



MiSTI

*U.S. DOT University Transportation Center for
Materials in Sustainable Transportation Infrastructure*



2008-2009 Annual Report



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2008-2009 Annual Report

TABLE OF CONTENTS

Director's Message	2
Center Information/Management	3
People Highlights	4
University Partnership	5
Education	6
Research	7
Workforce Development	8
Technology Transfer	9
FY 3 Budget Overview	10
Outreach and Leadership	11
Baseline Reporting	12





Director's Message

Dr. Lawrence Sutter, PhD
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This year I am pleased to report that the UTC-MiSTI hit the mark in all four programming areas; research, education, workforce development and technology transfer. With the Center's research program months away from yielding results or findings of its own, thereby providing opportunities for technology transfer, UTC-MiSTI stepped in to lead the technology transfer efforts on a recently completed pooled fund study. The Center, in partnership with Michigan Tech's Summer Youth Programs division secured and hosted Michigan's first National Summer Transportation Institute Program for high school students. A Summer Scholars program internal investigation, conducted the previous year, led to a funded research project with the Michigan Department of Transportation. Last, the Center's unique Summer Scholars program provided opportunities to advance the Center's goal of impacting sustainability through materials research in the revitalized area of rail transportation. These activities and other program accomplishments are highlighted in this report.

Lawrence Sutter

2008-2009 Center Staff

Center Director	Dr. Lawrence Sutter, PhD
Assistant Director	Elizabeth Hoy
Office Students	Michael Urena Emily Lang
Web Development / Publications Editor	Scott Bershing

Technical Advisory Council

Federal Highway Administration	Suneel Vanikar
Federal Rail Administration	Donald Plotkin
Michigan DOT	Kirk Steudle
Minnesota DOT	Roger Olson
We Energies	Bruce Ramme
Vulcan Materials	Robin Graves
Klett Construction	Jim Klett
Precast/Prestressed Concrete Institute	Emily Lorenz
Holcim, Inc.	Al Innis
Applied Pavement Technology, Inc.	Tom Van Dam

Baseline Faculty

Dr. Theresa Ahlborn, P.E.	Associate Professor, Structural Engineering
Dr. George Dewey	Associate Professor, Structural Engineering
Dr. Ralph Hodek	Associate Professor, Geotechnical Engineering
Dr. Lawrence Sutter	Professor, Cementitious Materials
Dr. Stanly Vitton	Associate Professor, Geotechnical Engineering
Dr. Zhanping You	Assistant Professor, Pavement Materials
Dr. Jacob Hiller	Assistant professor, Pavement materials
Dr. Pasi Lautala	Research Assistant Professor, Rail Trans.
Dr. Devin Harris	Assistant Professor, Structural Engineering
Dr. Karl Peterson	Research Assistant Professor, Materials

Center Information/ Management

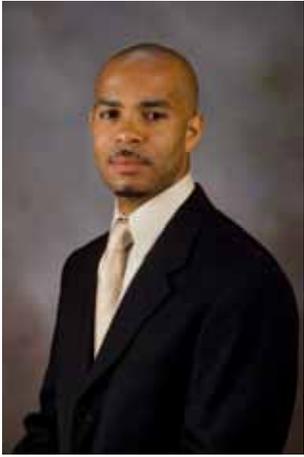
People continue to be a key driver in the Center's ability to achieve its mission of meeting the needs of state and national transportation agencies. This year the Center saw the addition of three new faculty to its baseline. Dr. Devin Harris joined the faculty in the department of Civil and Environmental Engineering as an Assistant Professor. He is highlighted on page 4 of this annual report.

Dr. Pasi Lautala, who joined the Michigan Tech Transportation Institute as a Research Assistant Professor and Director of the new Rail Transportation Program (RTP) in 2007, partnered with the UTC-MiSTI on rail-related materials research. This includes a synthesis of railroad engineering best practices in areas of permafrost and deep seasonal frost. Also, Dr. Lautala and Dr. Harris jointly advised a Summer Scholars investigation examining alternative rail tie materials. These and other RTP-UTC collaborations are featured in *Transportation News Vol. 3, No. 2*, available on the Center's Website, publication page.

Karl Peterson received his Ph.D. in May 2008 and began his role as the Director of the Materials Characterization Program. As an internationally-recognized concrete petrographer, Dr. Peterson's work contributes significantly towards determining causes of infrastructure material failures by investigating those materials on a microscopic level.

