UTC-MiSTI and Rail Transportation Program Research Alternative Crosstie Materials

The activities of the University Transportation Center for Materials in Sustainable Transportation Infrastructure (UTC-MiSTI) at Michigan Technological University (Michigan Tech) largely focuses on highway and road transportation, with faculty expertise in highway and bridge design, and in all aspects of construction materials including asphalt, portland cement concrete, aggregates and soil materials. But a few key events have lead to a unique and growing partnership in rail transportation. This partnership, albeit young, is gaining momentum and is providing new opportunities for students and faculty to become engaged in the mode of rail transportation.

Background

In 2005, through SAFETEA-LU, Michigan Tech was granted a Tier II University Transportation Center (UTC-MiSTI). The national UTC program, administered through the USDOT Research and Innovative Technology Administration, requires each Center to have representation on their external advisory board by a modal agency. The Center’s strategic planning committee considered all modes and the opportunities for enhancing the sustainability of each through the use of materials. Concurrently, there was a young graduate student at Michigan Tech whose research in to the needs of the 21st century rail industry revealed a need for education and research programs to support rail transportation. Although at this stage rail was only viewed as an opportunity for the University to expand its transportation activities, the UTC-MiSTI strategic planning committee identified rail as the best mode for the Center to align with. The strategic plan for the UTC was approved in June 2007 and in the fall of 2007 the Rail Transportation Program (RTP) was formed with the appointment of that young graduate student, now Dr. Pasi Lautala, as its Director. Both programs, the UTC-MiSTI and the RTP gained the attention of the Federal Rail Administration (FRA) when a representative of the FRA accepted a seat on the UTC-MiSTI’s Technical Advisory Council. This council provides input on Center activities to assist the Center in meeting the program mission of supporting state and national transportation agency needs.

Both centers work collaboratively to grow transportation as a multi-disciplinary research thrust at Michigan Tech. The UTC-MiSTI has provided graduate student support to help secure externally funded research in the area of rail infrastructure construction, and develop the role of materials in enhancing the sustainability of that infrastructure. This summer, the UTC-MiSTI is supporting an internal research investigation with an objective to benefit the rail industry through the identification of alternative crosstie materials that provide a more sustainable solution to this important engineering need.

Likewise, the two centers cooperate in outreach and education activities. In April 2008 and 2009, the RTP and the UTC-MiSTI participated in Michigan’s Construction Career Days. This event provides career and education awareness for middle and
Director’s Corner

At a small university like Michigan Tech, one often finds themselves wearing many hats. In addition to my role as Professor, directing numerous research projects and graduate students, I serve as the Director of the UTC-MiSTI and I also serve as the Director of the Michigan Tech Transportation Institute (MTTI). The UTC-MiSTI reports to the Department of Civil and Environmental Engineering, while MTTI reports directly to the Vice President for Research. MTTI has the charge of creating and fostering a collaborative, multi-disciplinary environment for transportation research at Michigan Tech. MTTI achieves this goal by directing resources to support existing programs and providing start-up resources for new programs. One new activity that we are very proud of is our Rail Transportation Program (RTP). Although the RTP is not a UTC-MiSTI activity, the two programs have become entwined through my involvement in both, and because there are simply numerous areas where the activities of both programs are in common. This synergy was identified right from the start. When forming the UTC-MiSTI’s external Technical Advisory Council (TAC), the strategic planning committee identified numerous opportunities for collaborating with the RTP and unanimously decided to recruit representation from the Federal Rail Administration (FRA) for a modal representative on the TAC.

The UTC-MiSTI and RTP partnership is a developing relationship. What started in the UTC-MiSTI’s strategic planning stages undoubtedly is benefiting both centers, keeping multimodal issues and rail transportation as a focus for the UTC-MiSTI. The ”sibling centers”, as we call them, collaborate in many areas. They are research partners. In this newsletter we discuss the RTP and UTC-MiSTI pursuing materials research to improve the sustainability of the rail industry. The two centers are partners in education, outreach and workforce development. Through graduate and hourly student support, and collaborative involvement in programs like Construction Career Days and the National Summer Transportation Institute, UTC-MiSTI and the RTP at Michigan Tech are fostering a unique and growing partnership. Because of our close relationship, we are pleased to highlight the RTP in this newsletter.

