

14th Semi-Annual Progress Report
for
National University Rail (NURail) Center:
Tier 1 University Transportation Center



National University Rail Center - NURail
US DOT OST-R Tier 1 University Transportation Center

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A handwritten signature in black ink, appearing to read 'Chris Barkan', with a stylized, cursive script.

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Table of Contents

1. Accomplishments	2
a. What was accomplished under these goals?	2
b. How have the results been disseminated?	4
c. What do you plan to do during the next period to accomplish the goals and objectives?	5
2. Participants and Other Collaborating Organizations.....	6
a. What organizations have been involved as partners?	6
b. Additional collaborators or contacts:	6
3. Outputs.....	6
a. Journal publications:	6
b. Books or other non-periodical, one-time publications:.....	7
c. Other publications, conference papers and presentations:	9
d. Website(s) or other Internet site(s):	10
e. Technologies or techniques:.....	10
f. Inventions, patent applications and/or licenses:.....	10
g. Other products (i.e. databases, audio/video products):	11
4. Outcomes	11
a. List how the research outputs described in section 3 are being used to create outcomes.	11
5. Impact.....	11
a. What is the impact on the effectiveness of the transportation system?.....	11
b. What is the impact on the adoption of new practices or instances where research outcomes have led to the initiation of a start-up company?.....	12
c. What is the impact on the body of scientific knowledge?	12
d. What is the impact on transportation workforce development?.....	13
6. Changes/Problems.....	13
a. Changes in approach and reasons for change	13
b. Actual or anticipated problems or delays and actions or plans to resolve them	13
c. Changes that have a significant impact on expenditures	14
d. Significant changes in use or care of human subjects, vertebrate animals and/or biohazards	14
e. Change of primary performance site location from that originally proposed.....	14

1. Accomplishments

National University Rail (NURail) Center funding has terminated and all projects from this grant are complete. Because there were a smaller number of active projects, there are fewer accomplishments, publications and other products that can be attributed to these expenditures in this last report.

The NURail Center was a rail-focused seven-university consortium led by the Rail Transportation and Engineering Center (RailTEC) at the University of Illinois Urbana-Champaign (UIUC). NURail's principal goals were to achieve a set of Research, Education, Technology Transfer Collaboration and Leadership objectives that not only fulfilled center objectives, but supported and assisted achievement of goals beyond the consortium members. These included the rail industry, AAR, and FRA research and workforce development goals. They also included working with other colleges and universities, both domestically and internationally, to advance academic rail education and research quality and quantity.

a. What was accomplished under these goals? (major activities; specific objectives; significant results (positive and negative); key outcomes)

NURail Consortium

- Consortium partners wrote 22 final reports in the past six months. Details in section 2d.
- Between April 1, 2020 and September 30, 2020, the NURail Center website had over 2,570 page loads and over 2,060 unique visits.
- Faculty, students and alumni from NURail partner and affiliate schools participated in the AREMA 2020 Virtual Conference & Expo held September 13 - 17. From giving presentations, participating on panels, and winning a poster competition, NURail was well represented during the conference.
- The Virtual Midwest Rail Conference was held on August 11 – 12 by Michigan Technological University and the theme was "Sustaining Midwest Rail". NURail's Tyler Dick, UIUC, presented "Operational Aspects of Precision Scheduled Railroading" in the first breakout session. In addition to hosting the conference, several NURail partners and affiliates were members of the conference planning committee while NURail partners Chris Barkan (UIUC), David Clarke (University of Tennessee, Knoxville) and Reg Souleyrette (University of Kentucky) were conference moderators.

University of Illinois Urbana-Champaign

- UIUC hosted two online William W. Hay Railroad Engineering Seminars. Richard Fox-Ivey, Railmetrics, presented "Innovations in Track Inspection – The Use of 3D Laser Sensing and AI to Detect Changes in Track Condition" on September 11. Marcus Dersch, UIUC, talked about "Timber Crosstie Spike Failures: Overview, Loading Demands, and Mitigation Considerations" on August 28. The total number of attendees for both seminars was 267 participants. Recordings of both were posted on YouTube for public viewing.

