



Center for Bio-mediated & Bio-inspired Geotechnics

Newsletter • Spring 2020 • Volume 15



As I See It: View from Director's Chair

Sustaining Our Momentum in this Time of Crisis

When I started jotting down notes for this newsletter (about a month ago), they were mostly congratulatory thoughts regarding the progress we have made in the past four and one half years, progress that led to a unanimous recommendation for the NSF Site Visit Team and approval without comment by the NSF Director's Review Board for reauthorization of CBBG, and what we needed to do to pave the way for CBBG to continue to flourish after the end of the next five years of NSF core funding. However, I will have to save those thoughts for another time, as circumstances have led to more pressing concerns, including concerns over the health of everyone in the CBBG community and concerns over how we can maintain the momentum of our research and development and education programs during this period of crisis, including the progress of CBBG students towards graduation.

The projected number of cases and the potential impacts of this virus can be overwhelming to consider. I believe that the most important immediate need is for us to get beyond this initial wave of infections that may overwhelm the capacity of the health care system. Personally, I take pride in the fact that the CBBG universities have been proactive leaders in taking the steps

necessary for this to happen. All four CBBG core institutions have gone to online instruction, working from home as much as possible, limiting laboratory access, and taking appropriate protective measures for those who have to be in the office or the lab well in advance of any directives from our political leaders. Presumably, once the wave has crested, effective therapies have been established, and the health care system has sufficient capacity to accommodate everyone who needs care, we will be able to return to our "normal" routine, e.g., working in our offices, laboratories, and the field. Still, I suspect there may be some long-lasting and perhaps permanent impacts of the extraordinary measures we have implemented to control this scourge on the way we conduct our business and personal lives. While I am confident that this will come to pass, how long it will take for this to occur is anyone's guess.

Until we can return to a semblance of our normal routine, we must come up with creative ways to maintain CBBG's momentum while allowing our students, staff, and faculty to meet their personal obligations and goals. In the short term, I suspect most of us will be able to keep busy writing papers, research plans, and sections of theses, conducting numerical analysis, reviewing literature, and other tasks that do not require physical presence in the lab or office. At the upcoming mid-year meeting, now an on-line one-day affair, we will be investigating additional ways we can put this hiatus to good use. However, as much of our work involves physical modeling and experimentation, there will be inevitable delays on some projects. This will certainly be taken into consideration as we review projects and allocate budgets for next year. An important consideration we need to address in this regard is the potential for delay in graduation for students working on thesis or culminating projects that require additional hands-on testing or experimentation. This is an issue that individual students will have to work out with their advisor. However, we are fortunate that our NSF funding gives us the capacity to maintain support for all

CBBG students through graduation as well as to accommodate any delays in completion of CBBG projects.

By the time you read this, the on-line mid-year meeting will likely have taken place and the leadership team will be busy looking at ways to implement the creative ideas I expect to come out of the meeting and that develop spontaneously as we adjust to the current situation that will enable us to maintain the momentum of our Center and the progress of our students towards graduation. The timeline for resolution of the current crisis should also be a lot clearer. In the meantime, please take appropriate precautions to protect yourself and your family while remaining engaged in CBBG activities.

Important Dates

YR5 Annual Meeting/NSF Site Visit
October 27, 2020: Rehearsal Day &
Student Retreat

October 28-29, 2020: Annual Meeting
Arizona State University

Research Highlights

DeJong Speaks on Biogeotechnics for National Academies Committee



On Thursday, February 20, CBBG co-PI and Thrust Leader Jason DeJong made a presentation on “Biogeotechnics: Bio-mediated Processes and Bio-inspired Ideas for Geotechnical Engineering Innovation” as part of the webinar series sponsored by the Committee on Geological and Geotechnical Engineering (COGGE) of the National Academies of Science Engineering and Medicine.

Professor DeJong’s presenta-

tion was the most widely viewed COGGE webinar to date, with over 484 registrants and at least 325 people attending. The attendees represented 51 countries and 45 U.S. states, and 40% were from industry while 38% were from academic fields. Attendees asked 259 questions during the Q&A and 215 registrants requested to join the COGGE mailing list. A link to the recording of the webinar (top of page) and a link to the slides Professor DeJong used for his talk (bottom of page) can be found at: <https://bit.ly/2wzE5Ke>

IAB Assists in Bio-Inspired Concepts Development

The CBBG Industry Advisory Board (IAB) assisted in development of bio-inspired concepts for next-generation autonomous site exploration and underground monitoring tools as part of a course in Bio-Inspired Design taught by Professor Julian Tao of ASU. IAB members completed a short survey on industry needs and will participate in follow-up interviews with the team. IAB input was invaluable in identifying not just geotechnical applications with commercial potential but applications across several other fields of engineering. The course was a collaboration between CBBG and the Innovation Space, an entrepreneurial joint venture among the Herberger Institute for Design and the Arts, the Ira A. Fulton Schools of Engineering, the W.P. Carey School of Business and the Julie Ann Wrigley Global Institute of Sustainability at ASU.