- Larry
high school youth. Michigan Tech was also recently awarded a National Summer Transportation Institute program by the Federal Highway Administration. This program will cover a broad spectrum of transportation concepts and opportunities, including rail, in its efforts to attract a diverse and educated workforce for the greater transportation industry.

2009 Summer Scholars Initiative

Over the past decade the need for sustainability, and materials and products to achieve sustainability, has moved from an academic concept to a societal expectation. This is true in both our personal lives as much as it is for business. The railroad industry is no exception. Sustainability in the railroad industry, like all industries, can be directly affected by the use of materials. Innovative materials, or the correct selection of materials, can reduce the amount of maintenance required, increase the service life, and decrease the need to dispose of potentially harmful waste. A prime example of this is railroad crossties. Railroad crossties are key to railroad infrastructure. They are what hold the correct gauge (tracks) between two rails and distribute the heavy axle loads, the main factor that makes the railroad an efficient mode of transportation.

The RTP in partnership with the UTC-MiSTI is conducting research into alternative materials for use in railroad crossties. As part of the UTC’s Summer Scholars program, one project is looking to identify new materials that can withstand the harsh railroad environment, reduce maintenance requirements and be economically recycled, possibly into new ties. There are several alternative materials in use but currently most crossties are either made from hardwood or softwoods, like oak or pine. The typical size required for most crossties, (i.e. 7 in. x 9 in.) often requires the tie be cut from the center of log. The slabs that are created may or may not be usable for other purposes, such as building materials. Meeting the growing need for ties is becoming less economical because of the extensive number of years needed for the tree to grow to the right dimensions. Even though softwoods grow faster, they still require 10-20 years to grow the timber to the required dimensions. Another significant factor with wood ties is the preservatives used to keep the ties from decaying. Creosote is most often used to preserve wooden crossties against decay and attack by insects. Creosote is a derivate of coal tar, which can be harmful to humans with prolonged exposure and is therefore not environmentally safe.

Alternative materials to the traditional wood ties include, concrete, steel, plastic or rubber, and composites. Concrete and steel have been used in service for a number of years. Concrete has proved itself very useful for heavy haul lines and high tonnage lines. Outside North America, it has been used almost exclusively on higher speed passenger rail lines. One drawback of concrete ties is that they are significantly heavier than their wooden counterpart. Plus, concrete is not without sustainability issues. Of the other alternative materials, steel ties have found their niche in sidings and small commercial yards, but are not currently practical for mainline use. Plastic, rubber and composite ties are still fairly untested in the railroad industry. Many problems faced with these alternative materials are cost and availability. The cost of these new types of tie materials and manufacturing can be significantly greater than what a wooden tie would cost. However what is promising is the sustainability and recyclability of the materials used to manufacture them. Plastic ties can be manufactured from everyday plastics that would have normally been land filled. Rubber ties use old tires that are then shredded and processed into new ties. Composite ties consist of either plastic or rubber around a wooden core. This helps the tie to better match the material properties of the...
Voted as the 2009 Howard E. Hill Outstanding Faculty Member by students of Civil and Environmental Engineering this past academic year, Dr. Devin Harris has wasted little time in making an impression at Michigan Technological University (Michigan Tech). Appointed in January 2008 as a Donald F. and Rose Ann Tomasini Assistant Professor in Structural Engineering in the Civil and Environmental Engineering Department, Dr. Harris has been active in teaching, research, publications, and presentations.

