U.S. Department of Transportation
Research and Innovative Technology Administration
University Transportation Center Grant Agreement

Grant No. DTRT12-G-UTC08
Mountain-Plains Consortium, North Dakota State University Denver Tolliver,
Director Denver.tolliver@ndsu.edu
(701)231-7190

January 31, 2015

DUNS: 803882299 and EIN: 45-6002439

North Dakota State University
Upper Great Plains Transportation Institute
NDSU Dept. 2880, P.O. Box 6050
Fargo, ND 58108-6050


Reporting Period End Date: December 31, 2014
Semi-Annual PPPR#6

Denver D. Tolliver

Director, Mountain-Plains Consortium North Dakota State University
1. **Accomplishments: What was done? What was learned?**

**a. What are the major goals of the program?**

The overall objectives are to: (1) conduct basic and applied research, the products of which are judged by peers or other experts in the field of transportation to advance the body of knowledge in transportation; (2) offer an education program in transportation that includes multidisciplinary coursework and participation in research; (3) conduct workforce development activities and programs to expand the workforce of transportation professionals; (4) provide an ongoing program of technology transfer to make transportation research results available to potential users in a form that can be readily used; and (5) provide planning and technical assistance to Native American tribes, especially those heavily impacted by energy development. Other program goals are to select projects and activities using peer review principles and procedures and client input that: (1) address the Secretary’s strategic goals, and (2) leverage UTC funds with matching funds from state and local governments and private industry. The chief operational goals for grant DTRT12-G-UTC08 is to make important contributions to research and technology transfer in key areas related to the Secretary’s goals of State of Good Repair, Safety, and Economic Competitiveness, while addressing critical issues of the region and stakeholder groups—especially issues in the rapidly growing Bakken oil production region. Under grant DTRT13-G-UTC38, the focus will shift more toward State of Good Repair. However, some safety emphasis is still necessary, given the issues posed by the transportation of Bakken crude oil by rail and truck.

**b. What was accomplished under these goals?**

**i. Project Selection and Peer Review**

Under grant DTRT12-G-UTC08, 47 research projects have been selected from federal fiscal year (FY) 2012 funds—which were received in 2013. An additional 36 research projects have been selected from FY 2013 funds—which were received in 2014. All projects have been selected through a peer review process that reflects substantial input and matching resources from state departments of transportation and other transportation agencies in the region. The projects selected under grant DTRT12-G-UTC08 are listed in Tables 1-8, under the primary strategic goal addressed by the project. Please note that many of the projects address several goals simultaneously. In particular, many projects that address State of Good Repair have potential Safety and Economic Competitiveness benefits.

**Table 1: MPC Research Projects Most Directly Correlated with Sustainability**

<table>
<thead>
<tr>
<th>Project ID</th>
<th>Project Title</th>
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</thead>
<tbody>
<tr>
<td>MPC-354</td>
<td>Geotechnical Limit to Scour at Spill-through Abutments (Year 2)</td>
</tr>
<tr>
<td>MPC-361</td>
<td>Building a Framework for Transportation Resiliency and Evaluating the Resiliency</td>
</tr>
<tr>
<td>MPC-367</td>
<td>Benefits of Light Rail Transit in Denver, Colorado</td>
</tr>
<tr>
<td>MPC-372</td>
<td>A Novel Methodology for Quantifying the Performance of Constructed Bridges in Cold Regions: Development, Assessment, and Repair</td>
</tr>
<tr>
<td>MPC-377</td>
<td>Assessing Existing Transportation Sustainability Rating Systems for use in the Mountain-Plains Consortium States</td>
</tr>
<tr>
<td>MPC-391</td>
<td>Implementation of Low Temperature Test for Asphalt Mixtures to Improve the Longevity of Road Surfaces</td>
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<tr>
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<td>Evaluation of Spliced Sleeve Connections for Precast Reinforced Concrete Bridge Piers</td>
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<td>Traffic Modeling of Transit Oriented Development</td>
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<tr>
<td>MPC-366</td>
<td>Structural Health Monitoring of Highway Bridges Subjected to Overweight Trucks, Phase I</td>
</tr>
</tbody>
</table>
– Instrumentation Development and Validation
4. MPC-367: Developing Statistical Models for Crash Severity Comparing Statewide, County and Indian Reservation Roads
5. MPC-368: Effectiveness of Advisory Letter in Preventing At-Risk Teen Driver Crashes: Pilot Project
6. MPC-369: ND Motor Crash Analysis and Rider Assessment for Improved Conspicuity
7. MPC-371: Decision Support for Strategic Truck Safety and Weight Enforcement Planning
8. MPC-373: Damage Assessment, Characterization, and Modeling for Enhanced Design of Concrete Bridge Decks in Cold Regions
10. MPC-375: Small Railroad Capital Investment Needs and Financial Options
11. MPC-378: MEMS Sensors for Transportation Structures
12. MPC-380: Investigation of Interactions between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado
13. MPC-381: Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic
14. MPC-386: Use of Travel Time, Travel Time Reliability, and Winter Condition Index Information for Improved Operation of Rural Interstates
15. MPC-406: Risk- and Reliability-Based Approaches to Analyzing Road Geometric Design Criteria
17. MPC-408: Exploring Unique Plastic-Reinforced Bridge Decks: Phase I
18. MPC-416: Development and Testing of Crashworthy Ipe Bridge Rails
19. MPC-418: 400 South Corridor Assessment
20. MPC-423: Impact of Energy Sector Growth on Perceived Transportation Safety in the Seventeen County Oil Region of Western North Dakota: A Longitudinal Analysis
21. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
22. MPC-431: Connected Vehicle Weather Data for Operation of Rural Variable Speed Limit Corridors
24. MPC-433: Real-Time Traffic Management to Maximize Throughput of Automated Vehicles
25. MPC-434: A Bicycle Network Analysis Tool for Planning Applications in Small Communities
27. MPC-445: A Sensor Fusion Approach to Assess Pavement Condition and Maintenance Effectiveness