Geo-Institute Webinar

On December 3rd 2019, Leon van Paassen (ASU) was invited by the Soil Improvement committee of the Geo-Institute to provide an online webinar on Field trials of Bio-mediated Ground Improvement.

Young Scholar Contributes to Interdisciplinary Bioinspired Research at NMSU

John Cooper is a CBBG Young Scholar at New Mexico State University and a senior in Las Cruces High School. He is a member of Dr. Douglas Cortes’ interdisciplinary team that develops an earthworm inspired geoprobe. John wrote Arduino control programs for the first and second generations of bio-inspired geoprobes in this project and provides technical and programming support during experimental testing, working



side-by-side with geotech, biology and electrical engineering students and faculty. John has participated in the CBBG Young Scholar Program with Dr. Cortes in

two summers and throughout the academic year since June of 2018. John presented his CBBG research poster at the 2019 CBBG Mid-Year Meeting in the Las Cruces Convention Center. John’s academic and research interests have always been in computer programming applied to robotics and mathematics. His programming team has participated in the First Robotic Competition in the past several years. John is a dual credit student at NMSU and will pursue his Bachelor of Science degree in Computer Science at the University of New Mexico in Albuquerque, NM starting this Fall. He is the president of the Las Cruces High Band and coordinates the Science Olympiad competitive team in the MESA (Mathematics, Engineering, Science, and Achievement) organization. In his spare time, John enjoys playing the piano and often shares his musical talents with choral groups and his church community.

NSF Invites Elizabeth Stallings Young to PREEMPTIVE Conference in New Zealand

The National Science Foundation invited Elizabeth Stallings Young to participate in the PREEMPTIVE New Zealand Advanced Studies Institute (ASI) to originally be held in late April at Te Papa in Wellington and at the University of Canterbury in Christchurch, New Zealand. The goal of the PREEMPTIVE ASIs is to build a diverse community of researchers across the Pacific Rim, and beyond, who share a focused interest in understanding, promoting and accelerating the adoption of protective systems to provide resilience for building and infrastructure systems and ensure sustainable societies. A series of earthquakes in 2010–2011 destroyed, or caused considerable damage to, vast portions of the city of Christchurch (then New Zealand’s second most populous city). Much of Christchurch’s central business district was “red tagged” and demolished, and significant portions of its suburban areas exhibited extensive liquefaction and ground subsidence to a sufficient level that entire neighborhoods were condemned and had to be abandoned. This third Institute will explore resilience and particularly consider the effects of soil conditions and geotechnical aspects of natural hazards in the overall performance of protective systems and measures. Participants will also have the opportunity to attend the Annual Conference 2020 of the New Zealand Society for Earthquake Engineering (NZSEE).

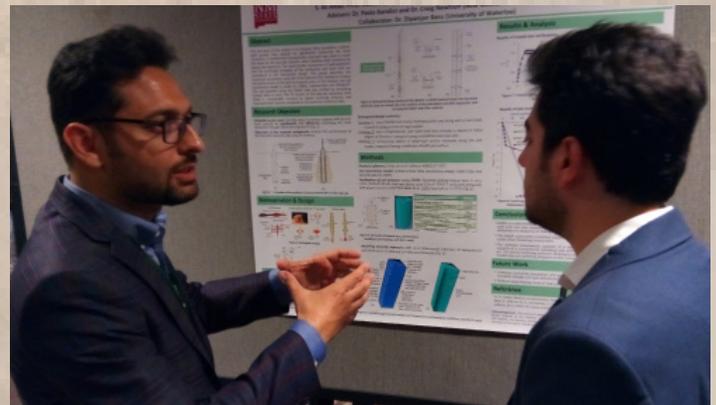
Out & About

CBBG at the Geo-Congress 2020



CBBG coordinated a Biogeotechnics Symposium at the Geo-Congress 2020 of the American Society of Civil Engineers Geo-Institute in Minneapolis on February 25-28. The Symposium included 3 podium sessions and a peer-reviewed Geotechnical Special Publication, GSP 320, on “Biogeotechnics”. GSP 320 included 24 papers on Biomediated Geotechnics, 8 papers on Bio-Inspired Geotechnics, and 4 papers on Life Cycle Analysis. Twenty-five (25) of these papers were presented in podium sessions on “Emerging Biogeotechnologies”, “Lifecycle Analysis and Bio-mediated Ground Improvement”, and “Biogeotechnics for Reinforcement, Penetration, and Foundations”. Other papers from the GSP were presented in a poster session and several CBBG student researchers presented posters in the student poster session at the Geo-Congress. Additional papers on CBBG research and education programs were presented in other podium sessions and GSPs associated with the Geo-Congress. All CBBG papers presented at the Geo-Congress are listed in the Publications page of the CBBG website and are available for download upon request.