Prior to arriving at Michigan Tech, Devin K. Harris received his PhD and MS degrees in Civil Engineering from Virginia Polytechnic Institute and State University and a BS degree in Civil Engineering from the University of Florida. Dr. Harris’s research interests include all aspects of structural engineering, with a main focus on bridges and innovative materials for civil infrastructure. He has conducted research on Sandwich Plate System (SPS) for use in bridges and ultra-high performance reinforced concrete and is currently interested in researching the repair and rehabilitation of structural members with externally bonded fiber reinforced polymers.

Before coming to Michigan Tech, Dr. Harris worked for the Exxon Company and the Exxon Mobile Development Company as a project engineer and senior project engineer. He was an instructor for Reinforced Concrete Design 1 at Virginia Tech and a guest lecturer for the course Finite Element Analysis of Structures and the Virginia Tech European Bridge Seminar.

A recipient of the Charles Via PhD and Masters Fellowships, the National Science Foundation (NSF) Integrative Graduate Education and Research Traineeship Program (IGERT) Fellowship, and the Graduate Dean’s Fellowship, Dr. Harris was also honored at the Virginia Transportation Conference with the T.Y. Lin Transportation Structures and Materials Student Paper Award in 2005. Additionally, he was a winner in the Precast/Prestressed Concrete Institute (PCI) Big Beam Competition Zone 5 at Virginia Tech.

Dr. Harris is a member of the American Concrete Institute (Committee 343 – Bridge Design), PCI, American Institute of Steel Construction (AISC), and the National Society of Black Engineers (NSBE).

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s Pasi Lautala tells people “I came to Michigan Technological University as an exchange student for nine months and am still here 13 years later.” Arriving from Finland in 1996 to work on his Master of Science degree, Dr. Lautala brought with him a lifelong interest in rail transportation, growing up as the son of a locomotive engineer.

After receiving his Master’s degree from Michigan Tech in 1997, Dr. Lautala consulted for the railroad and highway industry in Chicago before returning to Michigan Tech in 2003 to begin working on his PhD. Only one year later, in the summer of 2004, then PhD. student Pasi Lautala and Michigan Tech faculty member Dr. William Sproule, created the first Summer in Finland – International Summer Program in Railroad Engineering. What began as a single course in 2004 has developed into the Rail Transportation Program at Michigan Tech. Now in its sixth year, nearly 100 students from different disciplines have completed the Summer in Finland program, an intensive five-week collaborative program between Michigan Tech, the Tampere University of Technology in Finland, and the North American and Finnish railroad industry. Students spend two weeks on campus at Michigan Tech and on field visits to the Chicago area before flying to Tampere, Finland for three weeks of rail study and immersion in the Finnish culture. Today Dr. Lautala is also a Research Assistant Professor, as well as Director of the Rail Transportation Program (RTP), which was established by the Michigan Tech Transportation Institute (MTTI) in the fall of 2007.

Creating another first for Michigan Tech, Dr. Lautala also applied to the American Railroad Engineers and Maintenance Association (AREMA) to form a student chapter of the AREMA in 2005. Granted membership, the Michigan Tech REAC club (Rail and Engineering Activities Club) became the first ever official student chapter of AREMA in 2006. The club was established to raise awareness and interest in railroad engineering and to educate the student body about opportunities and benefits of a career in railroading. Additionally, the 30+ REAC student members organize and participate in events that increase the visibility of railroad industry on campus and among general public such as the annual Railroad Night, Copper Country Railroad History talk, and numerous trips to rail sites.

In addition to education and events and extracurricular activities, the Rail Transportation Program aims to provide increased exposure to rail transportation with the 3rd integrated activity group, projects, and research. Dr. Lautala, supported by other Michigan Tech faculty and by undergraduate and graduate students, is currently undertaking research on two projects “Synthesis of Railroad Engineering Best Practices in Areas of Deep Seasonal Frost and Permafrost” and “Study of Greenhouse Gas Savings associated with Congestion Reduction using Multi-Modal optimization of Timber Shipments in the North Central United States”. He also teaches International Railroad Engineering and Railroad Track Design and Design courses at Michigan Tech. In the near future, Dr. Lautala hopes that the RTP will be able to offer a multi-disciplinary certificate in rail transportation as well as offering rail oriented projects for senior designs and Enterprises, where a student-run company tackles real-world challenges with funding from industry.