People Highlights

In 2008-2009 the Center continued growth in the number of people engaged in Center activities. Dr. Devin Harris



joined Michigan Tech as an Assistant Professor in Civil & Environmental Engineering. Harris's research focuses on the use of innovative materials for civil infrastructure and the behavior and design of bridges. Dr. Harris advised two 2009 Summer Scholar teams, one focusing in the area of concrete bridge deck life enhancement through the application of ultra-high performance concrete (UHPC) overlays, and the other performing an investigation of material selection, based on life-cycle assessment, for cross tie alternatives for rail applications.



Dr. Amlan Mukherjee participated as a 2008 Summer Scholar team adviser. His research interests include developing platforms and tools that support informed decision



2008 UTC Student of the Year

Melanie Kueber was selected as the 2008 UTC Student of the Year for her research contributions towards identifying technologies facilitating the use of high carbon fly ash as a supplementary cementitious material in transportation infrastructure construction. Melanie is scheduled to graduate with her Ph.D. in Civil Engineering in 2011. She is advised by Dr. Lawrence Sutter.

making for transportation and construction processes. A 2008 Summer Scholars' internal investigation led to his leadership as Principal Investigator on a funded external project with the Michigan Department of Transportation to develop an integrative framework to study carbon emissions of road construction projects. The award of this project to the UTC-MISTI demonstrates the success of its unique approach to conducting research. Through an internal 2008 Summer Scholars investigation, Center faculty and staff developed the foundation for an externally funded project providing growth in research activity, leverage of Center funds to secure cost share and generating a project supporting a funded graduate student opportunity. Furthermore, this project will provide the Michigan Department of Transportation with critical information regarding the economic and environmental impacts of road construction.

LTAP/UTC DEVELOPING PARTNERSHIP TIME LINE

- October 2006-February 2007—Michigan's LTAP Director actively participates in the five month UTC-MiSTI strategic planning process providing insight regarding federal programs and processes, and regarding the delivery of technology transfer activities.
- UTC-MiSTI participates as an exhibitor at the 2007 Summer NLTAPA Conference in Chicago, Illinois to learn more about the LTAP program and begin the process of developing relationships between the two programs.
- April 2008—Michigan's LTAP provides leadership in establishing Michigan's first Construction Career Days. This activity helped the UTC-MiSTI meet one of its Workforce Development goals.
- UTC-MiSTI participates as an exhibitor at the 2008 Summer NLTAPA Conference in Breckenridge, Colorado to continue building relationships among the programs and looking for opportunities to partner.
- April 2009—Michigan's LTAP provides logistical support for Michigan's second Construction Career Days.
- February 2009 UTC-MiSTI and Michigan's LTAP partner in the delivery of four national Webinars on Winter maintenance Best Practices and results of TPF-5 (42) reaching 859 participants in 29 states and 3 countries.
- UTC-MiSTI participates as an exhibitor at the 2009 Summer NLTAPA Conference in Pittsburgh, Pennsylvania. UTC-MiSTI was invited to participate on a panel discussion related to partnerships and funding diversification.

University Partnership

Many University Transportation Centers operate on university campuses where that state's Local Technical Assistance Program (LTAP) is housed. There continues to be discussions at the national level, both within the Council of University Transportation Centers (CUTC) and the National Local technical Assistance Program Association (NLTAPA), regarding how these two programs can partner to advance transportation, especially in the area of technology transfer. At Michigan Tech, the two programs reside on the same floor of the Civil Engineering building, and play important roles in the overall growth and awareness of the capabilities of Michigan Tech as a leading transportation research, education and technology transfer partner.

Effort and perseverance by the UTC-MiSTI and Michigan's LTAP to forge a meaningful and working relationship has led to the Michigan Tech model being an example of true collaboration and partnership. At the 2009 Summer NLTAPA conference, UTC-MiSTI served on a panel discussion highlighting the partnership forged between the UTC and the LTAP at Michigan Tech.

More information on the Michigan LTAP/UTC-MiSTI partnership in the delivery of technology transfer is highlighted on page 9 of this annual report.