On the first day of the Geo-Congress, members of the CBBG IDEA (Innovation, Diversity, and Education Activities) team and CBBG graduate student researchers also participated in a workshop on “Geotechnical Faculty Teaching Strategies and Resources” sponsored by the US Universities Council on Geotechnical Education and Research. The workshop included presentations by CBBG personnel on the Summer Program initiatives and on the library of curated K-14 science lessons developed by participants in the CBBG RET program and other teaching resources available on the CBBG website on the Education Page under the Curriculum tab.



AZ Science Center – CREATE U and Innovate to Educate



On February 11, 2020, CBBG Director Dr. Ed Kavazanjian and graduate student Miriam Woolley led a biogeotechnical engineering career talk for the teens participating in the CREATE U program at the Arizona Science Center. This program is focused on developing college and career readiness skills for high school students. This semester the students are designing sustainable solutions inspired by nature to help their communities using the CREATE makerspace tools.

CBBG Education Advisor Dr. Willi Savenye organized and participated in the Innovate to Educate professional development event at the Arizona Science Center on February 28, 2020. She was joined by 2019 RETs, Olivia Lansing, Daniel Hood, and Scott Currier, plus graduate students, Caitlyn Hall and Kyle Reep. The team hosted a CBBG table and presented a breakout workshop, sharing CBBG research and curricula, modeling lessons related to biogeotechnical engineering, and recruiting for our summer RET program to over 100 teachers from Title 1 schools across Arizona that attended.



Roosevelt School District



In partnership with Roosevelt School District Executive Director of Innovation and Learning Dr. Richard Ramos, Dr. Jean Larson (CBBG Education Director), Kim Farnsworth (CBBG Education Coordinator), and 2019 RET Olivia Lansing presented a professional development workshop at Southwest School on January 24, 2020 for K-8 teachers. The interactive workshop focused on problem-based learning approaches to engineering education in biogeotechnics. Teachers were from across multiple disciplines from special education, to art and science.

The interdisciplinary nature of CBBG research provided a rich context for RET Olivia Lansing to share an activity from her CBBG lesson plan on bio-inspiration. Olivia's activity was a hit with teachers and sparked wonderful discussion about the potential for engineering education integration across multiple disciplines.

Tempe Elementary School District Board Meeting



CBBG IDEA group member and Arizona Department of Transportation partner Jim Lemmon attended a Tempe Elementary School District board meeting on January 22, 2020 with Dr. Jean Larson (Education Director) and

Kim Farnsworth (Education Coordinator). Jim shared his experiences with CBBG and the importance of our education outreach mission followed by Jean who presented an overview of the Center to the board and shared research opportunities for district teachers. Kim finished with sharing information about our planned after school programs and potential partnership with Tempe Elementary School District.

Gila River Indian Community Education Summit



Education Coordinator, Kim Farnsworth, and CBBG undergraduate student, Jeremy Nez, attended the Gila River Indian Community Education Summit on March 4, 2020. Jeremy and Kim were able to connect with several high school students and parents from the Gila River Indian Community and shared information about our summer Young Scholars and Research Experiences for Teachers (RET) programs. This was a great opportunity to share about CBBG research, biogeotechnics, and STEM-focused university studies.

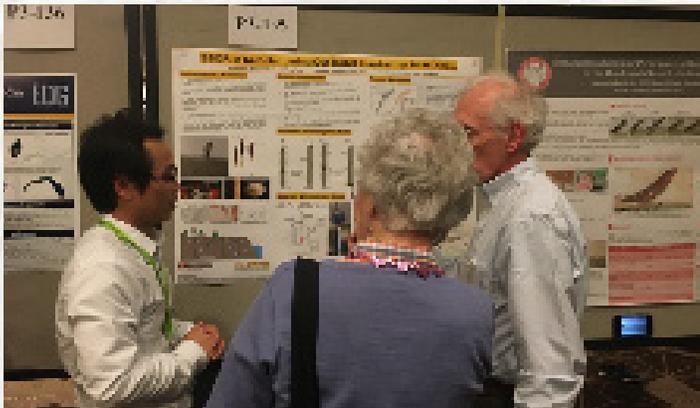
2019 Engineering Mechanics Institute Conference

The EMI conference is organized by the ASCE Engineering Mechanics Institute, which has as objective "to serve the needs of the engineering community by advancing the knowledge and improving the application of engineering mechanics and related sciences, and by contributing across a broad spectrum of interdisciplinary areas to address the needs of the 21st century." The EMI 2019 conference had an emphasis on geomechanics and granular materials, and it counted with a strong participation of CBBG students and senior personnel.

Society of Integrated and Comparative Biology Conference



Tao's group, including Sichuan Huang, Yong Tang, Yi Zhong and Julian Tao, attended the Society of Integrated and Comparative Biology (SICB) Annual Conference in Austin, Texas. Sichuan did a poster presentation on razor clam-inspired burrowing robot.



