



Mountain-Plains Consortium

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University of Wyoming Ph.D. student named MPC Student of the Year

Recent UW graduate Debbie Shinstine was honored in January as the MPC Outstanding Student of the Year at the 17th Annual Council of University Transportation Centers Winter Banquet.



Shinstine

A Cheyenne, WY, native, Shinstine earned a B.S. in civil engineering at the UW and an M.S. in civil engineering at the University of Arizona. Shinstine earned a Ph.D. in civil engineering from the University of Wyoming in May 2014. For her dissertation, she developed a method for identifying high-risk crash locations on Indian reservation roads for the purpose of assisting tribes improve safety on their roadways. The method has been implemented on the Wind River Indian Reservation. This work included crash data analysis, incorporating logistic statistical modeling of crash severity, and implementation of livability and sustainability measures.

Since her graduation, Shinstine has expanded her research as a post-doctorate to implement this methodology on reservations throughout the Mountain-Plains region and is currently working with three tribes in North Dakota and South Dakota.

She has 25 years of professional experience in civil engineering both in private practice and public service with a PE in three states. Prior to returning to the university to pursue her Ph.D., she worked for the Virginia Department of Transportation managing maintenance, construction, and land use.

(Student continued on page 2)

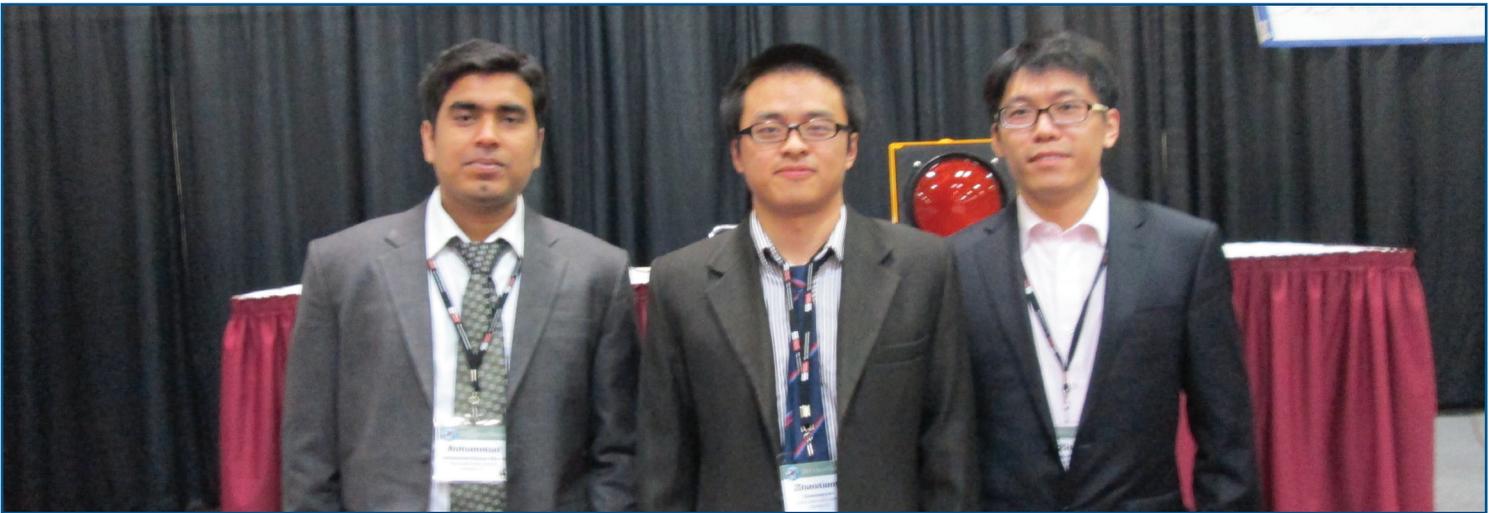
Taylor earns CUTC award for outstanding thesis

(Student continued)

Jeffrey Taylor received the Council of University Transportation Centers Pikarsky Award in Science and Technology for the thesis that he wrote for his M.S. in civil engineering at the U of U. The award was presented in January in Washington, D.C., at the 17th Annual Council of University Transportation Centers Winter Banquet.

The U.S. Department of Transportation honors outstanding students each year for their achievements and their potential future contributions to the transportation field. Students are selected based on their accomplishments,

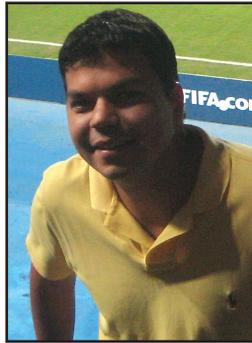
Taylor's thesis, "Method for Investigating Intra-driver Heterogeneity using Vehicle Trajectory Data: A Dynamic Time Warping Approach," presents a new method for car-following model calibration based on the Dynamic Time Warping algorithm. The research is an important step in improving traffic simulations, which attempt to describe how individual vehicles move on road segments in a network. Taylor graduated in May 2014. His advisor was R.J. Porter, assistant professor of civil and environmental engineering at U of U.



Student Activities

UC-Denver student selected for NSF program and named Eisenhower Fellow

UC-Denver PhD student Alejandro Henao was selected as a recipient of the NSF Bridge to Doctorate program as well as a Dwight D. Eisenhower Fellow. He is working with Dr. Wesley Marshall on transportation resiliency and beginning his doctoral work on mode share and travel behavior changes due to evolving technology, transportation services (e.g., app-based on-demand ride services, car-sharing, etc.), and information proliferation.



Henao

U of U students win ITE data contest

The U of U Institute of Transportation Engineers Student Chapter was selected to conduct data collection in the ITE Western District Data Collection Competition. The chapter conducted data collection for a trip generation and parking utilization study at a Smith's grocery store with a gas station in Salt Lake City, UT. The student chapter members and students from transportation engineering courses volunteered to help with the data collection. Funds from the data collection competition will support student travel to the ITE Intermountain Section Annual Meeting in May in Jackson, WY.

U of U students win scholarships

Ivana Tasic and Scott Shea, U of U Ph.D. students in transportation, received this year's Ellis L. Mathes scholarships awarded by the ITE Intermountain Section. The two annual scholarships are awarded to undergraduate or graduate students in the Intermountain Section area (Idaho, Montana, Nevada, and Utah) enrolled in engineering with an emphasis in transportation. The scholarships were awarded during the 54th Annual ITE Intermountain Section Meeting, held in Jackson, WY.

Anusha Musunuru, a Ph.D. student in transportation engineering, received this year's Women's Transportation Seminar (WTS) Scholarship awarded by WTS Northern Utah chapter. The scholarships are based on the applicant's specific transportation goals, academic record, and transportation-related activities or job skills. The scholarships were awarded during the WTS Northern Utah Chapter's 6th Annual gala held in April in Salt Lake City, UT.

Students at ASCE Transportation and Development Institute Congress

U of U transportation students attended the ASCE Transportation & Development Institute 2014 Congress. Ivana Tasic, a Ph.D. student at the U of U, presented "Evaluating the Performance of Innovative Intersections in Potential Transit Oriented Development Environments," co-authored by Dr. Milan Zlatkovic. Anusha Musunuru, an M.S. student at

the U of U, presented "A Reliability-Based Geometric Design Approach to Freeway Number of Lanes Decisions," co-authored by Dr. Richard J. Porter.