Education



Top Row: Jeremy Nyquist (BS-CE), Andrew Manty (BS-CE), Kelly Heidbrier (BS-CE), Shandre Huff (BS-CE), Travis Brush (BS-CE)

Middle Row: Kevin Mears (MS-CE), Emily Lang (BS-ENV), Jerry Anzalone (PhD-CE), Mary Christiansen (PhD-CE)

Front Row: David Carmody (BS-CE), Moua Lee (BS-ENV), Shu Wei Goh (PhD-CE), Melanie Kueber (PhD-CE), Jayeeta Sarkar (MS-CE), Tianlu Shen (BS-ENV)

BS= Bachelor of Science, MS=Master of Science, PhD=Doctoral Degree
CE=Civil Engineering, ENV=Environmental Engineering

2009 Summer Scholar Investigations

Material Performance Assessment of Cross-tie Alternatives for Rail Applications, faculty advisor Dr. Devin Harris; *Identifying the Fundamental Mechanisms of Potassium Acetate Deicer on Runways*, faculty advisor Dr. Lawrence Sutter; *Geopolymer Concrete Investigation: The ABCs of GPC*, faculty advisor Dr. Karl Peterson; *Neutralizing the Adsorptive Effects of Carbon in Fly Ash for Use in Concrete*, faculty advisor Dr. David Hand; *Performance of Porous Pavement Materials with Recycled Materials and Warm Mix Asphalt Technology*, faculty advisor Dr. Zhanping You; and, *Enhancement of Bridge Decks Through the use of Ultra High Performance Concrete Overlays*, faculty advisor Dr. Devin Harris.

The UTC-MiSTI's Summer Scholars Program contributes to all four programming areas of the Center. It provides students teaming, mentoring and research experiences. Undergraduates are paired with graduate students and a faculty advisor to conduct investigations intended to serve as a "seed" for a full proposal to an external funding agency. A 2008 Summer Scholar investigation led to a research project funded by the Michigan Department of Transportation that began this year. The project is funding a 2008 Summer Scholar undergraduate who has subsequently enrolled in graduate studies to continue his work on the project.

If asked their area of specialization, only a third of the students pictured to the right would say civil infrastructure materials. Structures, architectural, environmental or rail would more likely be their response. This program is exposing a broad group of students to the role materials play in a more sustainable transportation system.

Project Summaries of the investigations conducted this year can be viewed on the Center's Website at <http://www.misti.mtu.edu/index.php?p=pubs>



Research

Project Profile: MDOT Carbon Footprint Project

This study will establish a method for measuring the “carbon footprint” associated with the construction and maintenance of hot mix asphalt (HMA) and portland cement concrete (PCC) pavement projects. Global climate change is a critical challenge that necessitates agencies involved in the development and maintenance of transportation infrastructure to identify their contributions to greenhouse gas emissions. In response, it is important to identify the metrics to measure carbon footprints and greenhouse gas emissions, and develop standards that can be used to construct, rehabilitate and maintain transportation infrastructure in a lower carbon contributing manner. A goal of this research is to develop a tool for quantifying the carbon footprint for different pavement sections during the construction and maintenance phases of the pavement life-cycle and develop recommendations for how the established footprints can be used in the development of green construction standards.

This project builds on existing research that have investigated and applied life cycle analysis (LCA) approaches to assessing impacts of asphalt and concrete pavements. However the aim of this research is not to advocate the virtues of either concrete or asphalt pavements, but instead to provide a guide that can be used to develop standards for sustainable construction and maintenance practices that reduce the carbon footprint through the life cycle of either pavements. The study emphasizes emissions of greenhouse gases due to 1) energy consumption; 2) material wastage during the material acquisition, manufacturing, and construction phases; and 3) those due to maintenance during the serviceable life of the assets. This project is being conducted by Dr. Amlan Mukherjee, Assistant Professor at Michigan Technological University. The final report will be submitted to MDOT in May 2011.

Workforce Development



A shortage of youth pursuing educations that support science, technology, engineering and math (STEM) careers, and the industries that rely on these skills, is reaching a state of crisis. The transportation industry is among those needing an educated workforce in a variety of STEM fields to support the vast and changing needs of the national transportation system. UTC-MiSTI, in partnership with Michigan Tech's Summer Youth Programs division, secured a grant from the Federal Highway Administration to become Michigan's only host site for a National Summer Transportation Institute Program.