Table 3: MPC Research Projects Most Directly Correlated with State of Good Repair

1. MPC-354: Geotechnical Limit to Scour at Spill-through Abutments (Year 2)
2. MPC-362: Develop Design Guidelines for Integral Abutment Bridges
3. MPC-363: A Two-stage Approach for Estimating a Statewide Truck Trip Table
4. MPC-366: Structural Health Monitoring of Highway Bridges Subjected to Overweight Trucks, Phase I
– Instrumentation Development and Validation
5. MPC-371: Decision Support for Strategic Truck Safety and Weight Enforcement Planning
6. MPC-372: A Novel Methodology for Quantifying the Performance of Constructed Bridges in Cold Regions: Development, Assessment, and Repair
7. MPC-373: Damage Assessment, Characterization, and Modeling for Enhanced Design of Concrete Bridge Decks in Cold Regions
8. MPC-374: An Integrated Real-Time Health Monitoring and Impact/Collision Detection System for Bridges in Cold Remote Regions
9. MPC-375: Small Railroad Capital Investment Needs and Financial Options
10. MPC-376: Improved Understanding of Pavement Impacts and Cost-Effective Designs Based on Mechanistic-Empirical Methods
11. MPC-378: MEMS Sensors for Transportation Structures
12. MPC-379: Plastic-Aluminum Composites in Transportation Infrastructure
13. MPC-387: Comprehensive GIS-Based Rural Regional Transportation Planning Models
14. MPC-391: Implementation of Low Temperature Test for Asphalt Mixtures to Improve the Longevity of Road Surfaces
15. MPC-394: Quantifying Uncertainty in Nondestructive Bridge Inspection Methods for use in PBI
16. MPC-404: Seismic Performance of Concrete Filled Steel Tube (CFST) Bridge Columns For Accelerated Bridge Construction
17. MPC-405: Seismic Retrofit of Spliced Sleeve Connections for Precast Bridge Piers
18. MPC-406: Risk- and Reliability-Based Approaches to Analyzing Road Geometric Design Criteria
19. MPC-410: Predicting Fatigue Service Life Extension of RC Bridges with Externally Bonded CFRP Repairs
20. MPC-411: Re-Use of Mine Waste Materials Amended with Fly Ash in Transportation Earthwork Projects
21. MPC-413: A Pilot Case Study to Evaluate the Potential Impact and Benefit of Adopting and Implementing BIM on Bridge and Infrastructure Projects
22. MPC-414: Quantifying Sustainability Metrics for Trunk line Bridges in the Mountain Plains Region
23. MPC-415: Framework of Performance-Based Earthquake Design of Curved and Skewed Bridges
24. MPC-419: Experimental and Numerical Study for the Debonding Interface Between an Existing Pavement and a New Concrete Overlay
25. MPC-421: Seismic Rehabilitation of Skewed and Curved Bridges Using a New Generation of Bulking Restrainted Braces
26. MPC-423: Impact of Energy Sector Growth on Perceived Transportation Safety in the Seventeen County Oil Region of Western North Dakota: A Longitudinal Analysis
27. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
28. MPC-427: Fire Performance of Bridge Members Retrofitted with Near-Surface-Mounted Carbon Fiber Reinforced Polymer Composites
29. MPC-428: Using Recycled Concrete Aggregate in New Concrete Construction
30. MPC-429: A Methodology for Developing a Replacement Strategy for County/City Owned Bridges
31. MPC-430: Implementation of Intelligent Compaction Technologies for Road Constructions in Wyoming
32. MPC-432: Finding Innovative Solutions to Prevent Wildlife Access to Highways at Wildlife Guards
33. MPC-434: A Bicycle Network Analysis Tool for Planning Applications in Small Communities
34. MPC-444: Data-Driven Freeway Performance Evaluation Framework for Project Prioritization and Decision Making
35. MPC-445: A Sensor Fusion Approach to Assess Pavement Condition and Maintenance Effectiveness

Table 4: MPC Research Projects Most Directly Correlated with Economic Competitiveness