- *Shared Rail Corridor Adjacent Track Accident Risk Analysis – Phase 2 (Shared Corridor)* - A conference paper was presented; two new journal papers are being prepared for submission. The comprehensive adjacent track accident model was used in a couple of real-world cases, helping the rail industry solve shared-use rail corridor problems. Final report was written to summarize the project.
- *Schedule Flexibility and Railway Line Capacity (Line Capacity)* - Final project report completed.
- *Capacity of Hump Classification Yards (Hump Classification)* - Final project report completed. Two journal papers submitted for review with two more in final stages of preparation.
- *Intermodal Terminal Capacity Factor Interactions (Terminal Capacity)* - Final project report completed.
- *Relative Capacity and Performance of Fixed and Moving Block Train Control Systems (Train Control Systems)* - Final project report completed. One journal paper submitted for review.
- *Guidebook for Railway-themed K-12 STEM Outreach Activities (K-12 STEM)* - Final project report completed. Draft descriptions of multiple activities were prepared for the guidebook. Results from the survey on activities influencing interest in railway engineering education and careers were developed into two conference papers
- *Improving Track Substructure Designs and Settlement due to Complex Dynamic Loads from High-Speed Passenger and Freight Trains (Track Substructure)* - Final project report completed.
- *Numerical Investigation of Impact Load Effects on Railroad Track Systems (Load Effects)* - Final project report completed.
- *Quantifying Cyclic Loading Failure Criteria for Concrete Crossties (Concrete Crossties)* - Final project report completed.
- *Advanced Study of Resilient Materials: Effects on Track Stability, Crosstie Bending Moments, and Impact Attenuation (Resilient Materials)* – Final project report completed.

University of Illinois Chicago

- *Coupled Multibody and Finite Element Analysis of Rail Substructure Behavior* - Ran multiple simulations to examine settlement at track approaches. Results show an initial higher rate of settlement, with modestly increasing settlement after many passing trains. Results agree with experimental and more computationally expensive discrete methods.
- Developed a more advanced fastener model to improve the fidelity of finite model. This was beyond the scope of original project and is still in implementation.
- *Rail-highway crossing delay study for Dolton and Riverdale* - Completed the study and final report.

Michigan Tech University

- Undergraduate student, Walter Friesel, was the winner of the 2020 AREMA Virtual Conference & Expo Undergraduate Student Poster Competition. His poster was titled: "An Analysis of the Effectiveness of Locomotive Horns at Active Grade Crossings".
- Completed three exploratory research projects; *NURail2019-MTU-R17 - Understanding attention management and driver decision behavior at short-storage rail grade crossings*; *NURail2020-MTU-R18 - Improvement on the eddy current measurement for rail flaw detection and signal processing*; *NURail2020-MTU-R19 - Computer Learning and AI-Based Investigation of Outward Facing Locomotive Videos for Trespassing Events and Behavior*.
- Conducted 2020 Midwest Rail Virtual Conference which was co-sponsored by NURail, TRB AR040 Committee and Michigan Rail Conference Planning Committee. The Virtual Midwest Rail Conference was held on August 11 - 12 and the theme was "Sustaining Midwest Rail". This was the second Midwest Rail Conference and the first as a virtual platform.
- Supported two senior design groups for *Locomotive Traction Motor Field Service Apparatus for BNSF Railway* project.

University of Kentucky

- Continued in-track trackbed pressure measurements with revenue trains and the FRA's DOTX 218 Test Train at NS Railway test site.
- Continued to monitor trackbed design practices in Western European countries.

b. How have the results been disseminated?

NURail Consortium

- Twenty-two new final reports are available on the NURail Center website.
- Trains Magazine wrote an article about a three-person panel which discussed Precision Scheduled Railroading at the virtual Midwest Rail Conference. Tyler Dick, UIUC, presented "Operational Aspects of Precision Scheduled Railroading" as part of that panel.