In July 2009, twenty-nine (29) high school students spent two weeks at Michigan Tech learning about the types of educations and skills needed to support a multi-modal transportation system. In addition, the students were exposed to the broad range of transportation modes and the unique needs of each of those areas. Students learned through hands-on activities developed for the AASHTO TRAC curriculum, met with dozens of role model speakers, and visited on-going project sites. Michigan Tech's unique location provided opportunities for these youth to experience marine, pedestrian, air and surface transportation modes. A photo journal of the two week program, including student comments, is available for viewing on the Center's Website.

<http://www.misti.mtu.edu/index.php?p=nsti09>



Technology Transfer

This year, UTC-MiSTI supported the technology transfer efforts of a recently completed pooled fund study examining the deleterious chemical effects of deicing solutions on portland cement concrete. TPF-5(042) was conducted over four years by a research team from Michigan Tech and the University of Toronto. The project included field explorations and laboratory experiments evaluating the effects of five deicing agents; calcium chloride, calcium magnesium acetate, magnesium chloride, sodium chloride and an agricultural based product. The research provided clear evidence that magnesium chloride and calcium chloride both chemically attack concrete causing loss of strength, expansion and cracking.

UTC-MiSTI's technology transfer support included the development of publications, broadcast of four webinars and numerous on-site presentations. Center staff worked with the Tribal Technical Assistance Program (TTAP) editor to develop a four page Technical Brief and partnered with Michigan's LTAP to develop and deliver four webinars. These webinar broadcasts reached 859 professionals in 29 states and three counties. This activity also provided a great opportunity for these three programs, UTC, LTAP and TTAP, all located at Michigan Tech, to collaborate.

Publications

Project Summary
Technical Brief

Webinars

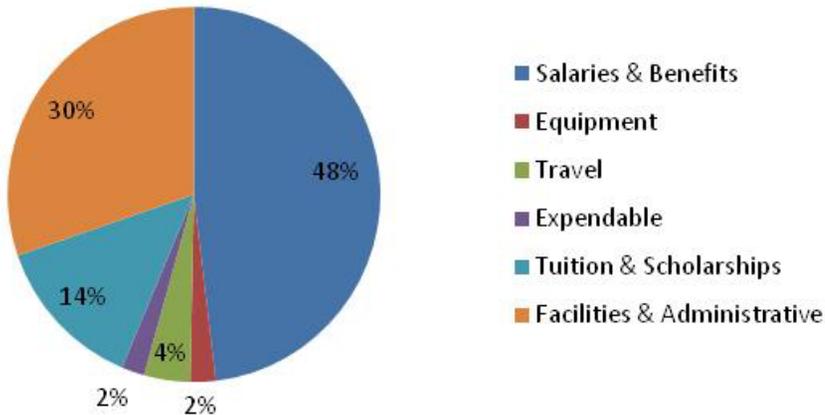
Winter Maintenance Best Practices-2
Project Specific Research Report Broadcast-2

Presentations

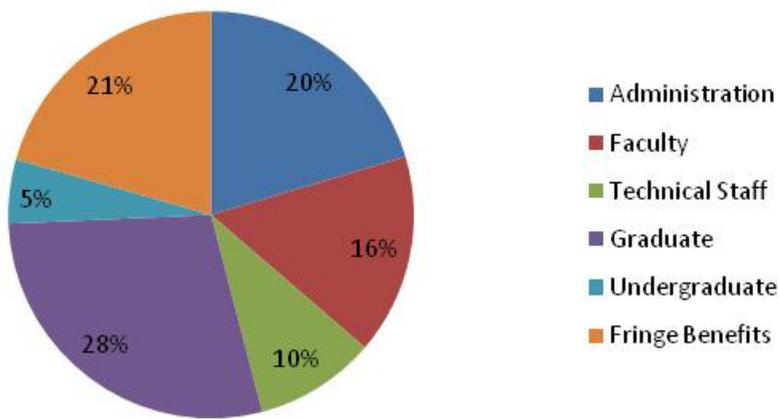
International Cement Microscopy Association
Durability International (Duralnt), Finland
Michigan County Engineers Workshop
Wisconsin Ready Mix Association
Wisconsin Concrete Pavement Association
South East Michigan Council of Governments
Michigan Concrete pavement Association
Iowa Research Council
Minnesota Concrete Council
Portland Cement Association
TRB-Performance Based Open Session
TRB-Durability Committee
National concrete Consortium



