. The first Sowers Lecture was delivered by its namesake's former student, Dr. G. Wayne Clough, BCE 1964, MSCE 1965, who was the first alumnus to become president of Georgia Tech.

PREVIOUS LECTURES

YEAR	SOWERS LECTURE	STATE OF THE PRACTICE	STATE OF THE ART
1998	G. Wayne Clough		
1999	J. Michael Duncan		
2000	Richard E. Goodman		
2001	Robert M. Koerner		
2002	Harry G. Poulos	William F. Brumund	Richard Finno
2003	John B. Burland	Allen Marr	Stephen G. Wright
2004	Kenneth H. Stokoe, II	Edward Cording	Andrew Whittle
2005	Fred H. Kulhawy	Mike Lewis	Chuck Dowding
2006	R. Kerry Rowe	Raymond Seed	Don J. DeGroot
2007	Eduardo Alonso	Ed Kavazangian	Ross Boulanger
2008	Michele Jamiolkowski	Steven Kramer	George Filz
2009	Thomas D. O'Rourke	Robert Bachus	Craig H. Benson
2010	David E. Daniel	John T. Germaine	David O. Potyondy
2011	Keith Kelson	Dan Brown	Cino Viggiani
2012	Bengt H. Fellenius	Jeffrey R. Keaton	Jorge B. Zornberg
2013	Paul W. Mayne	Ken Been	C. Guney Olgun
2014	Richard J. Jardine	Kyle M. Rollins	Ellen M. Rathje
2015	Jonathan Bray	Scott Anderson	Youssef Hashash
2016	Rudy Bonaparte	Roger Chandler	Roman Hryciw
2017	Richard Bathurst	Bruce Kutter	Rick Deschamps

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