1. MPC-354: Geotechnical Limit to Scour at Spill-through Abutments (Year 2)
2. MPC-363: A Two-stage Approach for Estimating a Statewide Truck Trip Table
4. MPC-366: Structural Health Monitoring of Highway Bridges Subjected to Overweight Trucks, Phase I
   – Instrumentation Development and Validation
5. MPC-375: Small Railroad Capital Investment Needs and Financial Options
6. MPC-379: Plastic-Aluminum Composites in Transportation Infrastructure
7. MPC-380: Investigation of Interactions Between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado
8. MPC-381: Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic
9. MPC-384: Understanding Public Perceptions of Different Revenue Generation Systems for Highway Construction and Maintenance
10. MPC-387: Comprehensive GIS-Based Rural Regional Transportation Planning Models
11. MPC-408: Exploring Unique Plastic-Reinforced Bridge Decks: Phase I
12. MPC-418: 400 South Corridor Assessment
13. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
14. MPC-426: Does the Livability of a Residential Street Depend on the Characteristics of the Neighboring Street Network?
15. MPC-427: Fire Performance of Bridge Members Retrofit with Near-Surface-Mounted Carbon Fiber Reinforced Polymer Composites
16. MPC-433: Real-Time Traffic Management to Maximize Throughput of Automated Vehicles
17. MPC-435: Realization of a Coarse Position Verification System for an Automated Highway System
18. MPC-445: A Sensor Fusion Approach to Assess Pavement Condition and Maintenance Effectiveness

Table 5: MPC Research Projects Most Directly Correlated with Livable Communities
1. MPC-361: Building a Framework for Transportation Resiliency and Evaluating the Resiliency Benefits of Light Rail Transit in Denver, Colorado
2. MPC-376: Improved Understanding of Pavements Impacts and Cost-Effective Designs Based on Mechanistic-Empirical Methods
3. MPC-379: Plastic-Aluminum Composites in Transportation Infrastructure
4. MPC-380: Investigation of Interactions between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado
5. MPC-381: Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic
6. MPC-387: Comprehensive GIS-Based Rural Regional Transportation Planning Models
7. MPC-392: Evaluation of Spliced Sleeve Connections for Precast Reinforced Concrete Bridge Piers
8. MPC-393: Traffic Modeling of Transit Oriented Development
10. MPC-417: Evaluation and Development of Livability and Sustainability Programs for Indian Reservations
11. MPC-418: 400 South Corridor Assessment
12. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
13. MPC-426: Does the Livability of a Residential Street Depend on the Characteristics of the Neighboring Street Network?
14. MPC-444: Data-driven Freeway Performance Evaluation Framework for Project Prioritization and Decision Making

Table 6: MPC Research Projects Most Directly Correlated with Environmental Sustainability
1. MPC-411: Re-Use of Mine Waste Materials Amended with Fly Ash in Transportation Earthwork Project
2. MPC-414: Quantifying Sustainability Metrics for Trunk line Bridges in the Mountain Plains Region
3. MPC-416: Development and Testing of Crashworthy Ipe Bridge Rails
4. MPC-417: Evaluation and Development of Livability and Sustainability Programs for Indian Reservations
5. MPC-418: 400 South Corridor Assessment
6. MPC-421: Seismic Rehabilitation of Skewed and Curved Bridges Using a New Generation of Bulking Restrained Braces
7. MPC-428: Using Recycled Concrete Aggregate in New Concrete Construction

Table 7: MPC Education Projects
1. MPC-385: Educational and Workforce Development Proposal: STEM Outreach at Colorado State University
2. MPC-403: Web-based Decision Support Tool for Traffic Management and Work Zone Analysis
ii. Educational Accomplishments

The transportation and transportation-related courses offered during Fall 2014 are listed in Table 8, organized by major subject area. In some cases, courses with the same titles were offered at more than one MPC university. In these cases, the number of courses offered is shown in parenthesis.

<table>
<thead>
<tr>
<th>Major Subject Area</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>Engineering &amp; Design</td>
<td>Adv. Geotechnical Engineering</td>
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<td></td>
<td>Advanced Construction Materials</td>
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<td>Advanced Reinforced Concrete Design</td>
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<td>Advanced Steel Design</td>
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<td></td>
<td>Bridge Design</td>
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<td></td>
<td>Design and Behavior of Steel Structures</td>
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<td></td>
<td>Engineering Applications of GIS and GPS</td>
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<td></td>
<td>Evaluation of Civil Engineering Materials</td>
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<td>Foundation Engineering</td>
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<td></td>
<td>Highway Engineering</td>
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<td></td>
<td>Intermediate Structural Analysis</td>
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<td></td>
<td>Mechanics of Fatigue and Fracture</td>
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<td></td>
<td>Open Channel Flow (Undergraduate)</td>
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<td></td>
<td>Pavement Design</td>
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<td></td>
<td>Pavement Design (Undergraduate)</td>
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<td></td>
<td>Pavement Management System</td>
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<td>Pedestrians and Bicyclists</td>
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<td>Pre-stressed Concrete</td>
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<td></td>
<td>Statistics and Economics (Undergraduate)</td>
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<td></td>
<td>Steel Design</td>
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<td></td>
<td>Structural Dynamics and Seismic Design</td>
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<td>Transportation Engineering</td>
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<tr>
<td>Freight &amp; Logistics</td>
<td>Freight Transportation Systems</td>
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<td>Logistics Systems</td>
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<td>Principles of Supply Chain: Management and Technologies</td>
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<td>Technology Advances/Logistics</td>
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<tr>
<td>Planning &amp; Environment</td>
<td>Disaster/Climate Change Planning</td>
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<td>Intermodal Business Planning Project</td>
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<td></td>
<td>Introduction to Sustainable Urban Infrastructure</td>
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<td>Leadership Development Planning Project</td>
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<td>Planning History and Theory</td>
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<td>Planning in the Developing World</td>
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<tr>
<td>Planning &amp; Environment</td>
<td>Planning Methods</td>
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<td>Quantitative Tools for Transportation Management</td>
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<td></td>
<td>Sprawl and Growth Management</td>
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<td>Transportation Management, Leadership, and Values</td>
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</tbody>
</table>
Altogether, 59 transportation and transportation-related courses have been offered during this reporting period. Altogether, 314 transportation courses have been offered during the grant period thus far. In addition to the courses listed in Table 8, foundational courses in engineering materials, mechanics, structural analysis, and geotechnical engineering have been offered at most of the MPC universities.