Tasic presents at ITE Western Annual Conference

Ivana Tasic, U of U Ph.D. student, presented her work on the effect of street connectivity on traffic operations in transit-oriented environments at the 2014 joint ITE Western-Midwestern Annual Meeting in Rapid City, SD. The presentation featured results from a three-year project sponsored by the Utah Transit Authority and the MPC, where multiple effects of transit-oriented design on traffic operations were explored by the U of U Traffic Lab research team. The annual meeting gathered ITE members from 24 states to present their transportation projects, represent their schools through student competitions, and network with experts from a variety of transportation fields.

U of U forms first ASCE Transportation and Development Institute Student Chapter

The first ASCE Transportation and Development Institute Student Chapter at the U of U was recently formed with MPC researchers Richard J. Porter, Pedro Romero, and Amanda Bordelon serving as advisors. The chapter will help students in their research and careers by creating a student network and connecting them with transportation professionals. Chapter officers were selected in November and new student members are being recruited. The Transportation and Development Institute Student Chapter is already involved in the U of U Engineering Day and in helping to plan a student conference in spring 2015.

Student is transportation intern with Kittelson & Associates

U of U M.S. student Anusha Musunuru was a transportation intern at Kittelson & Associates, Inc. during summer 2014. The internship provided broad exposure to the firm and profession. She worked on the basic areas of technical analysis: traffic operations, transportation planning, and traffic and functional design, along with engaging in technical, creative services, administrative, and business services aspects of the firm.

Transportation student earns award for airline research

Ju Dong Park, an NDSU transportation and logistics doctoral student, was awarded the Best Paper Award from the Transportation Research Forum at its 55th annual forum, which was held March 13-15 in San Jose, CA.



Park

Park's paper, "The Magnitudes of Economic and Non-Economic Factors in Demand for U.S. Domestic Air Passengers," analyzed air carriers' behavior in capturing market share by examining demand for air-passenger services, and price structure and economic factors affecting passenger behaviors toward air travel. The study also examined other non-economic factors such as seasonality, unexpected events, or airline mergers affecting passenger behaviors. Co-author of the paper was Won W. Koo, Chamber of Commerce distinguished professor in the NDSU Department of Agribusiness and Applied Economics.

U of U students participate at local conferences and workshops

The Western Regional Alliance (WRA) held a transportation symposium Sept. 30 to discuss global trends and the changes needed in the transportation field in order to maintain competitiveness in the rapidly changing economy. Several CEOs from across the western states were in attendance with transportation and planning students at the Rice Eccles Stadium in Salt Lake City.

The Wasatch Front Regional Council (WFRC) held a conference in the Salt Palace Oct. 23. Ph.D. students M. Scott Shea and Kiavash Fayyaz Shahandashti represented the U of U in a poster session, explaining the research performed by the Traffic Lab and highlighting the driving simulator, simulation, GIS, and other research capabilities of the U of U. Several contacts were made for possible collaboration of presentations and projects around the state and country.

Utah Traffic Lab students also attended Citilabs CUBE training Oct. 9-10 hosted by the Wasatch Front Regional Council. The two-day training included a

user group meeting and a hands-on training on the software, particularly in public transit modeling.

SDSU students competed in the Traffic Bowl and presented at the ITE Annual Conference

SDSU civil engineering graduate students attended the 2014 Joint Western/Midwestern District ITE Annual Meeting, June 29-July 2 in Rapid City, SD. For the first time, a group of three transportation engineering students Md. Razaur Shaon, Zhaoxiang He, and Zhao Shen, competed in the Traffic Bowl, a competition similar to TV game show Jeopardy but with a transportation and traffic engineering flavor. SDSU students attended technical sessions and workshops and presented five posters in the conference. All the posters received certificates from ITE for their outstanding accomplishments.

SDSU students presented at Mid-Continent Transportation Research Conference

SDSU transportation engineering graduate students Zhaoxiang He and Md. Razaur Shaon presented their MPC-funded research at the Mid-Continent Transportation Research Conference August 21-22 in Madison, WI. The conference focused on recent development in transportation research, including planning, traffic safety, and transportation infrastructure. He's presentation, "Using GIS to Evaluate Rural Emergency Medical Services (EMS)," was based on the MPC project "Improving Rural Emergency Medical Services (EMS) through Transportation System Enhancements." Shaon presented "Lane Specific Traffic Parameters to Lane Change Crashes." SDSU students also exchanged research ideas with students and professors from other universities.

USU students take fourth in concrete canoe competition

USU students took fourth place in the national ASCE Concrete Canoe Competition held at the University of Pittsburgh at Johnstown in June. The team was awarded best final product, third in the design paper competition, and fifth in their oral presentation. The competition highlights students' efforts to combine engineering excellence and hydrodynamic design in the construction of a water-worthy canoe.

RECENT GRADUATES

Colorado State University

Paula Miller graduated from CSU with an M.S. during the summer of 2014. Her thesis was "Numerical Simulation of Out-of-Plane Distortion Fatigue Crack Growth in Bridge Girders."

Tyler Sobiek graduated from CSU with an M.S. during the summer of 2014. His thesis was "Predicting Fatigue Life Extension of Steel Reinforcement in RC Beams Repaired with Externally Bonded CFRP."

Chris Bright graduated from CSU with an M.S. during the summer of 2014. His thesis was "Evaluation of New Reactive FRP Reinforcement Assemblies for Reinforced Concrete."

North Dakota State University

James Fuller graduated from NDSU in the fall 2014 with a Certificate in Transportation & Urban Systems. Fuller is a native of Columbia, SC, and plans to work in state and federal government in the transportation field. Fuller is currently working for the Virginia Department of Transportation as an Architect/Engineer I.

Maher Itani graduated from NDSU with a Ph.D. in transportation and logistics during the summer of 2014. Itani's research focused on identifying the logistical challenges faced by today's humanitarian organizations. His dissertation was "Dynamics of Deprivation Cost in Last Mile Distribution: The Integrated Resource Allocation and Vehicle Routing Problem." Upon completion of his doctorate degree Itani returned home to Beirut, Lebanon.

Sam Julius completed his Certificate in Transportation and Urban Systems from NDSU during the summer of 2014. His research interests are primarily in public transportation and high speed trains. Julius is a transit planner/grants manager for the Greenville-Area Transportation Study, an MPO located in the Greenville, SC, area.

Major Richard Mendenhall completed his M.S. in the Master of Managerial Logistics Program at NDSU in the fall 2014. He is a native from Hazel, SD and became interested in logistics from his experience as a squadron logistics officer in the U.S. Army and from working 6 Sigma at Caterpillar Inc. His research interests include army personnel force reduction planning. Mendenhall plans serve as a combined

arms battalion operations officer and executive officer.

Sumadhur Shakya earned his Ph.D. in transportation and logistics from NDSU during the summer of 2014. His degree specialized in logistics and supply chain systems in agribusiness with a focus on stochastic spatial optimization of supply chains applied to the nitrogen fertilizer industry in North America. His dissertation was "Structural Changes in North America Fertilizer Logistics." Shakya is now at California State University - Monterey Bay in Seaside, CA, as an assistant professor of production and operations management and agribusiness.

Colonel Matthew Shatzkin completed his Ph.D. in transportation and logistics from NDSU during the fall of 2014. Shatzkin's concentration was in supply chain management and his research focused on the role of automated requisitioning on emergency supply chains and introducing modeling & simulation at lower levels. His dissertation was "The Impact of Automated Requisitioning Systems on the Effectiveness of Emergency Supply Chains." Shatzkin is now at the Army Logistics University in Fort Lee, VA, as the commandant and military deputy.

Fang Xu graduated with a M.S. in the Master of Transportation & Urban Systems program from NDSU in fall 2014. Xu is originally from Wuhan, China, and studied logistics systems, transportation systems security, and transportation planning and environmental compliance. Xu's plans to move back to China to pursue a career there.