ASU Day at the State Capitol



ASU president Michael Crow presents researchers' work to Sen. Heather Carter during the annual ASU Day at the Capitol at the Wesley Bolin Memorial Plaza in Phoenix on Tuesday.

Jean Larson and Nasser Hamdan staffed the CBBG both at AZ State Capitol. State legislators, guests and ASU President Michael Crow stopped at the CBBG booth. An article about ASU Day at the Capitol also included a blurb about CBBG: "At ASU's Center for Bio-mediated and Bio-inspired Geotechnics, students and researchers are using nature to come up with sustainable, biologically based solutions to challenges like dust mitigation. Researchers are using the jack bean, a nuisance plant primarily found in southeast Asia, to create a natural cement. The bean produces an enzyme that creates calcium carbonate cement. When mixed with soil and water,

it bonds like glue. The center is working with three industry partners to test the water-based solution in an active landfill in Apache Junction". The article can be found here: <https://bit.ly/2JhPxNI>

26th IACGE Geotechnical Workshop

On January 23rd Leon van Paassen (ASU) was invited by the International Association of Chinese Geotechnical Engineers (IACGE) in Irvine, California to give a seminar about field trials on Bio-based Ground Improvement. The seminar was well attended by practitioners in the Los Angeles region. Prior to the seminar, possibilities for commercial application of bio-based ground improvement technologies at a field site in Orange County were discussed with CBBG industrial partners, Keller and Geosyntec.



CBBG Exhibits at ADSC Annual Meeting



CBBG was one of 18 exhibitors at the 2020 Annual Meeting of ADSC, the International Society of Foundation Drilling (formerly the Association of Drilled Shaft Contractors) in Tucson, Arizona, January 27-21. Director Ed Kavazanjian and Industry Liaison Officer Nasser Hamdan represented CBBG, joining over 300 delegates from industry, government, and academia at the meeting. Representatives of several CBBG Industry Partners were also in attendance. One of the highlights of the meeting was a breakout session on collaboration among industry, academia, and government on research, including presentations on ongoing ADSC collaborative research projects and on opportunities for collaboration.

Education & Outreach

ASU Open Door

ASU Open Door 2020 was a great success with CBBG faculty, students and staff manning several hands-on activities and demonstrations for community visitors to the ASU Tempe campus. Activities included bio-cemented emojis, liquefaction demonstrations, self-burrowing soft robotics, hydrogel hands-on magic tricks, among several others. In all, over 6 faculty, 15 students, and several staff volunteered their time and enthusiasm on a rainy Saturday, February 22nd to share all that we are doing at CBBG at ASU. Thank you to all who made this event possible!



Sacaton – Cross-ERC – Industry Orchard Project



CBBG and QESST education teams are partnering with the Gila River Indian Community and Standard Solar to upgrade and build upon Sacaton Middle School's existing school orchard. This project brings together multiple representatives from Sacaton Elementary School District #18, Sacaton Middle School, including CBBG 2019 RET Martina Ashley, and Dr. Jean Larson (CBBG Education Director), Kim Farnsworth (CBBG Education Coordinator), Dr. Leon van Paassen (CBBG faculty), Dr. Michelle Jordan (QESST Education Director), Tiffany Rybiski (QESST K-12 Outreach Coordinator), and Kent Farnsworth (Standard Solar Senior Project Engineer). Plans are underway to support Sacaton students in expanding and maintaining the school orchard using biogeo-

technical and photovoltaic research from both NSF ERCs along with the PV design expertise of Standard Solar.



Girl Scouts Visit CBBG

On February 9, 2020, CBBG hosted youth from Girl Scout Troop #6874. Led by CBBG graduate students Miriam Woolley and Belchor Sebastiao, the troop was able to conduct their own individual soil experiments, practice thinking like engineers, and learn about biogeotechnical engineering as well as tour research labs at Arizona State University. (The event was assisted by Ed Kavazanjian and Mary Bankhead.)



New After School Curriculum Developed

New Mexico State University CBBG faculty, students, and staff collaborated to create a new out-of-school time program curriculum for local 6th grade students. The new curriculum, titled “Natural Disasters and Geotechnical Engineering”, invites students to become engineering superheroes who use geotechnical engineering ideas and techniques to prevent or mitigate natural disasters such as earthquakes, tornados, and dust storms.

Work on developing the curriculum took place from November 2019 to January 2020. The final product is a combination of existing natural disaster lessons and new geotechnical engineering lessons, inspired by some lessons created during the RET program. The curriculum was introduced to teachers in early February at a professional development day for teachers participating in the afterschool program. Collaborators Judit Garcia, Cyrena Ridgeway, and Dr. Paola Bandini presented the new curriculum and demonstrated several of the new geotechnical activities.



Teachers observing activity demonstration during professional development training.