### iii. Workforce Development Accomplishments

**Training** events provided for transportation professionals during this reporting period are listed below.

1. Access Management Training
2. ATSSA Flagger Certification
3. ATSSA Traffic Control Technician (TCT)
4. Basic of a Good Road
5. Basic Surveying
6. Cement Seminar
7. Communication Skills for Supervisors
8. Concrete Pavements
9. Heavy Equipment Operations
10. Integrated Roadside Vegetation Management
11. Registered Storm water Inspector
12. Roadway Drainage
13. Transportation Safety
14. Tree Trimming
15. Trenching and Shoring
16. Winter Road Maintenance
17. Women in Transportation
18. Work Zones

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<td>Transportation Engineering (Undergraduate)</td>
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<td><strong>Transportation Safety</strong></td>
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<tr>
<td>Transportation Law and Regulation: Domestic and International</td>
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<td>Cognitive Psychology (Undergraduate)</td>
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<td>Traffic Simulation</td>
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<td><strong>Transportation Systems</strong></td>
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<td>Freight Transportation Systems</td>
<td>Intermodal Transportation Systems</td>
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<td>Introduction to Transportation Systems</td>
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<td>Transportation and Land Use</td>
<td>Transportation System Security</td>
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<td>Transportation Systems Analysis</td>
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<td>Transportation Systems I</td>
<td>Urban Transportation Systems Analysis</td>
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<td><strong>Public Transportation</strong></td>
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<td>Passenger Transportation Systems</td>
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12. Roadway Drainage
13. Transportation Safety
14. Tree Trimming
15. Trenching and Shoring
16. Winter Road Maintenance
17. Women in Transportation
18. Work Zones
iv. Research accomplishments

The following peer reviewed research reports/presentations were published during the period of July-December 2014 from grant DTRT12-G-UTC08 or previous grants.

<table>
<thead>
<tr>
<th>Project #</th>
<th>Title</th>
<th>Date</th>
<th>Report No.</th>
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<tbody>
<tr>
<td>393</td>
<td>Traffic Modeling of Transit Oriented Development</td>
<td>Sep 2014</td>
<td>MPC 14-270</td>
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<td>423</td>
<td>Impact of Energy Sector Growth on Perceived Transportation Safety in the Seventeen County Oil Region of Western North Dakota: A Longitudinal Analysis</td>
<td>Oct 2014</td>
<td>MPC 14-271</td>
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<td>413</td>
<td>A Pilot Case Study to Evaluate the Potential Impact and Benefit of Adopting and Implementing BIM on Bridge and Infrastructure Projects</td>
<td>Nov 2014</td>
<td>MPC 14-272</td>
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<td>277</td>
<td>Safety Factor Increase to Fatigue Limit States Through Shear Spiking for Timber Railroad Bridge Rehabilitation</td>
<td>Nov 2014</td>
<td>MPC 14-273</td>
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<td>376</td>
<td>Improved Understanding of Pavement's Impacts and Cost-Effective Designs Based on Mechanistic-Empirical Methods</td>
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<td>MPC 14-274</td>
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<tr>
<td>398</td>
<td>Selection of Discount Rates for Infrastructure Investment</td>
<td>Dec 2014</td>
<td>MPC 14-275</td>
</tr>
<tr>
<td>457</td>
<td>Tribal Emergency Preparedness Planning</td>
<td>Dec 2014</td>
<td>MPC 14-276</td>
</tr>
<tr>
<td>370</td>
<td>Anticipatory Guidance for Older Drivers</td>
<td>Dec 2014</td>
<td>MPC 14-277</td>
</tr>
</tbody>
</table>

c. How have the results been disseminated?

The results are being disseminated in a variety of ways, including: (1) workshops and conferences, (2) videoconferences, (3) online modules, (4) presentations at conferences, (5) publications, (6) webpage postings and displays, and (7) Internet-based dissemination media, including broadcast emails and webinars. These accomplishments are summarized under the products section of this report.

d. What do you plan to do during the next reporting period to accomplish the goals/objectives?