University of Illinois Urbana-Champaign

- UIUC wrote ten final reports.
- UIUC hosted two online William W. Hay Railroad Engineering Seminars reaching 267 participants.
- *Shared Corridor* - Conference paper was presented at the American Railway Engineering and Maintenance of Way Association (AREMA) Annual Conference in September 2020. Final report posted.
- *Line Capacity* - Final report posted.
- *Hump Classification* - Final report posted. A paper was presented at the AREMA Annual Conference in September.
- *Terminal Capacity* - Final report posted.

- *Train Control Systems* - Final report posted. A paper was presented at the AREMA Annual Conference in September.
- *K-12 STEM* - Final report posted. Activity descriptions are being held for posting to the NURail and Illinois RailTEC websites. A paper was presented at the AREMA Annual Conference in September.
- *Track Substructure* - Final report posted.
- *Load Effects* - Final report posted.
- *Concrete Crossties* - Final report posted.
- *Resilient Materials* – Final report posted.

University of Illinois Chicago

- One conference paper related to coupled multibody and finite element analysis of rail substructure behavior has been written and accepted. Publication and the conference have been delayed until 2021 due to the Covid-19 pandemic.
- A report on rail-highway crossing delays in Dolton and Riverdale was prepared for the South Suburban Mayors and Managers Association in Hazel Crest, IL.

Michigan Tech University

- The Virtual Midwest Rail Conference had over 270 participants and 32 presentations.
- Final reports on exploratory projects submitted. Journal publications building on earlier NURail projects submitted/published (see details below).

c. What do you plan to do during the next reporting period to accomplish the goals and objectives?

NURail Consortium

- The NURail Center grant has terminated. While this is the last reporting period, consortium members plan to continue to acknowledge NURail in publications related to NURail-funded projects and track them to include in future updates to NURail publications numbers.

University of Illinois Urbana-Champaign

- *Hump Classification* - Submit two more journal papers for review. Present research results at the INFORMS Railway Applications Section monthly webinar in October and during the 2020 INFORMS Annual Meeting in November.
- *Train Control Systems* - Follow-up on two journal publications currently under review.
- *K-12 STEM* - Assemble all activity descriptions into final guidebook and disseminate through NURail, RailTEC and the National Railroad Construction and Maintenance Association website.

University of Illinois Chicago

- Plan to implement the new fastener model into the code.

2. Participants and Other Collaborating Organizations

a. What organizations have been involved as partners?

Organization or University Name	Location	Contribution to the Project	Name (First and Last)
Metra	Chicago, IL	Shared data	Hilary Konczal
Federal Railroad Administration	Washington, DC	Co-funded project	Michael Jones
CN	Homewood, IL	Shared material samples	Adam Sohasky
Metra	Chicago, IL	Shared data	Hilary Konczal
NS Railway Corp.	Atlanta, GA	In-Kind Assistance	Ed Boyle

b. Additional collaborators or contacts:

Name (First and Last)	Company, University, Organization Name	Location	Contribution to the Project
Colin Brooks, Erick Vega, Richard Dobson	Michigan Tech Research Institute	Ann Arbor, MI	Leading projects that have built on NURail work
Tim Havens	Michigan Tech University	Houghton, MI	EE/CS professor leading “AI-based trespasser detection project”
Elizabeth Veinott	Michigan Tech University	Houghton, MI	CLS professor leading “Short storage crossing safety project”
Diego Cardona	Eiffage Industries	Corbas, France	Data and paper
Radim Bruzek	Ensco, Inc.	Falls Church, VA	In-Kind test equipment

3. Outputs

a. Journal publications:

University of Illinois Urbana-Champaign

- Branson, J.M., M.S. Dersch, A. de O. Lima and J.R. Edwards. 2019. Analysis of geometric ballast plate for laboratory testing of resilient track components. *Transportation Geotechnics*, 20: 100240.
- Wang, B.Z., C.P.L. Barkan and M.R. Saat. 2020. Quantitative analysis of changes in freight train derailment causes and rates. *Journal of Transportation Engineering, Part A: Systems*. 146 (11) doi:10.1061/JTEPBS.0000453.