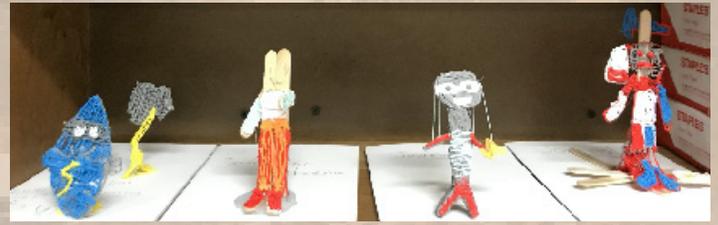


CBBG students help distribute program materials on professional development day.

6th Graders Explore Natural Disasters, Geotechnical Engineering After School

New Mexico State University’s STEM Outreach Center partners with CBBG to provide hands-on out-of-school time programs to local 6th grade students each spring. This spring students are exploring the new curriculum “Natural Disasters and Geotechnical Engineering”. Students create their own engineering superhero persona to combat natural disasters instigated by a variety of villains. As students explore earthquakes, quicksand, and tornados, they also investigate geotechnical engineering mitigation and prevention techniques for each disaster.

This semester about 100 6th grade students and 9 teachers at 9 local elementary and middle schools are participating in the program. Early feedback and pictures indicate that students are excited and engaged in the activities.



Engineering superheroes created by students using 3D pens.



Students build and test a model seismograph.



Students test the stability of their spaghetti and marshmallow structure on a shaker table.



(Left) Students analyze the composition of local soil samples. (Right) Students conduct liquefaction test.

CBBG & QESST Representation at NSF & NASA STEM Meeting

Delia Saenz, Director of Diversity & Inclusion, represented CBBG & QESST at a joint convening on Broadening Participation in STEM sponsored by NSF and NASA in Alexandria,

VA on Jan 27-28. The convening brought together leaders from higher education, professional organizations, minority serving institutions, research centers, and funding agencies focused on increasing the number of ethnic/racial minorities and women at all levels of STEM engagement. The convening provided opportunities for information-gathering, collaboration, and networking. As well, Saenz met with program officers in the service of advancing the Centers' goals and priorities.

New Courses at Georgia Tech for Spring 2020



Two new one-credit courses were introduced at Georgia Tech in Spring, 2020. These courses are part of a new mini-mester program being implemented across the Institute. The courses meet during a five week period. The first course was “Bio-inspired Geotechnics” and met during weeks 1 to 5 of the semester. The course was co-taught by Dr. Seth Mallett (Post-doctoral Fellow and former CBBG PhD student) and Dr. David Frost (CBBG Thrust 4 Leader and GT Lead). The courses meet during a five week period. The first course was “Bio-inspired Geotechnics” and met during weeks 1 to 5 of the semester. The course was co-taught by Dr. Seth Mallett (Post-doctoral Fellow and former CBBG PhD student) and Dr. David Frost (CBBG Thrust 4 Leader and GT Lead). Dr. Mike Hems delivered a “case history” lecture on bio-inspired design to the class also. The second course was “Bio-mediated Geotechnics” and met during weeks 6 to 10 of the semester. The course was co-taught by Dr. Susan Burns (CBBG Investigator and GT Education Lead) and Mr. Junghoon Lee (CBBG PhD student). A total of nine students registered for both classes. Apart from attending lectures, the students completed 3 homework assignments in each of the 5 week modules and performed mini-mester projects in each of the courses as part of 3-person groups. Students presented their projects at the end of each mini-mester course.

ASU ERC's Awarded Bronze Status by ASEE Diversity Recognition Program

ERC's at ASU positioned in a supportive College of Engineering, one that was recently recognized by the American Society for Engineering Education's (ASEE) Diversity Recognition Program. The school's 2020-2022 FSE Diversity, Equity, and Inclusion Plan — was recently awarded bronze status, the highest entry status a university can be awarded.

More information about the diversity program can be found here: <https://bit.ly/3bD62Ql>

Publications

Boya Wang, Rosa Krajalnik-Brown, Chen Zhou, Yihao Luo, Bruce E. Rittmann, Youneng Tang. 2020. “Modeling Trichloroethene Reduction, Methanogenesis, and Homoacetogenesis in a H₂-based Biofilm”. *Journal of Environmental Engineering*. 146:2 doi. org/10.1061/(ASCE)EE.1943-7870.0001642

Chris Purdy; Alena J. Raymond; Jason T. DeJong; and Alissa Kendall (2020) Life Cycle Assessment of Site Characterization Methods. *Geo-Congress 2020 : Geo-Systems, Sustainability, Geoenvironmental Engineering, and Unsaturated Soil Mechanics*. pp 80-89

Huang, S., Tang, Y., Ardente, A.#, Bagheri, H., Li, D., Aukes, D., Marvi, Tao, J* (2020) Frictional Anisotropy Enhances Self-burrowing of a Soft Actuator in Sand, *Advanced Intelligent Systems*. DOI: 10.1002/aisy.201900183

Huang, S. and Tao, J* (2020) Modeling Bio-inspired Burrowing in Dry Sand using Cavity Expansion Theory and DEM, *Acta Geotechnica* DOI:10.1007/s11440-020-00918-8

Kim, D., Mahabadi, N., Jang, J., van Paassen, L. (2020) “Assessing the Kinetics and Pore Scale Characteristics of Biological Calcium Carbonate Precipitation in Porous Media using a Microfluidic Chip Experiment”. *Water Resources Research*.