Not only did Dr. Lautala bring his knowledge of the rail industry to Michigan Tech when he arrived from Finland, he also brought his musical talent and love of Finnish music. Formed in 2006, The Pasi Cats with Pasi Lautala as lead vocalist, is a unique band performing Finnish music in the Copper Country from the 1940’s to today including waltz, polka, jenkka, foxtrot, tango, country and humppa music. Their flyer states, “Arguably the 3rd best Finnish Dance Band in the whole Copper Country”. Located in the Upper Peninsula of Michigan, where the history of Finnish immigrants still lives on, Michigan Tech and its Rail Transportation Program have become home 13 years after Dr. Lautala stepped off that plane for a nine-month visit.
Student Spotlight
Student Profile of Andrew Manty

After a year of ‘co-oping’ I will return for my fifth and final year at Michigan Technological University (Michigan Tech) and plan to graduate in May 2010 with a Bachelor of Science in Civil Engineering. Michigan Tech was an easy choice for me because of its close proximity to my hometown of Ishpeming, Michigan. As a born and raised ‘Yooper’ I had no desire to leave the Upper Peninsula. On many fall trips to the Keweenaw to see the fall colors I fell in love with the area and all it has to offer. I graduated from Westwood High School in 2005 with the intent to major in Computer Engineering (CpE) at Michigan Tech. I had taken a few tours of the University’s facilities while in high school and I knew CpE was for me.

After a few short months into my first semester I realized that I didn’t like computers as much as I originally thought I did. I then switched majors to Electrical Engineering (EE). This change lasted a little longer than my original choice of majors, but after a year of being in the EE program I realized it too was not for me. I wanted to participate in the International Senior Design (ISD), which the EE degree didn’t easily support. I did not end up participating in ISD that year but I did get accepted into the International Sustainable Development Engineering Research Experience Program (ISDEREP) for the summer of 2007. The ISDEREP was a three-year NSF grant funded program for undergraduate students to work on an international team and spend a month in Bolivia working on a research project. The teams were made up of two undergraduates from the University Technological Bolivia, a Michigan Tech undergraduate student, and a Michigan Tech graduate student as the team leader. The project team that I was working on was wastewater treatment in jungle villages in rural Bolivia.

Shortly before I left for ISDEREP I made what has proven to be my final departmental switch to Civil Engineering. After the month abroad I was sure that I had made the right choice. I returned from Bolivia with a new passion for school and for my degree (i.e. finally the right degree). I took classes that fall including Construction Engineering with Dr. Mattila, and Transportation Engineering with Dr. Alkire. Both classes further reinforced my decision to switch to Civil Engineering. In the winter of 2008 I went on co-op with Toyota Motor Engineering and Manufacturing in Ann Arbor, MI. I worked in Plant Engineering in Maintenance and Operations where I learned a great deal about building systems as well as the ‘Toyota Way’ and Lean Operations.

In the summer of 2008 I participated in the Summer in Finland program. The Summer in Finland program at Michigan Tech gives students an introductory course in railroad engineering and Finnish language and culture. The program lasts five weeks, with three weeks spent in Finland at the Tampere Technological University in Tampere, Finland. From the Summer in Finland program, I returned to the States where I started a 7-month co-op with Union Pacific Railroad (UPRR). With UPRR I worked in the Bridge Maintenance department where I traveled and worked in Chicago, IL for 3-months, Iowa for 1-month, and St. Paul, MN for the remaining 3-months. My co-op with UPRR taught me a lot about the rail industry and what it takes to keep the trains moving safely and efficiently. It also introduced me to a career specialization I had never considered in the past, structures, specifically railroad structures. I returned to classes in the winter semester of 2009 and will make the sprint into the final year of my degree.