- Dick, C.T., P. Lautala and B.W. Schlake. 2019. STEM K-12 outreach as the root of transportation education: experiences from the railway engineering field. *Transportation Research Record: Journal of the Transportation Research Board*. 2673 (12): 558-569. doi:10.1177/0361198119841564.
- Lin, C-Y., M.R. Saat and C.P.L. Barkan. 2020. Quantitative causal analysis of mainline passenger train accidents in the United States. *Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit*, DOI: 10.1177/0954409719876128.
- Lin, C-Y., M.R. Saat and C.P.L. Barkan. 2020. Semi-quantitative risk assessment of adjacent track accidents on shared-use rail corridors. *Safety Science* (Under Review).
- Lin, C-Y., M.R. Saat and C.P.L. Barkan. 2020. Hazards associated with shared-use rail corridors in the United States – literature review and research needs. *Safety Science* (Under Review).
- Lin, C-Y., M.R. Saat and C.P.L. Barkan. 2020. A Risk Management Tool to Evaluate Adjacent Track Accidents on Shared-Use Rail Corridors. In: *Proceedings of the American Railway Engineering and Maintenance-of-way Association (AREMA) 2020 Annual Conference*, Dallas, Texas, USA.

Michigan Tech University

- Ko, S.; Lautala, P.; Zhang, K. Log Truck Value Analysis from Increased Rail Usage. *Forests* 2020, 11, 677. <https://doi.org/10.3390/f11060677>.
- Ko, S.; Lautala, P.; Zhang, K. Data-Driven Study on the Sustainable Log Movements: Impact of Rail Car Fleet Size on Freight Storage and Car Idling. *Sustainability* (2020), 12, 4563., <https://doi.org/10.3390/su12114563>.
- Nadri, C., Lee, SC., Kekal, S, Li, Y., Li X., Lautala, P., Nelson, D., Jeon, M., Effects of Auditory Display Types and Acoustic Variables on Subjective Driver Assessment in a Rail-Crossing Context. *Transportation Research Record: Journal of the Transportation Research Board*. (under review by TRR Editorial Board)

University of Kentucky

- Thompson, B.D., D.B. Clarke and J.G. 2020. Modeling Crosstie-Ballast Load Distribution in a Railroad Trackbed using a Linear-Elastic Analysis. *Transportation Research Record: Journal of the Transportation Research Board*. doi: 10.1177/0361198120937962.

b. Books or other non-periodical, one-time publications:

NURail Consortium

- Twenty-two final reports were written and posted on the NURail Center website. Three reports were Educational Projects and 19 were research projects.

University of Illinois Urbana-Champaign

- Final Report. Barkan, C.P.L. and C-Y. Lin. 2020. NURail2017-UIUC-R18. “Shared Rail Corridor Adjacent Track Accident Risk Analysis - Part 2”.

- Final Report. Tutumluer, E., B. Feng and W. Li. 2020. NURail2012-UIUC-R03. “Improving Track Substructure Designs and Settlement due to Complex Dynamic Loads from High-Speed Passenger and Freight Trains”.
- Final Report. Dick, C.T. 2020. NURail2014-UIUC-R15. “Blocking Capacity and Level of Service in Railway Hump Classification Yards”.
- Final Report. Dick, C.T., Mussanov, D. and N. Nishio. 2020. NURail2014-UIUC-R16. “Train Delay and Railway Line Capacity Under Combinations of Structured and Flexible Operations”.
- Final Report. Dersch, M.S. and J.R. Edwards. 2020. NURail2017-UIUC-R19. “Numerical Investigation of Impact Load Effects on Railroad Track Systems”.
- Final Report. Dick, C.T., W.B. Chen and M. Pugh. 2020. NURail2017-UIUC-R20. “Quantifying Intermodal Facility Capacity Factor Interactions through Simulation”.
- Final Report. Dersch, M.S., J.R. Edwards, A. de O. Lima and J.C. Bastos. 2020. NURail2018-UIUC-R21. “Improved Concrete Crossties Design: Quantifying Cyclic Loading Failure Criteria”.
- Final Report. J.M. Branson, A. de O. Lima, M.S. Dersch and J.R. Edwards. 2020. NURail2018-UIUC-R22. “Advanced Study of Resilient Materials: Effects on Track Stability, Crosstie Bending Moments, and Impact Attenuation”.
- Final Report. Dick, C.T., A. Diaz de Rivera and D. Mussanov. 2020. NURail2019-UIUC-R23. “Relative Capacity and Performance of Fixed and Moving Block Train Control Systems”.
- Final Report. Dick, C.T. and L.E. Evans. 2020. NURail2014-UIUC-E09. “Guidebook for Railway-themed K-12 STEM Outreach Activities”.