Larson, J., Barnard, W., Chandler, J., O'Donnell, M., Savenye, W., & Zapata, C. (2020). Moving Beyond Technical Skills: Fostering the Development of Essential Skills Needed for a Successful Career in Engineering. In J. P. Hambleton, R. Makhnenko, & A. S. Budge (Ed.), *Geo-Congress 2020: Geotechnical Earthquake Engineering and Special Topics* (pp. 694-701). doi: 10.1061/9780784482810.07

Ossai, R., Rivera, L., and Bandini, P. (2020). Experimental Study to Determine an EICP Application Method Feasible for Field Treatment for Soil Erosion Control. *Geo-Congress 2020: Biogeotechnics. Geotechnical Special Publication (GSP) 320*. Reston, Virginia: American Society of Civil Engineers (ASCE), pp. 205 – 213

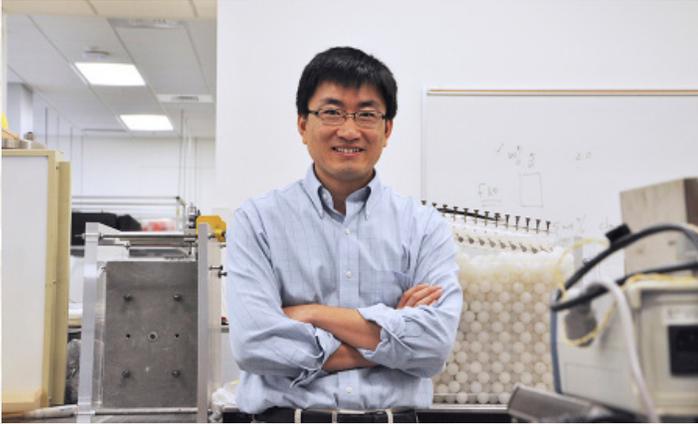
Raymond, AJ, Tipton, JR, Kendall, A, DeJong, JT. Review of impact categories and environmental indicators for life cycle assessment of geotechnical systems. *J Ind Ecol*. 2019; 1– 15. <https://doi.org/10.1111/jiec.12946>

Honors & Awards

Congratulations to Sichuan Huang

Sichuan Huang finished as the runner-up in the 10th Annual Graduate Research Symposium organized by the School of Sustainable Engineering and Built Environment at ASU.

Dai Wins Prestigious NSF CAREER Award



CBBG Assistant Professor Sheng Dai from Georgia Tech has won a 2020 Faculty Early Career Development (CAREER) Award from the National Science Foundation. Beginning May 1, Dai will receive \$540,362 over five years for his proposal, "Transforming Multiphase Flow in Porous Media from Passive Pore Fluids to Active Suspensions of Motile Bacteria." This research aims to understand the role of active particles (i.e., motile *Escherichia coli*) at the gas-liquid-mineral interfaces and use the insights gained to shift the paradigm in adaptive control of multiphase flow in porous media. The research findings are expected to provide innovative approaches to subsurface flow management, enhanced resource recovery, and targeted delivery of mass and heat transfer in porous media.

2019/20 AzTEA Innovation Award Winners



CBBG education partner, Dr. Richard Ramos from Roosevelt School District was selected as an Innovation Award winner by the Arizona Technology in Education Association. The Innovation Award is given to educators, support personnel, administrators, and community members who have demonstrated exemplary commitment to educational technology in Arizona.

Martinez Selected as Vic Milligan Award Runner Up

Alejandro Martinez, assistant professor at UC Davis was selected as the runner up for Vic Milligan Award for his paper titled "Interface response-based soil classification framework" published in the *Canadian Geotechnical Journal*.

NSF CAREER Award: Soil Penetration through Bioinspired Stress State Manipulation



Alejandro Martinez, assistant professor in the Department of Civil and Environmental Engineering, has received a CAREER award from the National Science Foundation's Faculty Early Career Development Program, for his proposal, "Soil Penetration Through Bioinspired Stress State Manipulation."

The grant is worth up to \$500,000 over five years. Martinez studies bioinspired geotechnics, a field that looks to biological organisms for inspiration to solve problems in geotechnical engineering.

Martinez joined the UC Davis faculty in 2016. He received a Bachelor of Science degree in civil engineering from the University of Texas at Austin, and master's and doctoral degrees in civil and environmental engineering from Georgia Tech.