Zijian Zheng graduated with a M.S. in transportation and urban systems from NDSU in the fall of 2014. His thesis was "Heavy Vehicle Impact on Rural Two Lane Highway Segments Operating Under Various Levels of Service Conditions." Zheng's research interests include highway planning, transportation planning, and traffic engineering. He plans to earn his Ph.D. in transportation and logistics at NDSU.

South Dakota State University

Zhao Shen completed his M.S. in civil engineering from SDSU in December. His thesis was "A Risk Analysis Method for Evaluating Collisions between Trucks and Overpass Bridges."

University of Colorado Denver

Recent University of Colorado Denver graduate **Dan Piatkowski** joined the Department of Political Science and Public Affairs at Savannah State University as

an assistant professor. His research centers on the intersection between sustainability, health, urban design, and transportation.

University of Utah

U of U graduate **Kevin Croshaw** began work with Horrocks Engineers in Pleasant Grove after graduating with his M.S. in April. He coordinated the ITE student chapter in their portion of the traffic counts for the U of U Transportation Master Plan that Horrocks was creating. He continues to work on the Master Plan, as well as other traffic signal timings and design projects in his work with Horrocks Engineers.

U of U Ph.D. graduate **Thanh Le** is a transportation safety engineer at Vanasse Hangen Brustlin in Raleigh, NC. He is primarily focusing on transportation safety, geometric design, and operations.

Uma Ramassy is a post-doctoral researcher at the U of U after recently earning her Ph.D. there. Her dissertation was on "Alkali-Silica Reaction Resistant Concrete Using Pumice-Blended Cement." This project used locally mined pumice from Malad, ID, and characterizing how it was more effective to reduce ASR by reducing the free calcium in the hydrated concrete. Her current work focuses on finite element modeling of the dynamic loading from transporting nuclear-containment steel casks.

NEW STUDENTS

Colorado State University

Brendan McGuire earned his B.S. in civil engineering and is currently pursuing an M.S. in structural engineering, both at CSU. His engineering interests include the mechanics, design, and modeling of bridges. He is currently working on a method to utilize building information modeling (BIM) software to track and assess the structural condition of bridges.

David Turner is a second-year M.S. student at CSU. He earned his bachelor's degree in civil engineering from the Virginia Military Institute. His MPC project deals with optimizing bridge elevation to avoid the isolation of a community during a flood event.

Patrick Sanders earned his bachelor's degree in civil engineering with an emphasis in structural engineering from Clemson University in the spring of 2013. He is a second-year master's student, working on research considering the effect of uncertainty

in bridge inspection results on bridge inspection scheduling.

University of Colorado Denver

Nick Ferenczak is a Ph.D. student at UC Denver working with Dr. Wesley Marshall on the "Why are Bike-Friendly Cities Safer for All Road Users?" project. He recently received his master's degree in geography and planning (with a focus on active transportation planning) from West Chester University.

North Dakota State University

Andrew Andrusko is an M.S. student in transportation and urban systems. Originally from Brooklyn Center, MN, he attended Minnesota State University, Mankato, where he quadruple majored in urban & regional studies, social studies, professional geography, and geology. Andrusko hopes to work with diverse transportation and transit projects in his current role as assistant planner with the Minnesota Department of Transportation.

Jared Annexstad is an M.S. student in transportation and urban systems. Originally from Saint Peter, MN, he attended Saint Cloud State University and earned a B.S. in aviation with a concentration on airline management. Annexstad's research focuses on the challenges facing the National Airspace System, which allows him to draw on his involvement with aviation from planning to execution. He wants to enhance his career as an aviation officer in the U.S. Army by gaining experience in transportation planning. He currently flies a UH-60 Black Hawk helicopter for the U.S. Army.

Craig Banner of Houston, TX, is a master's student in the managerial logistics program. He earned a B.S. in human resource development from Texas A&M University. Banner entered the U.S. Army as a logistics officer in 2007 and was deployed to Iraq in 2008 and 2010. He currently serves in a second company command in the division headquarters battalion with the 3rd Infantry Division at Fort Stewart, GA. He plans to further his knowledge of logistical operations in the civilian sector in order to help him progress as a U.S. Army officer in the logistics field.

Nicole (Seraphin) Berthiaume of Enfield, CT, is an M.S. student in the Transportation and Logistics Certificate Program. She earned a B.S. in civil engineering from Northeastern University. Her undergraduate degree in civil engineering sparked her interest in transportation. She plans to work for a nonprofit or government organization such as FEMA.

Stephanie Grossmann is an M.S. student in the Master of Managerial Logistics Program. Originally from Vernon, NJ, Grossmann earned a B.S. in business management from The Richard Stockton College of New Jersey. Her interest in logistics began when she studied business as an undergraduate. Grossmann plans to pursue a career in logistics and business management while traveling around the country.

Becky Hoffart of Rugby, ND, is an M.S. student in the Masters of Managerial Logistics Program. She earned her B.S. in microbiology with a minor in food safety from NDSU in 2004. She has received the SOLE Demonstrated Logistician Award and is currently in the U.S. Army as a medical logistics officer. She is interested in learning how to incorporate medical logistics into the broad spectrum of logistics.

Lauren Delaney is an M.S. student in the Transportation and Logistics Certificate Program. Originally from St. Louis, MO, she attended Northwestern University and earned a B.S. in civil engineering with a minor in transportation and logistics. She hopes that her knowledge of transportation and modeling will assist in planning and design. Her goal is to develop a process to easily calibrate micro-simulation models to use in local planning projects in order to choose cost-efficient, sustainable designs.

Kathryn Ferguson of Alpena, MI, is a doctoral student in transportation and logistics. She earned B.S. degrees in transportation and logistics and computer information systems from the University of Wisconsin-Superior in 2006. Ferguson then attended the University of Minnesota-Duluth and earned a master's degree in business administration. She became interested in transportation and logistics during her undergraduate career and hopes to pursue a career in higher education.

Robert Froberg was raised in numerous locations throughout the United States as well as the Federal Republic of Germany but calls the central valley of California home. While continuing to serve as an active duty logistics officer in the U.S. Army at Fort Lee, VA, he is attending NDSU part time as a Ph.D. student in the Transportation and Logistics Program. He earned his M.S. in logistics management from Florida Institute of Technology and his B.S. in industrial technology from California State University-Fresno. He was awarded the Demonstrated Master Logistician designation in 2012 from the International Society of Logistics.

Azadeh Jaber Jahromi is a civil engineering doctoral student. Originally from, Tehran, Iran, she earned a B.S. in civil engineering from Tabriz University and then completed an M.S. in structural engineering at the Iran University of Science and Technology. She has had four articles published in multiple journals and has presented publications at conferences across the United States. Her research focuses on the rehabilitation of aging bridges and infrastructure to enhance their strength and ductility.

Bryan King of West Haven, CT, is an M.S. student in transportation and urban systems. He earned a B.A. in economics from the University of Connecticut in 2009. King has a strong interest in macro and micro economic studies of both domestic and international markets and their economies. He also studies the constant flux of supply and demand within different industries and the resulting effects on the global economy. King plans to apply his graduate degree to his work with Metro North where he hopes to further his career advancement in management or capital planning.

John Szum is an M.S. student in the Masters of Managerial Logistics Program. Originally from Amherst, NH, he earned his B.S. in economics from the University of New Hampshire. Szum is currently in California in the United States Army. Szum's research interests focused on economic growth modeling of India. He plans to retire after a career in the Army.