(1) Continue to offer the multidisciplinary multimodal catalogue of courses described in the prospectus and teach those courses scheduled during the academic year (2) Continue to deliver extensive programs of technical training, similar to the programs illustrated in b.iii. (3) With the guidance of the recently established North Dakota Transportation Safety Advisory Group, identify a two-year work plan to conduct safety research and technical training that addresses key Bakken-related issues, including motor carrier, railway, and pipeline safety. (4) In conjunction with tribal partners, develop a two-year plan for tribal transportation research and technical assistance to include: a) the development of an emergency management/response guidebook, b) GIS modeling and technical assistance in traffic forecasting; and c) help in implementing road safety procedures and countermeasures on tribal roads. (5) Continue the strong MPC research programs, which will result in many new publications and journal papers. (6) Participate in 4 or more conferences and workshops on transportation and energy development. (7) Collaborate with other UTCs to promote greater exchange of information and explore partnering possibilities in railway and waterway transportation. (9) Continue to involve graduate students in MPC research projects.
2. Products: What has the program produced?

a. Publications, conference papers, presentations

i. Participation in key conferences and workshops
   - 2014 ASCE T&DI Congress, June 8-11 2014, Orlando, Florida
   - 2014 Rocky Mountain Geo-Conference, Denver, Colorado
   - 2014 Tailings and Mine Waste Conference, Keystone, Colorado
   - ABC Bridge Conference. Miami, FL
   - ACI Fall Convention. Washington, D.C.
   - Annual Fuel Cycle Technologies Meeting, Idaho Falls, ID
   - Annual Meeting of the American Psychological Science Association, San Francisco, CA
   - ASCE Global Conference. Panama City, Panama
   - Association of Collegiate Schools of Planning (ASCP), Philadelphia, PA, November 2014
   - Australian and South East Asia Conference in Structural Engineering and Construction Conference (ASEA-SEC-2) in Bangkok, Thailand. November 2014
   - ESCAR Embedded Security in Cars Conference, June 18-19, Hamburg, Germany
   - International Rail Safety Conference, Berlin, Germany
   - ITE Joint Western/Midwestern District Annual Meeting, Rapid City, SD
   - Ninth International Conference on Structural Dynamics - EURODY, June 30 - July 2, Univ. of Porto, Porto, Portugal
   - North Dakota Conference on Injury Prevention and Control, Bismarck, ND
   - Probabilistic Safety Assessment and Management (PSAM 12), Honolulu, HI
   - Tenth U.S. National Conference on Earthquake Engineering
     Frontiers of Earthquake Engineering (10NCEE), July 21-25, 2014, Anchorage, Alaska
   - TRB Alternative Intersections and Interchanges Symposium and Midyear Meetings of TRB Operational Effects of Geometrics Committee (AHB65), TRB Geometric Design Committee (AFB10), and AASHTO Technical Committee on Geometric Design, Salt Lake City, UT
   - U.S. Department of Transportation ITS Joint Program Office Workshop on Incorporating ITS Education into University Curriculum and Learning Programs, Washington, D.C.
   - Utah Department of Transportation 2014 Annual Conference, Sandy, UT
   - Wasatch Choice for 2040 Consortium Meeting, Salt Lake City, UT
   - World Congress of Health and Safety, Frankfurt, Germany, August 24-27, 2014

ii. Key Journal Articles or Conference Publications
   - Ahmari, S., Yang, M.J., “Impact load identification through measurement with uncertainty’, Smart Materials and Structures, 2013, (22) 085024
   - Bridgelall, R., “Precision bounds of pavement distress localization with connected vehicle sensors,” Journal of Infrastructure Systems, American Society of Civil Engineering, DOI:


• Huffaker, C., Barr, P.J., Halling, M.W. and Boyle, H. "Behavior and Analysis of an Integral Abutment Bridge." UDOT Annual Conference, Sandy, Utah, November 5th-7th, 2013.


• Kim, Y.J. Moment-shear interaction mechanism for CFRP-strengthened RC beams in flexure, ACI Structural Journal, American Concrete Institute (ACI), 111(4), 967-975, 2014.


• Namrou, A.R. and Kim, Y.J. An experimental investigation into the behavior of concrete elements retrofitted with NSM composite strips at elevated temperatures, American Concrete Institute (ACI) Special Publication on Advanced Materials and Sensors toward Smart Concrete Bridges: Concept, Performance, Evaluation, and Repair, 225-239, 2014.


• Sanbonmatsu, David, David Strayer, Arwen Behrends, Nate Medeiros-Ward, and Jason Watson. Why drivers use cell phones and why they support legislation to restrict this practice. Draft Final Report for MPC-407. (submitted for review)
• Tasic, I., Zlatkovic, M., Martin, P.T., and Porter, R.J. “Street Connectivity Versus Street Widening: Enhanced Street Connectivity on Traffic Operations in Transit-Supportive Environments,” Transportation Research Record: Journal of the Transportation Research Board, submitted. (federal support)
• Yang, M.J., Ahmari, S., “Dynamic Behavior of Deck-Girder System of Bridges Subjected to Settlement through Finite Strain Plate Theory”, Engineering Structures (Accepted).
• Zhou, Xuesong, Peter T. Martin, Milan Zlatkovic and Ivana Tasic. Traffic Modeling of Transit
iii. Key Conference Papers


- Kim, Y.J., Hyun, S.W., Yoshitake, I., Kang, J.-Y, and Seo, J. A composite-bonded steel substrate with silyl-modified polymer exposed to thermal distress, Probabilistic Safety Assessment and Management (PSAM 12), Honolulu, HI, 2014.