FY 3 Total Budget Allocations



FY 3 Salaries & Benefits



-- Year Three Budget Highlights

The Center's fiscal year three (FY 3) total budget included \$421,500 in federal fund allocations and \$35,500 in additional Center funding provided by the Technical Corrections Bill. This \$457,000 in federal support was matched with \$457,006 in non-federal cost share for a total operating budget of \$914,006. FY 3 cost share partners included the University, the Michigan Department of Transportation through sponsored research, and the Portland Cement Association. Specific budgetary initiatives included:

- Manufactured Equipment-Creep Frames to identify testing standards for Ultra High Performance Concrete (UHPC) \$20,000.
- Full-time Research Assistant Faculty position to support the Materials Characterization research and education Program \$70,000.
- Hourly graduate and undergraduate research assistantships offered through the Summer Scholars Program \$50,412.
- Stipend and tuition support for five funded graduate lines and recruitment scholarships through a Memorandum of Agreement with the Michigan Department of Transportation to support workforce development and education \$195,636.

UTC-MiSTI on the Move

UTC-MiSTI continued an aggressive schedule of participation at regional and national meetings, conducting technology transfer activities, Center outreach, and building relationships towards future partnerships.

- National Local Technical Assistance Program Association (NLTA), Breckenridge, Colorado (July)
- AASHTO RAC Meeting, Portland, Maine (July)
- Michigan Department of Transportation, Lansing, Michigan (July)
- Midcontinent Research Conference, Madison, Wisconsin (August)
- Michigan Concrete Paving Association meeting, Grand Rapids, Michigan (August)
- Portland Cement Association meeting, Chicago, Illinois (August)
- Great Lakes Cement Promotion Association, Lansing, Michigan (September)
- Alpena Community College - World Center for Concrete Technology, Alpena, Michigan (September)
- Alkali Silica Reactivity - Technical Working Group, Atlanta, Georgia (September)
- National Concrete Consortium, Minneapolis, Minnesota (September)
- Michigan Department of Transportation, Lansing, Michigan (October)
- American Concrete Institute-Strategic Development Committee, Palm Harbor, Florida (October)
- Southeast Michigan Council of Government, Detroit, Michigan (October)
- Transportation Engineering Road Research Alliance board meeting, Minneapolis, Minnesota (October)
- American Concrete Institute annual meeting, St. Louis, Missouri (November)
- American Standards and Testing Materials, Miami, Florida (December)
- Transportation Research Board, Washington, D.C. (January)
- Wisconsin Ready Mix Concrete Association, Wisconsin Dells, Wisconsin (January)
- Asphalt Paving Association of Michigan meeting, Kalamazoo, Michigan (February)
- Wisconsin Concrete Paving Association, Appleton, Wisconsin (February)
- Michigan County Engineers Workshop, Mt. Pleasant, Michigan (February)
- Michigan Concrete Paving Association, Plymouth, Michigan (February)
- Minnesota Paving Conference, St. Paul, Minnesota (February)
- Michigan Department of Transportation, Lansing, Michigan (March)
- American Concrete Institute, San Antonio, Texas (March)
- VTT, Finland (March)
- Transportation Engineering Road Research Alliance board meeting, Minneapolis, Minnesota (March)
- Iowa DOT, Research Advisory board meeting Ames, Iowa (APRIL)
- International Cement Microscopy Association Conference, St. Petersburg, Florida (April)
- Michigan's 3rd Construction Career Days, Mason, Michigan (April)
- USDOT - Research and Innovative Technology Administration, Washington, D.C. (June)
- UTC-MiSTI Technical Advisory Council meeting, Ann Arbor, Michigan (June)
- American Society for Testing and Materials (ASTM), Vancouver, British Columbia (June)
- Portland Cement Association, Chicago, Illinois (June)
- Council of University Transportation Centers and UTC program meeting, Amherst, Maine (June)

Fiscal Year Three Baseline Performance

METRIC	DESCRIPTION	2005-06 Baseline	2006-07	2007-08	2008-09
1	RESEARCH SELECTION				
1a	Basic	0	0	0	0
1a	Advanced	0	0	0	0
1a	Applied	0	12	12	13
2	Total Projects	0	\$100,443.00	\$238,917.00	\$553,622.62
	RESEARCH PERFORMANCE				
3	Published Reports	0	0	3	3
4	Papers Published	0	0	2	8
	EDUCATION				
5	Undergraduate Courses	7	1	0	0
	Graduate Courses	11	0	1	1
6	Students Engaged in Research	0	14	23	30
	Undergraduate	0	6	11	15
	Graduate	0	8	12	15
	HUMAN RESOURCES				
7	Masters Programs Offered	2	0	0	0
	Doctoral Programs Offered	1	0	0	0
8	Students Enrolled in MS Program	13	13	12	13
	Students Enrolled in PHD Program	4	11	10	10
9	MS Degrees Granted	5	2	6	5
	PhD Degrees Granted	0	0	1	2
	TECHNOLOGY TRANSFER				
10	Seminars, Workshops etc. Conducted	0	2	7	21
11	Number of Participants	0	169	231	2068