Charalambos Pangelis Appointed Interim Director of NMSU's CEMRC

Prof. Charalambos Pangelis of New Mexico State University (NMSU) was appointed Interim Director of NMSU's Carlsbad Environmental Monitoring and Research Center (CEMRC). CEMRC is a 26,000 ft² facility that conducts environmental and human health monitoring for the U.S. Department of Energy's Waste Isolation Pilot Plant (WIPP)—the nation's only deep geologic repository for defense-related transuranic nuclear waste. CEMRC also provides analytical assistance and laboratory space for Sandia National Laboratories, Los Alamos National Laboratory, and WIPP Laboratories. The WIPP facility is the world's only active nuclear-waste repository.

Susan Burns Awarded Engineer of the Year Award



Dr. Susan Burns, CBBG Senior Investigator and Senior Investigator was recently awarded the Engineer of the Year Award by the Georgia Society of Professional Engineers in recognition of her educational leadership and administrative accomplishments. This is a highly competitive award. Apart from a significant research activity, some of which is supported through CBBG funds, she also maintains a solid teaching load

and serves as Associate Chair for Administration and Finance for the School of Civil & Environmental Engineering.

J. Kyle Reep Successfully Defends Thesis



J. Kyle Reep, an Environmental Engineering undergraduate student and a Barrett's Honor college student, successfully defended his Honor's thesis titled "An Evaluation of Basic Oxygen Furnace Slag as Post-Treatment for Acid Rock Drainage". Kyle was an undergraduate research assistant working in Dr.

Anca Delgado's laboratory. His thesis research was part of a CBBG project sponsored by one of CBBG industrial members, Freeport McMoran Inc. The project explored innovative approaches for remediation of acid rock drainage using BOF slag, a by-product from the steel industry, in conjunction with sulfate-reducing bioreactors. His thesis defense was one of the milestones in completing his B.S. in Environmental Engineering at Arizona State University. As a testament to his academic performance, research and professional experiences, and outreach activities, Kyle was selected as the Outstanding Graduate of the Environmental Engineering graduating class of Spring 2020. Kyle has been accepted into the Ph.D. program in Environmental Engineering at ASU and will start in Fall of 2020.

Professor Doug Cortes of New Mexico State University receives NASA and NMSGC funding for subsurface exploration testbed



Professor Doug Cortes of New Mexico State University was awarded a research initiation grant from the National Aeronautics and Space Administration (NASA) and the New Mexico Space Grant Consortium (NMSGC) to develop a regolith subsurface exploration testbed. The subsurface

of Mars and the Moon store a wealth of resources ranging from basic human necessities such as water (in the form of ice) to propellants such as methane (in the form of hydrates). While subsurface sampling and testing on earth is relatively simple, there is a need for relatively large and heavy surface equipment to provide the necessary reaction force to drive testing probes into the ground. Emulating earthworms, the research team is developing a new generation of self-excavating subsurface characterization tools that are both light and small, so they could easily be transported to the Moon and to Mars. Funding for this proposal will allow Cortes' group to develop an instrumented regolith subsurface exploration testbed in which bio-inspired devices can be tested under controlled laboratory conditions. As part of this project, two test cham-

bers capable of accommodating probes up to 4-inch in diameter will be instrumented with acoustic emission sensors to monitor Martian and lunar regolith simulant response during penetration. Cortes was also able to leverage CBBG funding to obtain matching funds from the Civil Engineering Department at NMSU and NMSGC for the acquisition of a modular loading frame to accommodate the large test chambers.

Upon completion of this project, a new regolith subsurface exploration testbed will be available at New Mexico State University to meet the needs of CBBG researchers working towards the development of extraterrestrial subsurface exploration. Our vision is to develop a platform in New Mexico from which to launch a new generation of devices that will help make the dream of an extraterrestrial human settlement a reality. The testbed will complement and support current and future research efforts by Cortes, including the proposal titled "Self-excavating Mars Ice Sampler" (currently under review by NASA).

Industry & Innovation

Arcosanti joins CBBG.

The famed urban laboratory of Italian-American architect, Paolo Soleri, has joined CBBG. Arcosanti is located in Yavapi County in central AZ.

CBBG researchers at ASU awarded patent in February for cementation methods using Enzyme Induced Carbonate Precipitation

This patent is focused on the application of enzyme induced carbonate precipitation (EICP) via columnar approach. The applications of EICP include improving bearing capacity of foundations; reducing settlement potential of foundations or embankments; increasing lateral resistance of foundations; enhancing stability of slopes or embankments; reducing lateral earth pressures on retaining walls; increasing passive resistance of retaining walls; increasing capacity of ground anchors or soil nails; increasing the side resistance and tip resistance of deep foundations; facilitating tunneling in running or flowing ground; stabilizing excavations bottoms; soil erosion control; and groundwater control.