- Sanjay Pokharel, Debbie Sue Shinstine, Khaled Ksaibati. "Developing a Livability Program for Indian

- Yang, M.J., Bond Strength of PCC Pavement Repairs Using Metakaolin-Based Geopolymer Concrete, EMI2015HK
- Yang, M.J., Bridge Settlement Criteria Based on Reliability Analysis of Close-to-Reality Modeling Results, EMI2015HK
- Yang, M.J., Progressive failure of fiber reinforced pervious concrete with inclusion of cohesive interface modeling, EMI2015HK

iv. Key Presentations


- Wehbe, N., B. Tigges, and A. Boudaqa. "Low Flexural and Shear Capacity Bridge Columns under Truck Collision Loads." ACI Fall Convention, Washington, D.C., October 27, 2014

• Yang, M.J., Bond Strength of PCC Pavement Repairs Using Metakaolin-Based Geopolymer Concrete, EMI2015HK
• Yang, M.J., Bridge Settlement Criteria Based on Reliability Analysis of Close-to-Reality Modeling Results, EMI2015HK
• Yang, M.J., Progressive failure of fiber reinforced pervious concrete with inclusion of cohesive interface modeling, EMI2015HK

b. Books or other non-periodical, one-time publications
• University of Wyoming will have two journal articles appear in journals during spring 2015.

c. Website(s) or other internet site(s)
• Hosted a week-long Summer Transportation Institute camp for junior high students and produced a video documenting the experience: http://youtu.be/UDT4OgHS6Us
• Website that describes in details the backend simulation engine with all of its components for Web-based Decision Support Tool for Traffic Management and Work Zone Analysis, www.learning-transportation.org
• The PI facilitated a student Capstone project that utilized a model produced by this research to implement an iOS app (Apple iPhone) that logs inertial and geospatial data to measure ride-quality. The PI is collaborating with two other UGPTI departments (DOTSC, TLN) and the NDSU Computer Science department to facilitate another Capstone project that will implement a web-service that will use the models produced by this project to monitor pavement ride-quality for North Dakota counties. Website: http://www.ugpti.org/research/projects.php?view=226&program=smartse

d. Technologies or Techniques
• QEM spreadsheet; an excel-based application for signal timing parameters estimation integrated with the DTA tool
• Relational Database linking incidents, weather and the traffic sensor data at each station along I-15 corridor to support Data-Driven Freeway Performance Evaluation Framework for Project Prioritization and Decision Making.

e. Inventions, patent applications, and/or licenses?
Nothing to report at this time.

f. Other
Nothing to report at this time.

3. Participants and Other Collaborating Organizations: Who has been involved?
a. What individuals have worked on the program?

The principal investigators, faculty, and administrators participating in MPC project:

Nine principal investigators, faculty, and administrators participating in MPC projects at Utah State University are: Kevin Heaslip, University Program Coordinator and PI; Anthony Chen, PI; Ryan Bosworth, Co-PI; Michael Thomas, Investigator; Patricia Cramer, PI; Paul Barr, PI; Marv Halling, Co-PI; Ryan Gerdes, PI; and Thidapat (Tam) Chantem, PI. In addition, twelve students are participating in MPC research projects at Utah State University: Doctorate Students – Sarawut Jansuwan, Seunkyu Ryu, Ali Soltani Sobh, Donghyung Yook, Ryan Barnes; Masters Students – Conner Huffaker, Joseph Flower, Divya Desiraju, Niranjan Chandrappa; Undergraduate Students – Eric Meissner, Jaque Johansen, and Jacqueline Su.

Nine principal investigators, faculty, and administrators participating in MPC projects at the University of Wyoming are: Khaled Ksaibati, University Program Coordinator and PI; Robert Ettema, PI; Rhonda Young, PI; Richard J. Schmidt, PI; Kam Ng, PI; Jennifer Tanner, PI; Debbie Shinistine, Post Doctorate; Ed Kempema, Lab Director; and James Branscomb, Engineer. Fourteen students participating in MPC research projects at the University of Wyoming: Doctorate Students: Edward Offei, Vijay Sabawat, Prometheus Saha; Masters Students - Ram Chakradha, Mike Jung, McKenzie Danforth, Darby Hacker, Nicholas Owen, Rebecca Franke, Sanjay Pokharel, Christopher Savan; Undergraduate Students - Chris Leclerc, Bryce Fiore, and Britton Hammit. Others who participated in the projects at the University of Wyoming: Wendy Perkins, Administrator; Shaun Wulff, Statistics Professor; David Reynaud, NCHRP; Bart Bergendahl, FHWA; Larry Arneson, FHWA.

Seventeen principal investigators, faculty, and administrators participating in MPC projects at the University of Utah: Richard Porter, University Program Coordinator and PI; David Sanbonmatsu, Co-PI; Peter Martin, PI; Chris Pantelides, PI; Lawrence Reaveley, Co-PI; Pedro Romero, PI; Xuesong Zhou, PI; David Strayer, PI; Luis Ibara, PI; Evert Lawton, PI; Ivana Tasic, PI; Cathy Liu, PI; Milan Zlatkovic, PI; Muhammad Farhan, PI; Amanda Bordelon, PI; Jinjin Tang, Researcher, Visiting Professor; and Francesco Biondi, Researcher, Vising Scholar. Eighteen graduate and undergraduate students are working on MPC research projects at the University of Utah: Doctorate Students – M.J. Ameli, Ivana Tasic, Tie Shi, Jeffrey Taylor, Min Ook Kim, M. Scott Shea, Yuandong Wang, and Zhuo Chen; Masters Students - Joel Parks, Dylan Brown, Catherine Tucker, Daniel Sudbury, Dillon Lee, Anusha Musunuru, Arwen Behrends, Shannon Moore, and Anurag Upadhay; Undergraduate Students - Crystal Orantes.