Jeffrey Valliere of Cleveland, OH, is a student in the Transportation and Urban Systems Certificate Program. He earned a B.A. degree from Ohio State University and his J.D. from Louisiana State University. He served as the lead manager and attorney for the Transportation Division of the Louisiana Public Service Commission. He was involved in regulating aspects of passenger transportation and transportation related to the oilfield industry. He plans to use this degree to assist him in the transition from attorney to planning with the transportation industry. He would like to be involved in planning or operations of a transportation system in a major city.

Yuan Xu is a transportation and logistics doctoral student. Originally from Xian Tao, China, she earned her master's degree from Dalian Maritime University. While earning her undergraduate degree, Yuan earned an award for learning excellence and won multiple math competition prizes. She plans to become an economist and a researcher so that she can provide input on important social and economic

issues or help entrepreneurs maximize their businesses potential.

Fangzheng Yuan of Jiangxi, China is a Ph.D. student in the Transportation and Logistics Program. In 2014 Yuan earned his master's degree in transportation and urban systems from NDSU. His bachelor's degree is in aircraft design at Nanchang University. He also holds a B.S. in manufacturing engineering from NDSU. Yuan is studying GIS modeling, network analysis, pavement design, and gravel road modeling. He plans

South Dakota State University

Hasan Md Moonam of Dhaka, Bangladesh, is a graduate research assistant in the Department of Civil and Environmental Engineering. He graduated with a B.S. in urban and regional planning in March of 2009. The focus of his research, which is funded by Wisconsin Department of Transportation, is the development of a statewide crash mapping automation tool. Hasan worked for TechnoVilla Solutions Ltd. in Bangladesh for two years. He anticipates earning his M.S. in civil engineering in May of 2016.

University of Utah

Catalina Arboleda is a Ph.D. student working on smog-reducing coatings for infrastructure and fiber-reinforced concrete pavements.

Zhuo Chen is a Ph.D. student working as a graduate researcher on MPC-444, Data-driven Freeway Performance Evaluation Framework for Project Prioritization and Decision Making.

Margaret A. Corrigan is an M.S. student serving as a graduate on MPC-465, Development of Performance Matrices for Evaluating Innovative Intersections and Interchanges.

Kiavash Fayyaz is a Ph.D. student working on MPC-469, Improving Efficiency and Reliability of Bus Rapid Transit.

Mingde Lin is an M.S. student.

Jem Locquiao is an M.S. student working on MPC-466, First- and Last-Mile Strategies for Transit Systems.

Yu Song is a Ph.D. student serving as a graduate researcher on MPC-469, Improving Efficiency and Reliability of Bus Rapid Transit



Education and Workforce Development

U of U hosts summer transportation camp

The U of U Department of Civil and Environmental Engineering held the first annual summer transportation camp sponsored by the Federal Highway Administration. The week-long program introduced high school students to the transportation industry and created a STEM focus experience. During the camp, the Utah Department of Transportation and the Utah Transit Authority provided field trips to the Warm Springs FrontRunner Control and Maintenance Facility, Jordan River Light Rail Facility, Traffic Operations Center, and an active bridge building project. The students also participated in hands-on activities in the traffic and materials labs on campus. A student produced video about the camp can be viewed at <http://youtu.be/UDT4OgHS6Us>. The video was entered in the American Road and Transportation Builders Association Student Transportation Video Contest.

Junior and senior high school students visit U of U campus for STEM outreach

The Utah Transit Authority, the Women in Transportation Seminar, and the Transportation YOU program recently brought a group of junior high and high school girls from the Salt Lake Center for Science Education Charter School to participate in a lab experience on the U of U campus. The effort, hosted by the U of U Department of Civil and Environmental Engineering Department, introduced the students to opportunities in civil engineering and related STEM careers. At the U of U Traffic Lab they learned about tools used by traffic and transportation engineers. While touring the Earthquake Mobile Lab, the students gained hands-on experience on the causes and implications of earthquake faulting and soil liquefaction as well as the types of damage caused following large earthquake events.

In October, students from several area high schools traveled to the U of U campus to explore and learn more about STEM disciplines and various aspects of engineering through discussions, project demonstrations, and exhibits prepared by the university's engineering student chapters. As part of engineering day, the Utah Traffic Lab allowed high school students to know and learn more about transportation, and how a transportation engineer's work impacts daily life. Participants experienced driving the simulator, seeing how traffic operations and simulations work, and learning about the different fields in transportation engineering.

NDSU offers courses for post-baccalaureate certificate program

NDSU was among the institutions that offered online courses in fall 2014 for a post-baccalaureate certificate program sponsored by the Regional University Transportation Centers. Universities offering courses for the fall semester included NDSU, Kansas State University, Texas A&M University, and the University of Illinois at Urbana-Champaign.

The award-winning, nationally recognized program allows students to take transportation courses online through the Transportation Leadership Graduate Certificate program. By enrolling in online graduate level courses for transportation professionals, the program prepares future leaders of the transportation industry. The online course format provides a flexible and convenient education opportunity for professionals to advance in their careers. Some of the most prominent courses offered for the fall semester were High-Speed Rail Construction Management, Logistics Systems, Transportation and the Environment, Sustainable Transportation Asset Management, and Urban Transportation System Analysis.

Through the collaborative efforts of 60 university transportation centers and transportation industry professionals, the program offers high-quality instruction from transportation experts across the country. Visit www.transleader.org for any additional information on the program and to register.

USU hosts engineering event for high school students

USU hosted an event for high school students to come to campus and learn about engineering. The Civil Engineering faculty hosted a challenge session on bridge design, stressing the importance of our nation's infrastructure and associated needs. Students designed their own bridges using the West Point Bridge Software and then constructed their own bridge (using the steel bridge that was used in the ASCE).

Transportation students see course applications in visit to Metro COG

Members of the NDSU student chapter of the Association of Transportation and Logistics learned how knowledge from transportation and logistics courses are used in the real world during a visit to the Fargo-Moorhead Metropolitan Council of Governments.

Nine students, all Ph.D. students in transportation and logistics, visited the FM Metro COG's offices for a Feb. 28 tour. Students attending included Vu Dang, Yasaman Kazemi, Nimish Dharmadhikari, Zijian Zheng, Chijioke Ifepe, Yong Shin Park, Aslaam Mohamed Muhammad, Sardar Muhammad Zahid, and Hamad Al Qublan. Also participating was Eunsu Lee, an associate research fellow with NDSU's Upper Great Plains Transportation Institute (UGPTI).

Discussion focused on travel demand modeling, environmental justice and impacts for existing and proposed transportation projects, public input meetings and stakeholders' influence in the decision-making processes, MATBUS involvement in transit routes, and corridor studies in the metro area.

Metro COG and the UGPTI have a working partnership and rely on UGPTI's Advanced Traffic Analysis Center for travel demand models. "It is very good to see our transportation and logistics students taking a look at how some of our end products are being used to enhance transportation at the MPO level," noted Bradley Wentz, ATAC program director.

Scholarships awarded at NDSU

Four NDSU students with an interest in transportation were awarded scholarships at NDSU with support from the MPC.

Kenneth Bahm and Daniel Julson received the Paul E.R. Abrahamson Transportation Scholarship, which is awarded to students who demonstrate interest in the transportation and logistics of agricultural commodities and processed agricultural products. Bahm is a senior in agricultural economics from Mandan, ND. Julson is a senior in agribusiness from Wahpeton, ND.