Title: Cementation Methods

Patent #: US 10,563,233 B2

Inventors: Edward Kavazanjian and Nasser Hamdan



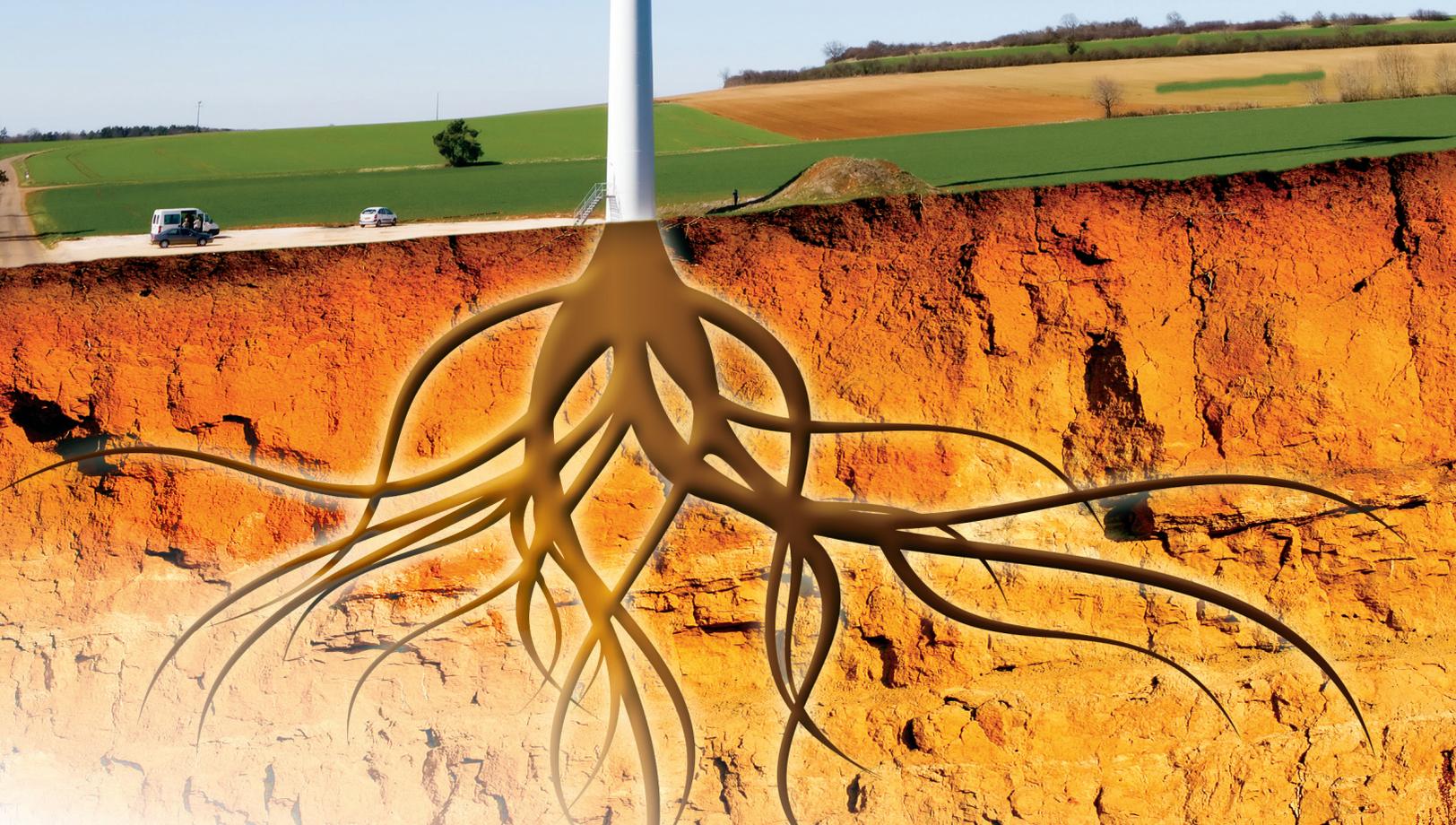
Partner Universities

UCDAVIS
UNIVERSITY OF CALIFORNIA

ASU ARIZONA STATE
UNIVERSITY

NM
STATE
UNIVERSITY

 **Georgia Institute
of Technology**



How does nature do it?

Nature has developed elegant, efficient and sustainable biologically-based solutions to many challenges that vex geotechnical infrastructure systems. Examples include ant excavation processes that are 1000 times more energy efficient than man-made tunneling machines, carbonate cemented sand that is exceptionally resistant to erosion and earthquakes, and self-sensing and self-healing tree root structures that are 10 times more efficient than any mechanical soil reinforcing/foundation system yet devised.

The NSF Engineering Center for Bio-mediated and Bio-inspired Geotechnics (CBBG) will focus on ecologically friendly, cost-effective solutions, inspired by nature, for development and rehabilitation of resilient and sustainable civil infrastructure systems. It will serve as a nexus for two transformative trends in engineering: biologically-based design and sustainability.



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