As a UTC Summer Scholar this summer I am able to get a feel of what graduate school would be like. In the last year I have been considering graduate school more and more. The Summer Scholars Program is helping me to see many of the aspects that graduate school would require of me. With the experiences I’ve gained through the Summer Scholars Program I will be more prepared for graduate school and will already have some research experience under my belt. This summer I am also serving as the Rail Transportation Program Student Coordinator. I am currently working on promotional material for the Rail Transportation Program, the Railroad Engineering and Activities Club, and the Summer in Finland Program.

My involvement with the Rail Education Activities Club (REAC), has taken me to the State fairgrounds in 2008 and 2009 to represent Michigan Tech and the Rail Transportation Program at Michigan’s Construction Career Days. Our involvement in this career awareness and workforce development event has been encouraged and supported by the UTC-MiSTI. Here I’ve been able to talk with high school and middle school youth about my experiences leading to a degree in Civil Engineering and rail transportation.

I’m still unsure of the path I will take once I graduate, if I’ll return for graduate school or if I’ll go out into industry. I know which ever path I choose, through the experiences I’ve gained at Michigan Tech through my involvement with the RPT, UTC-MiSTI and my international and co-op opportunities I am well prepared for whatever my next ‘adventure’ will be.
I’m Russ Lutch and I’m pursuing a Master’s of Science degree in Civil Engineering with a concentration in structural engineering from Michigan Technological University (Michigan Tech). My projected graduation date is December 2009. Currently my family is in Chisago City, Minnesota but has lived in numerous places such as Tacoma, Washington and Naperville, Illinois. Right now I consider Houghton, Michigan to be my home. I received my Bachelor of Science degree from Michigan Tech in May 2008, but left for the summer before beginning graduate school to complete my second internship with Kiewit Engineering Company (KECo) in Omaha, Nebraska. There I was a structural engineering intern working on the design of temporary structures such as formwork, falsework, and work access platforms. I have participated in projects such as the Oakland Bay Bridge, Tacoma Narrows Bridge and Willis Avenue Bridge. Once I complete graduate school I will join KECo as a full-time structural engineer in January 2010.

My introduction to the railroad industry began my senior year of my undergraduate degree, when I worked as a research assistant for professors Dr. Theresa Ahlborn and Dr. Devin Harris. They were working on a rail transportation project proposal for the State of Alaska. Following the award of the project, I was asked to stay on as a graduate research assistant. Currently, with nearly all my course requirements completed in my first year of graduate school, I am now focused on my research related to the rail transportation project “Synthesis of Railroad Engineering Best Practices in Deep Seasonal Frost and Permafrost Areas” sponsored by the University of Alaska-Fairbanks. This project includes an evaluation of railroad engineering practices related to the proposed Alaska Canada Rail Link (ACRL), which would connect the Alaskan railroad to the continuous 48 states. For this project I have been given the task of evaluating the use of prestressed concrete railroad ties and other tie materials in areas of deep seasonal frost and permafrost.

In the spring and summer of 2009 I was the leader of Michigan Tech’s team for The Precast/Prestressed Concrete Institute’s Student Engineering Design Competition: Big Beam. In the competition, a student team designs, fabricates, and tests a prestressed concrete beam with the goal of achieving an ultimate load within a specified range. Our team choose to use an inverted-beam design which we fabricated with the help of Spancrete, Inc. in Green Bay, Wisconsin. Testing was completed in mid June and the results of judging should be released by the end of summer 2009. Overall this competition was an excellent experience for myself and the other students, providing an opportunity to apply our engineering design knowledge obtained at Michigan Tech and to develop a respect/understanding of the fabrication process which could not be achieved in the classroom.