Sean Kelly and Joseph (Alex) Zikmund received the Transportation Engineering Scholarship which is awarded to students who have an interest in transportation and display academic excellence. Both are seniors in civil engineering. Kelly is from Dickinson, ND, and Zikmund is from Aberdeen, SD.

Funding for the \$1,500 scholarships is provided by the Mountain-Plains Consortium. The scholarships were awarded at the Upper Great Plains Transportation Institute Annual Awards Banquet in October.



Bahm



Julson



Kelly

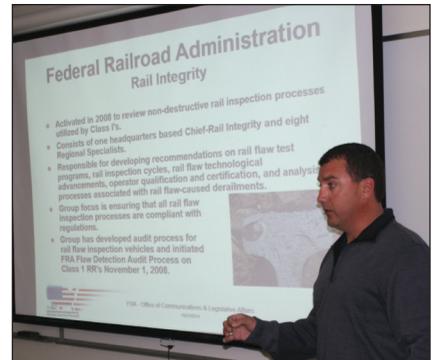


Zikmund

Front-line rail workers bring expertise and perspective to NDSU class

Students in NDSU's railroad planning and design class were able to hear from experts in rail operations and regulation during the fall semester. Instructors for the course, MPC director Denver Tolliver and civil engineering assistant professor Ying Huang, invited managers from a North Dakota short line railroad as well as officials from the Federal Railway Administration to be guest lecturers in the class.

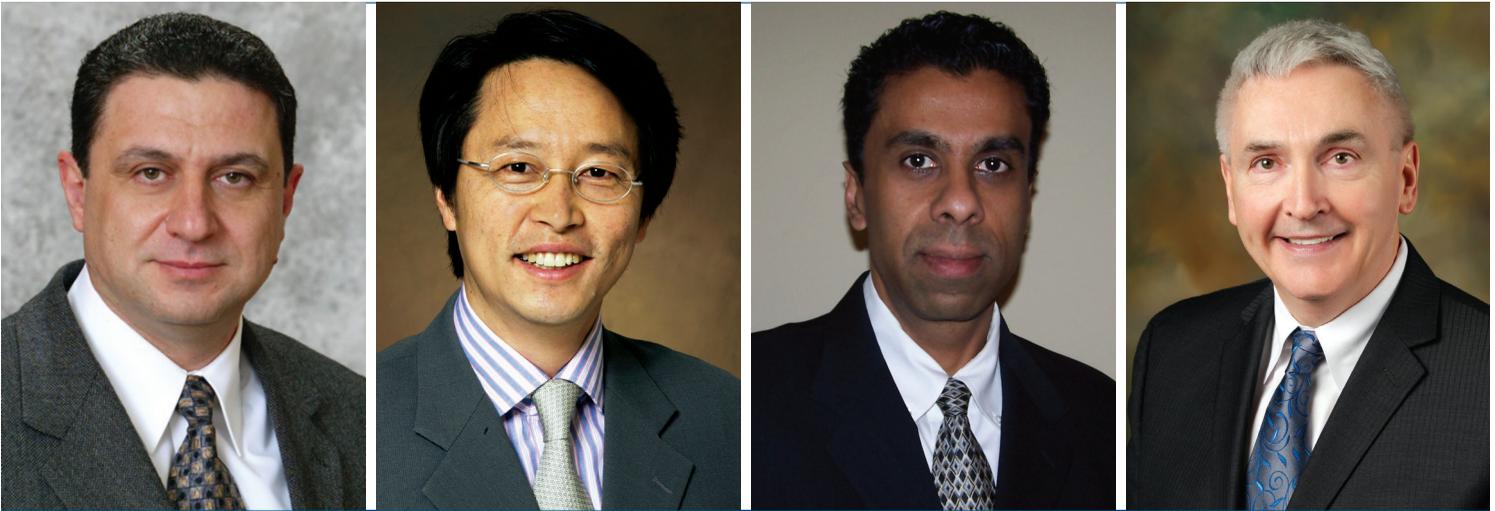
Early in October, two FRA specialists, Michael Bachmeier, a railroad safety specialist, and Blaine Luck, a rail integrity specialist, visited the class and discussed safety programs and enforcement



as well as potential careers in railroad regulation. In particular, Bachmeier and Luck discussed safety challenges associated with rapidly growing rail volume across the country in general, and, in particular, related to the movement of oil from the Bakken oil fields of North Dakota.

Later in the month, Mike Bazan, director of marketing and sales for the Northern Plains Railroad, and Larry Jamieson, former president of the railroad, discussed short line rail operations with the class. Jamieson continues to consult with NPR on large engineering projects. The railroad, based in Fordville, ND, leases 388 miles of branch line track in northern North Dakota and Minnesota from the Canadian Pacific Railway and operates lines owned by Mohall Railroad, Inc. and Mohall Central Railroad.

With 34 students in the class, enrollment has grown over the past several years, Huang noted, "Students are recognizing the importance of railroads in the economy and in the transportation system. They are interested in the career opportunities the engineering challenges associated with railroads."



Faculty Activities

Bordelon achieves PE status



Bordelon

MPC researcher Amanda Bordelon recently became a licensed professional engineer in Utah. Bordelon is an assistant professor in the U of U Department of Civil and Environmental Engineering. Her research focuses on concrete and fiber-reinforced concrete pavement design.

U of U professor honored for educational excellence

Richard J. (R.J.) Porter, assistant professor in civil and environmental engineering, recently received the American Society of Civil Engineers (ASCE) 2014 ExCEEEd New Faculty Excellence in Teaching Award. The ExCEEEd, or Excellence in Civil Engineering Education, award recognizes Porter for his outstanding teaching record, commitment to education, and contributions to the academic and local communities since joining the U of U in 2009.



Porter

Porter leads faculty and students in research at the Utah Traffic Lab to ensure motorist safety and reduce congestion. He received a plaque commemorating the award in June during the Civil Engineering Division Banquet at the annual American Society for Engineering Education conference in Indianapolis in June.

USU researchers earn 2013 Best Paper Award from TRB

Xiangdong Xu, Anthony Chen, and Lin Cheng of USU were awarded the Shinya Kikuchi Best Paper Award from the Artificial Intelligence and Advanced Computing Committee (ABJ70) at the 2013 Transportation Research Board annual meeting. The committee serves as a technical forum on the application of artificial intelligence to transportation problems and disseminates information about applications that are potentially useful to the transportation community.

The USU paper, "Stochastic Network Design Problem with Fuzzy Goals," describes the development of a hybrid goal programming approach for modeling both subjective and objective uncertainties simultaneously in the transportation network design problem decision-making process.

MPC researchers at U of U re-appointed to TRB committees

The Transportation Research Board recently reappointed the following faculty from the U of U Department of Civil and Environmental Engineering to various committees:

Pedro Romero – AFK-20, Technical Committee on Characteristics of Asphalt Materials.

Amanda Bordelon – AFD-70, Pavement Rehabilitation, and AFN-10, Basic Research and Emerging Technologies Related to Concrete.

Xiaoyue Cathy Liu – AHB-35, Managed Lane Committee.

Dan Fagnant – AHB-30, Vehicle-Highway Automation, and ANF-30, Motorcycles & Mopeds.

Chris Pantelides – AFF-50, Seismic Design and Performance of Bridges.

Richard Porter – ANB-20, Safety Data, Analysis, and Evaluation, and AHB-65, Operational Effects of Geometrics



Wehbe

Wehbe elected SEI Fellow

Nadim Wehbe, professor and head of the Department of Civil and Environmental Engineering at SDSU, was elected Fellow of the Structural Engineering Institute (SEI) of the American Society of Civil Engineers. He and 28 other individuals were

recognized as new Fellows of SEI on April 5 at the 2014 Structures Congress in Boston, MA.