University of Illinois Chicago

- Final Report. Foster, C. 2020. NURail2017-UIC-R16. “Coupled Multibody and Finite Element Analysis of Rail Substructure Behavior”.
- Final Report. Kawamura, K. and A. Allahyari. 2020. NURail2020-UIC-R18. “Rail-highway crossing delay study for Dolton and Riverdale”.

Michigan Tech University

- Final Report. Lautala, P. and M. Jeon. 2020. NURail2016-MTU-R14. “Highway-Rail Grade Crossing Research with NDS Data and Driver Simulator”.
- Final Report. Lautala, P., K. Zhang and S. Ko. 2020. NURail2018-MTU-R16. “Log Movement in the Superior Region – Rate and Capacity Based Analysis of Modal Shares”.
- Final Report. Veinott, E., A. Linja and P. Lautala. 2020. NURail2019-MTU-R17. “Understanding attention management and driver decision behavior at short-storage rail grade crossings”.
- Final Report. Wang, J., Q. Dai and P. Lautala. 2020. NURail2020-MTU-R18. “Improvement on the eddy current measurement for rail flaw detection and signal processing”.
- Final Report. Havens, T. and P. Lautala. 2020. NURail2020-MTU-R19. “Computer Learning and AI-Based Investigation of Outward Facing Locomotive Videos for Trespassing Events and Behavior”.

University of Kentucky

- Final Report: Rose, J. G. 2020. NURail2016-UKY-R12. “Pressure distributions and magnitudes tie/ballast”.

University of Tennessee, Knoxville

- Final Report. Huang, B. and W. Song. 2020. NURail2013-UTK-R07. “Laboratory Investigation of Steel Tie Performance”.
- Final Report. Gui, Q. and Z.J. Ma. 2020. NURail2014-UTK-R10. “Seismic Performance of Stone Masonry and Unreinforced Concrete Railroad Bridge Substructures”.
- Final Report. Clarke, 2020. D.B. NURail2013-UTK-E02. “Continuing Education for the Railway Industry”.
- Final Report. Clarke, 2020. D.B. NURail2013-UTK-E03. “Railway Operations Class”.

c. Other publications, conference papers and presentations:

University of Illinois Urbana-Champaign

- Lin, C-Y, M.R. Saat and Barkan, C.P.L. 2020. A Risk Management Tool to Evaluate Adjacent Track Accidents on Shared-Use Rail Corridors. In: *Proceedings of the American Railway Engineering and Maintenance of Way Association Annual Conference (AREMA)*, Virtual Conference, September 2020.
- Diaz de Rivera, A., C.T. Dick and M.M. Parkes. 2020. Using advanced PTC with moving blocks to improve the operational feasibility of short trains on single-track rail corridors. In: *Proceedings of the American Railway Engineering and Maintenance-of-Way Association Annual Conference*, Virtual Event, September 2020.
- Dick, C.T.. 2020. Quantifying the relative influence of classification yard performance factors. In: *Proceedings of the American Railway Engineering and Maintenance-of-Way Association Annual Conference*, Virtual Event, September 2020.
- Evans, L.E. and C.T. Dick. 2020. Understanding influences on student pursuit of railway education and careers. In: *Proceedings of the American Railway Engineering and Maintenance-of-Way Association Annual Conference*, Virtual Event, September 2020.
- Bastos, J.C., M.S. Dersch, Edwards, J. Riley and T.A. Roadcap. 2019. Water Damage in Cracked Pretensioned Concrete Sleepers. In: 12th World Congress on Railway Research (WCRR), Union Internationale des Chemins de Fer (UIC), Tokyo, Japan.
- Bastos, J.C., M.S. Dersch, J.R. Edwards and C.P.L. Barkan. 2019b. Water Damage in Cracked Prestressed Concrete Sleepers. In: International Heavy Haul Association STS Conference (IHHA 2019), International Heavy Haul Association (IHHA), Narvik, Norway.