In addition to the previously stated projects, I have been working on my thesis titled “Evaluation of Concrete Materials for Rail Seat Abrasion Resistance in North America’s Railroads.” The research will evaluate the suspected causes for rail seat abrasion and then use various concrete mix designs to increase the abrasion resistance of the concrete. This project will be collaborative between Michigan Tech and several rail industry partners. I choose this topic due to my background in structural engineering and concrete materials, which aid me in understanding the failure mechanisms of rail seat abrasion, one of the most detrimental processes afflicteding North America’s railroads. This summer, I’m also working on some publications related to concrete ties and rail seat abrasion for presentation at the AREMA 2009 and ASCE Cold Regions Engineering 2009 conferences. Russell Lutch uses a concrete vibrator while working on a pre-stressed beam for the 2009 PCI Big Beam Competition.
Trains, Planes, Automobiles, and More
Michigan Tech to host the National Summer Transportation Institute

On July 19th, thirty high school freshman and sophomores from across Michigan will convene on Michigan Tech’s campus for two weeks of trains, planes, automobile, marine, and pedestrian transportation topics. Through the National Summer Transportation Institute Program (NSTI), sponsored by the Federal Highway Administration, these students will expand their understanding of modal and intermodal transportation issues while honing their math, science, engineering and civic skills. NSTI provides a two-week residency for youth interested in careers and education in transportation. Through eight modules developed for the TRAC program, students will experiment with magnetic levitation and laws of motion, bridge building, roadway design and construction, traffic technology, city planning and motion and transportation. Field trips will provide opportunities to see firsthand, airport operations, marine transportation and rail system operations. Also, role model speakers will share career insight. Watch for program highlights in a future issue and on the Center’s Website.

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traditional wood tie. The important factor to finding an alternative to wooden crossties is the life cycle cost compared to traditional ties.

Many questions have to be asked when attempting to identify or develop a new tie material. For example, can it be recycled? Will a tie made from the new material last as long, if not longer than, traditional wooden ties? What, if any, special disposal is required at the end of service of the tie? What kind of maintenance, if any, is required? Can it be harmful to the environment or does it provide an environmental benefit over existing materials? The real challenge is finding a material that is all of these and more. The ideal material will have a long in-service lifespan, can be recycled, reused or repurposed, and isn’t harmful to workers or the environment, all reducing the environmental footprint of the railroad.

Rail transportation offers many benefits over other modes of transportation and functions well in partnership with other modes through intermodal transport. Rail transportation is gaining attention as a more sustainable approach to shipping freight over land. The rail industry, like other transportation modes, needs more sustainable infrastructure solutions. As part of the UTC’s Summer Scholars Program the UTC-MiSTI and the RTP at Michigan Tech are partnering to explore other options for crosstie materials to help meet these sustainability goals.
The University Transportation Centers (UTC) program, initiated in 1987 under the Surface Transportation and Uniform Relocation Assistance Act, authorized the establishment and operation of transportation centers in each of the 10 standard federal regions. The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) reauthorized the UTCs for an additional six years and added four national centers and six University Research institutes (URI). The mission of the 14 UTCs was to advance U.S. expertise and technology transfer. The six URIs each had a specific transportation research and development mandate.

In 1998 the Transportation Equity Act for the 21st Century (TEA-21) reauthorized the UTC Program for an additional six years and increased the total number of Centers to 33. In addition to the ten regional Centers, which were to be selected competitively, TEA-21 created 23 other Centers at institutions named in the Act. TEA-21 established education as one of the primary objectives of a University Transportation Center and institutionalized the use of strategic planning in university grant management.

The Safe, Accountable, Flexible, Efficient Transportation Equity Act, enacted on August 10, 2005, authorized up to $76.7 million per year from Federal FY2005-2009 funds for grants to establish and operate up to 60 University Transportation Centers throughout the United States. Twenty of these centers were competitively selected during 2006, and forty centers are located at institutions named in the legislation.

The UTC program is managed by the Research and Innovative Technology Administration, U.S. Department of Transportation.