Bareither receives ASCE award

Christopher Bareither, assistant professor of civil and environmental engineering at CSU, was awarded the ASCE 2013 Thomas A. Middlebrooks Award, which recognizes a paper contributing to geotechnical engineering. The award was for the paper entitled, "Deer Track Bioreactor Experiment: Field-Scale Evaluation of Municipal Solid Waste Bioreactor Performance," published in the June 2012 issue of the *ASCE Journal of Geotechnical and Geoenvironmental Engineering*.

Mahmoud presents Dexter Memorial Lecture

Hussam Mahmoud, assistant professor of civil and environmental engineering at CSU, was the recipient of the 2014 Robert J. Dexter Memorial Lecture from the American Iron and Steel Institute (AISI) Steel Market Development Institute Steel Bridge Task Force and the AASHTO Technical Committee for Structural Steel Design. The program was instituted in 2005 in memory of Robert Dexter, an internationally recognized expert on steel fracture and fatigue problems. The honoree presents a lecture on his/her steel bridge activities to the SMDI Steel Bridge Task Force and participates in its semi-annual three-day meeting. The award was presented at the SMDI Steel Bridge Task Force meeting in Denver in August.

Work to prevent vehicle hacking highlighted

Ryan Gerdes, USU assistant professor of electrical and computer engineering, was highlighted on Salt Lake City television station KSL with regard to an NSF grant he received. The \$1.2 million grant was based on the work he did with a UTC grant focused on preventing hackers from interfering with computer-controlled vehicles. View the story at <http://www.ksl.com/?nid=148&sid=31252693>.

Bridgelall receives Rising Star Award



Raj Bridgelall, researcher with the Upper Great Plains Transportation Institute at NDSU, recently received the "Rising Star Award" by Sensors Magazine at the 2014 Best of Sensors Expo in Rosemont, IL. Bridgelall's

award was one of 11 awards presented to focus attention on applications and innovations in sensors. Bridgelall has been leading development of sensor, wireless, software, and big data technology and business solutions. His current project is to assess and develop a means of optimizing hyperspectral remote sensing for use with lightweight unmanned aircraft systems.

Lee presents webinar for FHWA



Lee

EunSu Lee, a researcher with the Upper Great Plains Transportation Institute at NDSU, presented a webinar June 26, "Using FAF Data in Economic Analysis/Case Study: North Dakota," to about 160 participants across the United States. The webinar was one of FHWA's Quarterly Freight Analysis Framework (FAF) Webinars. Lee

described the use of FAF in transportation modeling and planning in North Dakota as an example of how practitioners across the country can use FAF data to support economic analysis, such as cost-benefit studies, freight investment scenarios, and other activities. Slides from the webinar can be viewed at <http://www.ugpti.org/resources/presentations/>

NDSU researcher inducted into Phi Kappa Phi honor society

Raj Bridgelall, researcher with the Upper Great Plains Transportation Institute at NDSU, was recently inducted into the Honor Society of Phi Kappa Phi. Membership is by invitation and requires nomination and approval by a local chapter. Graduate students in the top 10 percent of the number of candidates for graduate degrees. Faculty, professional staff and alumni who have achieved scholarly distinction are also eligible.

MPC director invited to comment at meeting with U.S. Secretary of Transportation

MPC director Denver Tolliver was invited to make comments at a rural transportation roundtable discussion with U.S. Secretary of Transportation Anthony Foxx, April 24 in West Fargo, ND. Tolliver was part of a panel that also included state and local officials. Tolliver's comments focused primarily on the need to upgrade regional rail infrastructure as well as the need for government help for those upgrades. The event was organized by ND Senators Heidi Heitkamp and John Hoeven. For more on the meeting, visit: <http://www.agweek.com/event/article/id/23183/>



Tolliver

NEW FACULTY

University of Colorado Denver

Farnoush Banaei-Kashani joined the faculty in the Department of Computer Science and Engineering at UC-Denver after more than a decade as a research at University of Southern California. His research focuses on big data management and mining with a special interest in transportation.

Caroline Clevenger joined the faculty of the Department of Civil Engineering at UC Denver after spending the last five years at Colorado State University. She was recently named the assistant director of the Construction Engineering and Management Program. Clevenger's research interests include sustainability and building information modeling.

University of Utah

Daniel J. Fagnant joined the U of U as an assistant professor in civil engineering. He holds civil engineering doctoral and master's degrees from the University of Texas and a computer engineering bachelor's degree from Gonzaga University. Fagnant is a member of the TRB's Vehicle-Highway Automation Committee and Motorcycle and Moped Committee. His research on autonomous vehicles has been presented to the U.S. House Subcommittee on Highways and Transit. Other research interests include project planning and evaluation, transportation safety, motorcycles, bicycles, and pedestrians. Fagnant also worked for five years with the Alaska Department of Transportation.



Outreach Activities



Bordelon

Bordelon provides outreach for concrete results

MPC researcher and U of U assistant professor of civil and environmental engineering Amanda Bordelon presented “Smog-Eating Concrete” at the Utah Society of Professional Engineers Continuing Education

seminar in Salt Lake City and “What is New About Concrete” at the ASCE Utah Branch luncheon seminar. Bordelon also presented, organized, and ran concrete mixing activity at Hi-GEAR girls summer camp and attended, along with several UDOT employees, a demonstration of BASF’s microsphere technology.

MPC researcher co-authors chapter in Guide to Concrete Overlays

A new book, *Guide to Concrete Overlays*, was recently released by the National Concrete Pavement Technology Center. Amanda Bordelon assistant professor of civil and environmental engineering at U of U is a co-author for the chapter on design and the appendix on fiber-reinforcement. View the book at http://www.cptechcenter.org/technical-library/documents/Overlays_3rd_edition.pdf.

TRB features Wyoming work on roadway safety on Indian reservations

MPC work at UW was featured in the “Research Pays Off” section of the September–October 2014 edition TR News. The feature article explores the Wyoming Rural Road Safety Program (WRRSP), which was developed to help local and tribal governments improve highway safety at high-risk locations. “Research Pays Off” is a regular series highlighted in TRB’s bimonthly magazine, TR News.

The article highlights efforts by the Wind River Indian Reservation, which now has a comprehensive traffic safety program developed through the use of the WRRSP. The projected reduction in the annual crash rate—and in injuries and fatalities—by 50 percent across the Wind River Indian Reservation would yield a potential savings of more than \$4 million per year. The methodology developed in the UW research can be adapted to the specific needs of tribes across the United States. WYT2-LTAP has been working with Tribal Technology Assistance Program centers across the country to facilitate implementation. Read the article at <http://onlinepubs.trb.org/onlinepubs/trnews/trnews294rpo.pdf>.



Project Highlights

UC Denver studies impact of urban arterial streets on neighborhood residents

As part of a study to develop design guidelines, Students and researchers at the University of Colorado Denver hit the streets this summer and fall to learn how urban arterial streets – those with fast and heavy traffic – impact residents of local Denver neighborhoods through the Denver Neighborhood Connections Survey.

The survey is part of the Livable Arterials project, an MPC research endeavor that aims to determine how street design features affect residents' perceived safety and comfort and improve quality of life in neighborhoods near arterial streets. Wesley Marshall, assistant professor of civil engineering, and Carolyn McAndrews, assistant professor of planning and design, are leading the effort.