University of Illinois Chicago

- Foster, C.D. and S. Kulkarni. “Coupled Multibody and Finite Element Modelling of Track Settlement.” Accepted for presentation at the 16th International Conference of the International Association for Computer Methods and Advances in Geomechanics, May 5-8, 2021 Turin, Italy. (rescheduled from July 2020)

Michigan Tech University

- Veinott, E., Linja, A., Lautala, P., Nelson, D., *Improving Highway-Rail Safety at Cognitively Complex Intersections: Examining the Impact of Short-Storage Crossings on Driver Decision Behavior and Incident Outcome*, Abstract accepted for presentation at 2021 Joint Rail Conference, April 2021. (rescheduled from April 2020)
- Lautala, P., NURail Grade Crossing Safety Research presentation and panel discussion at Midwest Virtual Rail Conference, Aug. 11, 2020.

University of Kentucky

- Thompson, B., D. Clarke and J. Rose. *Wood Crosstie-Ballast Average Interfacial Pressure Magnitudes and Relative Distributions: In-Track Measurements and Finite Element Modeling*. (The International Conference on Transportation Geotechnics (ICTG) has accepted a paper on wood crossties for presentation and publication in the ICTG Proceedings. This meeting was originally scheduled to be held in Chicago in September 2020 but was postponed until May 2021.)

d. Website(s) or other Internet site(s):

University of Illinois Urbana-Champaign

- NURail Center website - <http://www.nurailcenter.org/>

Michigan Tech University

- Web links for Summer Youth - <http://www.rail.mtu.edu/event/rail-and-intermodal-summer-youth-program-2020>
- Midwest Rail Conference - <http://www.rail.mtu.edu/MRC2020>

e. Technologies or techniques:

University of Illinois Chicago

- In-house software package for analyzing settlement.

f. Inventions, patent applications and/or licenses:

- Nothing to report.

g. Other products (i.e. databases, audio/video products):

Michigan Tech University

- Midwest Virtual Rail Conference recorded sessions available at Rail Learning System - <https://rail-learning.mtu.edu/>

4. Outcomes

a. List how the research outputs described in section 3 are being used to create outcomes.

University of Illinois Urbana-Champaign

- *Hump Classification* – Based on the research results, the PI developed a new description of approaches to quantify yard and terminal capacity and proposed it as new material for AREMA Manual Chapter 16. AREMA Committee 16 then voted to adopt the new content and it was published in the 2020 edition of the AREMA Manual for Railway Engineering.
- *Shared Corridor* – The risk assessment model that was developed has been used in the rail industry to address shared-use rail corridor problems.

University of Illinois Chicago

- Improved methodologies for predicting vibrations in buildings.
- Improving processes for predicting soil settlement at transitions.

Michigan Tech University

- Exploratory research outcomes used to develop concept papers for the FRA Broad Agency Announcement and Broad Agency Announcement, Intelligent Railway Systems. (Under review).

5. Impact

a. What is the impact on the effectiveness of the transportation system?

University of Illinois Urbana-Champaign

- *Shared Corridor* – By using the developed risk assessment model the rail industry can address and reduce shared-use rail corridor problems.
- Terminal capacity constraints are a major issue for the railroads. With major investments in new hump yard and intermodal terminal projects underway, design and sizing of new yards and terminals is a growing need for the rail industry. Research on interaction between yard and mainline capacity will allow railroad practitioners to make better capital investment decisions to maximize the overall capacity of the rail network through properly balanced investments in mainline and yard projects. Similarly, research to better understand the factors that control intermodal facility capacity will allow railroads to make prudent investments in

new and expanded terminals to handle the fast-growing intermodal rail traffic market sector. Proper allocation of capital investments that minimizes delay, dwell and shipment transit time improves the overall effectiveness, efficiency and economies of freight rail transportation.