In 2008-09 the Center achieved significant growth in all performance categories. Most notable are the increases in the value of the research projects being conducted by the Center (Metric 2-expenditures) and in the Center's technology transfer activities (Metric 10 and 11). The value of the Center's research expenditures surpassed the federal investment (FY 3 award of \$408,300.00 plus the Technical Corrections Bill investment of \$21,500.00) demonstrating the Center's ability to leverage the federal funds to support the national transportation research investment. New research awarded to the Center in 2008-2009 includes:

- Michigan Department of Transportation-Laboratory Evaluation of Warm Mix Asphalt (PI You, project value \$226,642.00)
- Michigan Department of Transportation-An Integrative Framework to study the Carbon Emissions of Road Construction Projects (PI Mukherjee, project value \$199,999.49)
- Portland Cement Association-Alkali Silica Reactivity Investigation (PI Sutter, project value \$60,000.00)

The Center's growth in the category of technology transfer is a result of the Center's efforts to support the transfer of knowledge surrounding a recently completed pooled fund study. More information on this effort is provided on page 9 of this annual report.



Dr. Tess Ahlborn, PhD, P.E. is an Associate Professor in the Department of Civil and Environmental Engineering at Michigan Tech. She also directs the Center for Structural Durability. Her areas of research include pre-stressed concrete, ultra high performance concrete and bridge engineering.



Dr. George Dewey, PhD, is an Associate Professor in the Department of Civil and Environmental Engineering at Michigan Tech. He serves as the advisor of the Pavement Design, Construction and Materials student Enterprise. His areas of research include pavement design and structural engineering.



Dr. Ralph Hodek, PhD, P.E. , is an Associate Professor in the Department of Civil and Environmental Engineering at Michigan Tech. He is the chair-elect of the ABET Applied Science Accreditation Council. His areas of research include the use of cement kiln dust as a base stabilizer and geotechnical engineering.



Dr. Amlan Mukherjee, PhD, is an Assistant Professor in the Department of Civil and Environmental Engineering at Michigan Tech. His areas of research include developing platforms and tools that support informed decision making for construction processes.



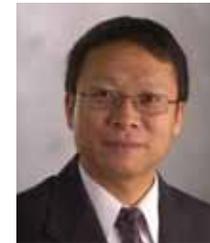
Dr. Jacob Hiller, PhD, is an Assistant Professor in the Department of Civil and Environmental Engineering at Michigan Tech. His areas of research include pavement mechanics and the interaction between materials, analysis and performance.



Dr. Lawrence Sutter, PhD, is a Professor and Director of the Michigan Tech Transportation Institute. His areas of research include the effects of deicing chemicals on pavement materials, use of fly ash and other recovered industrial materials in pavements and materials characterization.



Dr. Stanley Vitton, PhD, P.E. , is an Associate Professor in the Department of Civil and Environmental Engineering at Michigan Tech. His areas of research include geotechnical engineering, geomechanics, slope stability and dust management.



Dr. Zhanping You, PhD, P.E. is an Assistant Professor in the Department of Civil and Environmental Engineering at Michigan Tech. His areas of research include bituminous materials, asphalt binders, use of recycled asphalt pavements and sustainability related to asphalt materials.



Dr. Pasi Lautala, PhD, is a Research Assistant Professor within the Michigan Tech Transportation Institute and serves as the Director of the Michigan Tech's new Rail Transportation Program.



Dr. Devin Harris, PhD, is an Assistant Professor in the Department of Civil and Environmental Engineering at Michigan Tech. His areas of research include innovative materials for civil infrastructure and behavior and design of bridges.

Dr. Karl Peterson (not pictured), PhD, is a Research Assistant Professor in the Department of Civil and Environmental Engineering at Michigan Tech. His areas of research interest include Petrography and materials characterization.



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