Members of the CU Denver team went door-to-door conducting the survey, asking residents to answer a few short questions about their neighborhood, their travel patterns, their transportation choices, their local street, and about an arterial street located near their residence. The research team is currently analyzing the data to help better understand the connections between street and street network characteristics and the livability of these nearby neighborhoods.

U of U researchers use big data to evaluate highways for decision making

Researchers at the U of U are looking for innovative ways to use the large volume of data from roadway sensors to help transportation planners find ways to reduce congestion and accidents.

Assistant professor of civil and environmental engineering Cathy Liu, with Ph.D. student Zhuo Chen have developed data-driven algorithm to determine the incident-induced delay on highway segments and to identify secondary incidents based on UDOT's incident database and the traffic sensor data archived in its freeway performance measurement system. The algorithm builds upon multi-dimensional databases and is able to identify the shockwave front for each individual incident to determine its spatial and temporal impact. After a pattern matching procedure is used (background subtraction) to eliminate the effect of recurrent congestion, the delay solely induced by incident and the secondary incidents are determined.

The algorithm is being tested along a segment of the I-15 corridor, and if it proves to be effective it will be incorporated into the transportation planning and programming to assist with decision making and project prioritization.

Liu notes that incident management is increasingly recognized by transportation agencies as a critical component of effective freeway performance monitoring and assessment. Traffic operators must understand the characteristics associated with different types of incidents to respond to the emergency appropriately and efficiently. Meanwhile, the increasing availability of traffic data from the large-scale deployment of roadway sensor networks facilitates the observation and modeling of the congestion evolution through data mining techniques.

Study predicts performance of fiber-reinforced concrete overlays

Making sure that pavement overlays last as long as possible is critical to cost-effective maintenance of highways. Researchers at the U of U are studying fiber-reinforced concrete (FRC) overlays to better understand how the fibers affect their performance.

U of U assistant professor Amanda Bordelon notes that despite years of research, cracking, and debonding of pavement overlays remains a serious issue because they often limit the service life of pavement structures. Many studies have been carried out to predict crack spacing and crack width of jointed plain or continuously reinforced concrete pavements. However, there is no existing equation which predicts crack spacing or crack widths of FRC overlay pavements.

Bordelon says this is partially because there is a limited number of FRC pavements and there are even fewer projects which have attempted to correlate the FRC lab-tested properties to an FRC pavement performance. "This is a growing interest in applying fibers to concrete pavements in order to prevent and/or minimize cracking. So it will be useful to have improved design parameters that take into account an accurate effect of fibers."

Bordelon and graduate student Min Ook Kim are studying cracking and debonding of thin FRC overlays cast over existing aged asphalt pavements. A previous research project involved creating a full-scale field constructed FRC overlay that is 5 cm (2 inches) thick over a milled asphalt pavement. The cracked joint spacing, crack widths, and debonding were all monitored for five years of thermal and shrinkage loading (no traffic loading at this time). These field measurements will be compared to a theoretical predictive crack width equation and to

finite element modeling of the same temperature and shrinkage loading.

The theoretical equation that is being developed to predict crack width of thin FRC overlay combines the joint opening calculation from AASHTO's pavement design guide and is modified to consider the fiber effect based on either the fiber aspect ratio from a structural RILEM reference or the FRC flexural strength and post-cracking properties. The two-dimensional finite element model (FEM) being developed investigates the cracking and FRC-asphalt interfacial debonding when subjected to temperature loading within the FRC overlay layer. The model uses fracture energy of the FRC to characterize the opening of cracking at joints. A maximum bond strength criterion was applied to the interface cohesion between FRC and the underlying asphalt layer.

Figure 1 shows the tensile stress distribution when the cracking and debonding are occurring based on FEM. Preliminary calculations indicate that the crack widths from the proposed theoretical equation and from the analytical FEM results were closely matched to the measured field investigation data. Figure 2 shows the comparison between the calculated crack widths and field measurements. Again, these calculated crack widths show good agreement with measured crack widths.

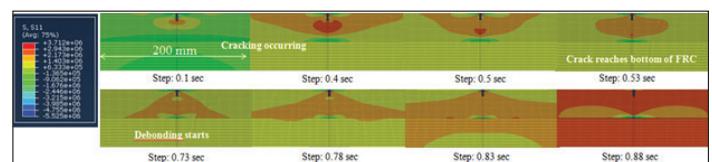


Figure 1. Stress distribution when cracking and debonding are occurring in an FRC overlay on asphalt.

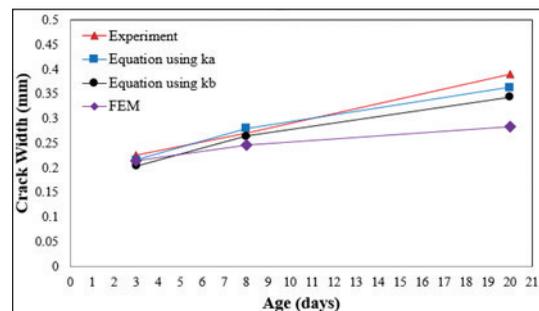


Figure 2. Comparison of calculated crack width to field measurements for FRC overlays subjected to temperature loading.

The finite element model developed by the researchers will be used to investigate the effects of joint spacing, slab thickness, tensile bond strength, and fiber dosage on cracking and debonding of thin FRC overlay. In addition, lab-scale experiments determine how the hardened properties of FRC change as they age. These experiments include

measuring restrained shrinkage, coefficient of thermal expansion, residual flexural strength, fracture energy, tensile bond, and shear bond. These properties and their function with time can be implemented into developed equation and the finite element analysis for better prediction of crack opening of FRC overlay at early ages. These tests will be done on both plain concrete and FRC mixtures to verify the effect of fiber on each property. The early age properties are needed for 1, 3, and 7 days in addition to later age properties at 28 and 90 days. The material variables for this research are three different fiber types (one steel fiber and two synthetic fibers) and three different fiber contents (0.25, 0.5, and 1.0% volume fraction) in concrete. The same mix proportions as used in the field experiment will be re-created in the lab for these new specimen experiments.

Bartlett studies use of expanded polystyrene geofoam for transportation infrastructure

The U of U Transportation Center, in conjunction with the Mountain-Plains Consortium (MPC), is researching the use of expanded polystyrene (EPS) geofoam for use in transportation infrastructure. One MPC-funded project is being conducted in corporation with the Norwegian Public Roads Administration (NPRA). The project is evaluating the use of EPS geofoam to support bridges on soft ground without the use of deep foundation systems. A preliminary concept paper was presented in Berlin, Germany, last year at the 10th International Conference on Geosynthetics (bridges on geofoam). The research and evaluations are currently ongoing. In this project, laboratory testing and calculations are being performed to evaluate the feasibility of supporting 1- to 2-lane single span temporary or permanent bridges on EPS geofoam abutments. This technology provides for accelerated bridge construction (ABC) on soft ground without causing significant settlement of the bridge or the associated approach embankments.

Additionally, Dr. Steven Bartlett visited Istanbul and Ankara, Turkey, in June 2014 to present various topics regarding the use of EPS geofoam for transportation engineering applications to the Turkish Highway Administration and others. Topics included lightweight embankments, preventing settlement at bridges, culverts, etc. and the use of EPS geofoam in light-rail and commuter rail systems (geofoam transportation). For his efforts, the Expanded

Polystyrene Board of Directors of Turkey (EPSDER) presented him a recognition award.

The University of Utah, in conjunction with the University of Memphis and NPRA, continues research in this area. More information can be found at: <http://www.civil.utah.edu/~bartlett/Geofoam/>. An international EPS conference is planned for Istanbul, Turkey, in early summer of 2017. Contact bartlett@civil.utah.edu for more information.