University of Illinois Chicago

- Settlement analysis will help predict rates of settlement, especially near transitions, and examine potential remedies. The tools will especially help in predicting more accurate source vibration estimates from passing trains.
- Vibration analysis will help quantify vibrations in nearby buildings, avoiding unnecessary mitigation. The tools can also be used to determine which mitigation techniques are most effective.
- The just-completed study on rail-highway crossing delays will improve safety at rail grade crossings.

Michigan Tech University

- NURail2018-MTU-R16, Log Movement in the Superior Region - Rate and Capacity Based Analysis of Modal Shares, provided new tools and knowledge to the forest products industry for more collaborative approach on log movements, a shift that industry is currently exploring.

University of Kentucky

- Higher quality and safer railway trackbed designs.

b. What is the impact on the adoption of new practices or instances where research outcomes have led to the initiation of a start-up company?

- Nothing to report.

c. What is the impact on the body of scientific knowledge?

University of Illinois Chicago

- Settlement modeling has the potential to improve economy of rail systems, reduce maintenance, and possibly increase safety.
- Vibration analysis improves understanding of how vibrations travel through and how they can be reduced.
- Numerical methods developed have a wide variety of applications in the areas of geomaterial modeling, contact, and computational plasticity.

Michigan Tech University

- 2020 Midwest Virtual Rail Conference had 270 total participants with diverse backgrounds, ten sessions, and 35 presenters.

d. What is the impact on transportation workforce development?

University of Illinois Urbana-Champaign

- UIUC taught three rail courses in Fall 2020. The total enrollment was 115 undergraduate and graduate students including online students. Many of these students will be pursuing careers in rail transportation and these classes have the dual impact of motivating student interest in such careers and improving their capabilities once they enter the workforce.
- UIUC hosted two online William W. Hay Railroad Engineering Seminars reaching and educating 267 participants in the rail industry.
- Student participation in rail-focused research helps develop the next generation of railway professionals and trains them in the application of advanced technologies and techniques.
- Developing rail-focused K-12 student outreach activities is essential to attracting a new generation of youth to develop an interest in railway transportation and engineering at earlier stages of their education. Based on experience in other STEM fields, students that are aware of railway technology and engineering concepts earlier in their K-12 education are more likely to enroll in rail-focused education programs and ultimately pursue careers in the railroad sector.

Michigan Tech University

- Midwest Virtual Rail Conference 2020 offered free registration for students and had more than 20 students learning on latest developments in the rail transportation industry.
- More than 20 total students from variety of disciplines were involved in the student senior design and research projects supported by NURail at Michigan Tech during the reporting period.

6. Changes/Problems

a. Changes in approach and reasons for change

NURail Consortium

- All universities had to shift to virtual communications and activities due to COVID-19.
- Summer 2020 internships were essentially non-existent due to the pandemic.

b. Actual or anticipated problems or delays and actions or plans to resolve them

University of Illinois Chicago

- One conference paper has been written and accepted. Publication and the conference have been delayed until 2021 due to the Covid-19 pandemic.

Michigan Tech University

- Summer Youth Program in Rail and Intermodal Transportation 2020 canceled due to COVID-19 (all on-campus youth programs canceled by the university). Plans to resume again in 2021.
- 2020 Midwest Rail Conference adapted from in in-person conference to virtual format via Zoom Webinar.

University of Kentucky

- One conference paper that was scheduled to be presented in September 2020 has had to be postponed until May 2021 due to coronavirus gathering restrictions.

c. Changes that have a significant impact on expenditures

- Nothing to report.

d. Significant changes in use or care of human subjects, vertebrate animals and/or biohazards

- Nothing to report.

e. Change of primary performance site location from that originally proposed

- Nothing to report.