Six principal investigators, faculty, and administrators are participating in MPC projects at South Dakota State University: Nadim Wehbe, University Program Coordinator and PI; Allen Jones, PI; Xiao Qin, PI; Guanghui Hua, PI; Haifa Samra, PI; and Aaron Breyfogle, Project Manager, SDDOT. In addition, seven graduate and undergraduate students are working on MPC research projects at South Dakota State University: Masters Students - Zhao Shen, Zhaoxiang He, Jacob Humbug, Micah Underberg, Michael Konrad, Walker Olson, and Abdullah Boudaqa.

Nine principal investigators, faculty, and administrators are participating in selected projects from Colorado State University: Rebecca Atadero, University Program Coordinator and PI; Paul Heyliger, PI; Suren Chen, PI; Hussam Mahmoud, PI; Mehmet Ozbek, PI; Caroline Clevenger, PI; John van de Lindt, PI; Christopher Bareither, PI; and Bolivar A. Senior, PI. In addition, fifteen graduate and undergraduate students are working on MPC research projects at Colorado State University: Doctorate Students- Xiaoxiang Ma, Kristen Peterson, Luke Chen; Masters Students – Patrick Sanders, Chris Bright, Mohammad Reza Hassanzadeh Gorakhhi, Sultan Abdulaziz Alhohair, Sherona Simpson, Tyler Sobieck, Vaishak Gopi, Nasser Alberuti, Blaine Fanning, Thomas Wilson, and Robert Lankford.

Altogether, sixteen principal investigators, faculty, and administrators are participating in selected projects at
North Dakota State University: Kimberly Vachal, University Program Coordinator and PI; Andrew Bratlien, Co-PI; Brenda Lantz, PI; Frank Yazdani, PI; Mijia Yang, PI; Doug Benson, PI; EunSu Lee, PI; Pan Lu, PI; Alan Dybing, Co-PI; Raj Bridgelall, PI; Ying Huang, Co-PI; Denver Tolliver, Director; Donald Malchose, Project Researcher; Laurel Benson, Research Specialist; Mike Telste, Graduate Assistant; and Saeed Ahmari, Postdoctoral Researcher. In addition, fifteen graduate and undergraduate students are working on MPC projects at North Dakota State University: Doctorate Students- Oz Khan, Poyraz Kayabas, Anne Campbell, Elvis Ndemb, Chijioke Ihepe, Hai Zhong, Andrew Kubas, and Zhiming Zhang; Masters Students- Mike Telste, Ashkan Saboori, Sara Mamani, Liuqing Hu, Leonard Chia, and Xiao Liang; Undergraduate Student- Nathan Todd.

Two principal investigators, faculty, and administrators participating in MPC projects at the University of Denver include Patrick Sherry, University Program Coordinator and PI and Briana Hedman, Assistant Director. Four graduate and undergraduate students working on MPC projects at University of Denver include: Doctoral Students - Keaton Zucker; Masters Students Rachel Mulholland, Allison Bondanza, and Yifan Shi.

Four principal investigators, faculty, and administrators participating in MPC projects at the University of Colorado Denver include: Wesley Marshall, University Program Coordinator and PI; Jimmy Kim, PI; Carolyn McAndrews, PI; and Bruce Janson, PI. Seventeen graduate and undergraduate students working on MPC projects at University of Colorado Denver include: Masters Students - Alejandro Henao, Rachael Bronson, Mahdi Alavizadeh, Greg Colucci, Zachary Heinry, Mayam Karimi, Jenny McGinnis, Sarah Rosenberg, Tong Wen, Shile Dong, Kenny Qian, Kun Jiang, Thushara Sirwardanage, Laia Mitchell, and Craig Fisher; Undergraduate Students- Ben Johnk and Mat Tostle.

b. What other organizations have been involved as partners?

The timing of match funding and the commitments of collaborators vary widely throughout the life of the grant. During this period, we have the following committed collaborators.

1. AAR John Gray, Frank Hardesty, Shannon Stare
2. Ajou University, Korea
3. ASLRRRA Scott Sullivan, Elizabeth Petty, Richard Timmons
4. Boyle Engineering
5. City and County of Denver
6. City of Salt Lake Transportation Division
7. Colorado DOT
8. Denver Regional Council of Governments
9. Federal Highway Administration (FHWA)
10. Florida Atlantic University
11. Fort Berthold Reservation
12. FRA Administrators
14. Minnesota Department of Transportation (MnDOT), MnROAD research facility
15. National Cooperative Highway Research Program
16. National Institute of Standards and Technology, Boulder
17. NCAR
18. NCHRP, in developing the project's ideas for a possible national-level project
19. ND Department of Transportation
20. NDDOT is providing crash data
21. NDHP is providing officer log and CAD data
22. Northern Plain TTAP Center
23. Northern Plain TTAP Center
24. Regional Transportation District
25. Sean Vonfeldt, Triunity (contractor of Regional Transportation District (RTD)). RTD has provided
matching funding for the project. In addition, Sean is co-authored the conference proceeding currently under review.