SDSU searches for ways to reduce damage from truck collisions with bridge columns

Current AASHTO load and resistance factor design bridge design specifications require unprotected bridge columns within close proximity to the traveling lanes be designed for a collision force of 600 kips (1000 pounds-force) applied laterally at 5 ft. above ground. The collision force provision is set to prevent bridge collapse under the extreme event of a semi tractor-trailer collision with the bridge column. The majority of existing overpass bridges on interstates and other major highways were designed and constructed prior to the introduction of these collision load design requirements.

Researchers at South Dakota State University are concluding a three-phase study to develop risk assessment and mitigation plans for collision loads to existing bridge columns on South Dakota interstates. In the first phase of the study, the researchers developed risk assessment of the likelihood of truck collision with bridge columns. The second phase included experimental work to examine the structural performance under collision loads of bridge bents that had been identified in the first phase of the study as "high-risk" structures. Two one-third scaled specimens representing as-built and retrofitted bents were tested to failure under simulated collision loads. Results indicate that the as-built bent failed at less than one-half the prescribed collision load while the addition of a concrete crash strut between the columns increased the bent collision load capacity to at least 1.5 times the demand imposed by AASHTO. In the third and final phase, a finite element computer simulation using LS-DYNA is being conducted to evaluate the accuracy of the AASHTO prescribed collision load when trucks hit the prototype bridge bent at different speeds.

The study is co-sponsored by MPC and the South Dakota Department of Transportation. The research team includes SDSU civil and environmental engineering professor Nadim Wehbe, associate professor Xiao Qin, and graduate students Zhao Shen, Brett Tigges, and Abdullah Boudaqa.

Research focuses on improved performance of bridge girder systems

Precast double-tee bridge girder systems are routinely used by local governments in South Dakota for bridge construction on local roads. Many existing double-tee bridges have exhibited early signs of deterioration along the joints between adjacent girders. SDSU civil and environmental engineering professor Nadim Wehbe and graduate research assistant Michael Konrad are developing a new connection between adjacent girders to improve performance of precast-prestressed double-tee bridge girder systems.

The researchers tested two full-scale specimens of a 23" deep double-tee girder bridge system under fatigue loading at SDSU's Lohr Structures Lab. The researchers wanted to determine the long-term performance of longitudinal joints built according to current detailing and an alternative proposed detailing. The current detailing requires adjacent girder decks to be connected by welding 5" long steel plates to steel angles embedded in each girder at 5' intervals. A longitudinal non-shrink grout shear key, which tapers from 2" to 1.5" in width, runs the length of the girder. In the proposed joint detail, the wire mesh reinforcement in the girder deck is extended 6" beyond the deck edge. During bridge construction, the wire mesh extension of adjacent girders is overlapped inside a non-shrink grout shear key. The overlapped mesh and shear key run the length of the girder.

The fatigue test results revealed severe inadequacy of the currently used joint detail and exceptional performance of the proposed joint detail. The shear key of the specimen with the current joint detail exhibited signs of progressive and rapid deterioration with increased number of loading cycles. The joint started to leak at the equivalent of four years of service and the first weld failure in the connecting plates occurred at the equivalent of 12 years of service. Most of the welded connections failed at the equivalent of 16 years of service. On the other hand, the specimen with the proposed joint detailing was subjected to fatigue loading equivalent to

more than 100 years of service without showing any significant joint or stiffness degradation.

The study is co-sponsored by MPC and the South Dakota Department of Transportation.

Testing of full scale bridge connection recently completed at CSU

Research into the behavior of Simple Made Continuous (SMC) bridges with exposed steel diaphragms has been ongoing at CSU. SMC bridges are constructed as simple spans for the dead load of the girders and the composite concrete slabs. Additional top reinforcing is placed in the deck slab from roughly the center of the first span to the center of the last span. Once the concrete attains its design strength, this reinforcing allows the girders to achieve continuity at the interior supports and thus, the composite girders become continuous for live loads.

This project studies a unique SMC connection designed by the Colorado Department of Transportation. While most steel SMC bridges use steel girders cast into concrete diaphragms, the connection under investigation does not use concrete diaphragms, leaving the girders exposed. The exposed steel connection has several advantages, including greater accessibility for inspections and potentially quicker construction.

Following investigation of the connection performance with basic mechanics and subsequent finite element analysis, a full scale test on the continuity connection was conducted in the structures lab at the CSU Engineering Research Center. The physical test spanned two consecutive days and consisted of applying increasingly higher loads at both ends of the cantilevered beams to simulate a negative moment at the SMC connection at the center of the model; the maximum applied load at each end was 198 kips, which would cause a centerline moment of 2,376 kip-feet. The model was instrumented with 32 strain gages to measure strains in the concrete, the reinforcing, the steel girders, and the girder bearing plate. Additionally, seven potentiometers were installed to measure displacements at the girder ends and at the center of the connection to measure girder displacements.

Based on the results of the physical test, internal forces in the various elements of the connection were determined in order to verify the internal moment at the center of the support. The internal moment and resulting internal forces will be further investigated for correlation with the hand calculations in order to develop a design methodology for this type of connection.

UGPTI predicts infrastructure needs for North Dakota

An average of \$407 million per year will need to be invested in North Dakota's county and township roads and bridges to maintain them over the next 20 years, according to a recent study from the Upper Great Plains Transportation Institute at NDSU. Researchers there estimate the total investment needed over the next 20 years will be \$8.1 billion, with about half of the estimated amount going to needs in the oil and gas producing counties of western North Dakota. Unpaved road funding needs comprise approximately 67% of the total. If averaged over the next 20 years, the annualized infrastructure need is equivalent to \$407 million per year.

With a dramatic increase in traffic from North Dakota's oil and agricultural industries over the past several years, there has been a significant impact on the state's county and township road system. To plan for maintenance and upgrades to the system, the North Dakota Legislature directed the Upper Great Plains Transportation at NDSU to project infrastructure need for those roads.

This is the third such study conducted by UGPTI. For each study, researchers included additional data on production forecasts, traffic estimates, and roadway conditions.

During the past two years, researchers undertook a significant data collection effort to provide the most complete and current data on the condition of

county and township roads. Condition information was collected in conjunction with the North Dakota Department of Transportation using its Pathways van, which utilizes scientific instruments and software to provide objective assessments. Falling weight deflectometer and ground penetrating radar analyses were conducted to develop a clear picture of the existing pavement and subgrade structure. In addition, more than 1,000 traffic counts were collected to calibrate a statewide travel demand model, which was used to forecast traffic levels.

UGPTI developed a detailed Geographic Information System (GIS) model, which includes the origins of key inputs to the oil production process, destinations for crude oil and saltwater shipments, and the capacities of each source or destination. The origins of movements on the highway network include railroad stations where sand, pipe, and other inputs are transferred from rail to truck. The destinations of crude oil shipments include refineries and railroad and pipeline transfer facilities. In the model, the estimated capacities of transfer sites are expressed in throughput volumes per day, while the capacities of material sources are expressed in quantities of supplies available during a given time period.

A similar model is used to predict the trips of each crop produced in each township to elevators and/or processing plants, subject to the demands of these facilities. Using truck characteristics and typical weights, these trips are converted to equivalent axle loads and trips per day. These two factors, in conjunction with the condition ratings and structural characteristics of roads, are used to estimate the improvements and maintenance expenditures needed for the expected traffic. While the focus is on agricultural and oil-related activities, other movements (such as farm inputs and shipments of manufactured goods) are included in the analysis.

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