26. South Dakota DOT
27. South Dakota DOT
28. Tailings and Mine Waste (TMW) Conference Committee, which is a consortium of consulting companies and industry partners that support research related to tailings and mine waste at CSU. Tailings and fly ash materials were obtained through three different consulting companies that are a part of the TMW consortium.

29. Tegracore, Industrial partner
30. The AAA Foundation for Traffic Safety
31. Tom Streicher, American Short Line Railroad Association
32. University of Utah (faculty start-up funds)
33. Utah Department of Transportation
34. Utah Department of Transportation
35. Utah Division of Wildlife Resources
36. Utah DOT
37. Utah Transit Authority
38. Ward Johnson, NIST, collaborator
39. Wasatch Front Regional Council
40. Wind River Indian Reservation
41. Working on access to the FMSCA portal data
42. WSDOT
43. WYDOT
44. Wyoming Division of FHWA
45. Wyoming DOT

**c. Have other collaborators or contacts been involved?**

The list of collaborating organizations in 3(b) is complete, as of this grant period.

**4. Impact**

The impacts of the program will become clearer in future years. The implementation of research findings often lags project selection and completion. However, certain impacts are emerging. The benefits of the program are already being felt in many respects.

1. **Graduate Education.** Collectively, the MPC universities offer one of the most diverse and comprehensive multimodal multidisciplinary graduate education programs in the nation. As shown earlier, 59 courses were offered in the fall 2014 and 314 courses have been offered since the inception of the program. The impact of the educational program will increase in future years, as the MPC universities expand the number of courses offered through their existing exchange program, in which students from any MPC university can take courses from other universities. These courses must be placed online for the collaborative exchange to work most effectively. Considerable progress has been made, thus far, in converting classroom courses to online courses and increasing the reach of the program. The Master of Transportation and Urban Systems degree is offered fully online at NDSU as is the Master of Managerial Logistics.

2. **Workforce Development.** MPC’s technical training program is having a major impact in the region. Online modules, short courses, webinars, and on site/videoconferencing events are reaching state and local transportation department employees and tribal transportation planners. By harnessing the capabilities of the four LTAP centers located at the MPC universities and the multimedia capabilities of the Transportation Learning Network (which was founded and is partly funded by MPC) more than 18
technical training events were offered in the second half of 2014. These training modules and short courses are critical to transportation agencies that need to improve or renew the skills of engineering technicians and other frontline workers. Many MPC courses or training events result in the certification of workers. Even when certification is not required, TLN’s online learning management systems allow employees and employers to set learning goals and monitor progress towards these goals.

MPC is making another major impact in workforce development. Altogether, 92 graduate students are working on MPC research projects under the tutelage of faculty researchers. These graduate students represent the researchers and technical analysts of tomorrow. Without the MPC program and the stipend funds that it provides, these students may not be specializing in transportation; but, instead would be seeking career opportunities in other fields. The MPC research program allows faculty to mentor graduate students while allowing the students to work on projects for federal and state transportation agencies—thereby, gaining valuable practical experience.

3. **Tribal Transportation Technical Assistance.** The program is already having a major impact in terms of providing tools and assistance for Native American tribes in the region, especially those impacted by energy development in Wyoming and North Dakota. To better coordinate and plan tribal-related activities, NDSU has designated a tribal transportation program coordinator to help the director identify critical needs and leverage resources to meet those needs. Technical assistance is already being provided in road safety, GIS transportation model building, forecasting heavy truck traffic attributable to energy development, and facilities planning. An emergency response planning guidebook (to help tribes plan for and respond to natural disasters that impact the transportation system and the delivery of life-saving services) is currently under development and will be disseminated within the region and the western United States when completed.

4. **Research.** During this rating period eight research projects have been completed and final reports published that address critical regional and national issues. Multiple journal articles and conference papers have been derived from each project, increasing their reach and impact. MPC’s strategy of requiring journal articles and presentations at national conferences (such as TRB and the Transportation Research Forum) is greatly magnifying the impacts of the research projects and MPC reports.

5. **Leadership.** MPC researchers and program administrators are having a major impact through participation in TRB, TRF, ITE, and other national organizations and conferences. Moreover, MPC is a leader in responding to the dynamic and sometimes unprecedented transportation demands and issues posed by shale energy development. MPC research projects in Wyoming and North Dakota are helping impacted states and local/tribal governments develop long-term road and bridge investment strategies. The newly formed North Dakota Transportation Safety Advisory Group (which includes representation from NDDOT, North Dakota Highway Patrol, FRA, PHMSA, and FMCSA) is identifying critical research projects for 2015-2016 and leveraging technical assistance and training for transportation operators, emergency responders, and state and local planners. Even though MPC’s primary focus is State of Good Repair, MPC has responded quickly to urgent requests for safety training and research in light of the unprecedented issues associated with the transportation of Bakken crude oil via rail, pipeline, and truck.

5. **Changes/Problems -** Nothing to report at this time.

5a. **Additional Information Regarding Products and Impacts** - Nothing to report at this time.

**PROGRAM OUTPUTS:** Nothing to report at this time.

**PROGRAM OUTCOMES:** Nothing to report at this time.
PROGRAM IMPACTS: Nothing to report at this time.

6. SPECIAL REPORTING REQUIREMENTS: None