

## **Quarterly Progress and Performance Indicators Report:**

**Project Number and Title:** Project 1.2: Condition/Health Monitoring of Railroad Bridges for Structural Safety, Integrity, and Durability

**Research Area: Thrust 1** -Transportation Infrastructure Monitoring & Assessment for Enhanced Life

**PI:** Ramesh B. Malla, Ph.D., F. ASCE, F. EMI, Professor, Department of Civil & Environmental Engineering, University of Connecticut, and  
**Institutional Lead** for US DOT Region 1 UTC-TIDC Program

**Co-PI(s):** N/A

**Reporting Period:** April 01, 2022, to June 30, 2022

**Submission Date:**

**\*\*\*IMPORTANT:** *Please fill out each section fully and reply with N/A for questions/sections with nothing to report. For ease of reporting to the USDOT, please do not remove, or change the order of, any sections/text. You may remove/add rows in tables as needed. Thank you! \*\*\**  
*The report is due on the last day of the reporting period in .doc format to tidc@maine.edu.*

### **Overview:**

Provide **BRIEF** highlights of activities performed during the reporting period.

Research work performed over this reporting period include the following:

- The research team has processed and analyzed the material testing and filed test data collected during the research period (figure 1 and 2).
- The Final report is being written in compliance with TIDC requirements, aiming to be informative and beneficial to DOTs, railroad industry, and future researchers.
- The research team held a meeting with the Technical Champions of the project from CT DOT, Metro North Railroad and Polytec Inc., and partners on June 30, 2022.
- The research team presented information on the railroad infrastructure to K-12 students virtually on June 24th and 25<sup>th</sup> 2022.

### **Meeting the Overarching Goals of the Project:**

*How did the previous items help you achieve the project goals and objects? Please give one bullet point for each bullet point listed above.*

- Understanding the behavior of truss railroad bridges under the operation loading of different trains, such as, Acela Express, Amtrak Regional and Metro-North M8.
- Development of procedure for field data analysis and verification and calibration of finite element models of the bridges
- K-12 Student outreach activities (Appendix A).

### **Accomplishments:**

*List any accomplishments achieved under the project goals in bullet point form...*

- Better understanding of the field-testing procedures and railroad bridges dynamic behavior.
- Dissemination of research results via conferences and Outreach to K-5 and K-12 students (Appendix A).
- The team continue to maintain strong collaboration with State DoT (CT DOT), railroad management company (Metro North), device manufacturer (Polytec, Inc.) and other rail industries.

**Task, Milestone, and Budget Progress:**

Complete the following tables to document the work toward each task and budget

<b>Table 1: Task Progress</b>			
<b>Task Number: Title</b>	<b>Start Date</b>	<b>End Date</b>	<b>% Complete</b>
Task 1: Literature search and review; communication with New England state DOTs for railroad bridge material collection and information/data	October 1, 2018	December 31, 2021	100%
Task 2: Existing railroad bridge material testing	January 1, 2019	August 31, 2022	95%
Task 3: Finite Element (FEM) modeling of railroad bridge	June 1, 2019	September 1, 2022	97%
Task 4: Determine number/types and locations of sensor for effective bridge condition monitoring	December 1, 2019	September 1, 2022	85%
Task 5: Determine from the analytical and FEM analysis effects of vehicle speed/type on bridge response and DMF	June 1, 2020	September 1, 2022	85%
Task 6: Prepare procedure to field test and data collection by applying a limited number of sensors to bridge, collect field data, update FEM, and verify that sensors give sufficient info to determine condition of bridge	October 1, 2020	September 1, 2022	85%
Final Report preparation and submission	January 1, 2022	June 30, 2022	50%
Overall Project:	October 01, 2018	June 30, 2022	90%

<b>Table 2: Milestone Progress</b>			
<b>Milestone #: Description</b>	<b>Corresponding Deliverable</b>	<b>Start Date</b>	<b>End Date</b>
Milestones will closely represent task items listed above	Quarterly and final reports	Will closely follow task dates (See Table 1 above)	Will closely follow task dates (See Table 1 above)

<b>Table 3: Budget Progress</b>		
<b>Project Budget</b>	<b>Spend – Project to Date</b>	<b>% Project to Date (include the date)</b>
<i>Enter Phase 1 Full Budget</i>	<i>Enter Phase 1 Full Spend Amount (Federal + Cost Share)</i>	<i>Enter Phase 1 % Spent</i>
Will be provided separately	Will be provided separately	Will be provided separately

**Is your Research Project Applied or Advanced?**

**Applied** (The systematic study to gain knowledge or understanding necessary for determining the means by which a recognized and specific need may be met.)

**Advanced** (*An intermediate research effort between basic research and applied research. This study bridges basic (study to understand fundamental aspects of phenomena without specific applications in mind) and applied research and includes transformative change rather than incremental advances. The investigation into the use of basic research results to an area of application without a specific problem to resolve.*)

**Education and Workforce Development:**

*Answer the following questions (N/A if there is nothing to report):*

1. Did you provide any workforce development or training opportunities to transportation professionals (already in the field)? If so, what was the training? When was it offered? How many people attended? (i.e. The research team provided an in the field training for the SAR technology for 3 maintenance crew members of the MassDOT on 3/31/2021. The members learned how to use the technology and interpret the data.)
  - N/A
  
2. Did you hold meetings with any transportation industry organizations or DOTs? If so, what was the meeting’s purpose? When was it offered? How many people attended? (i.e. The research team held a meeting with MaineDOT to update them on the progress of the research findings and how the findings can be implemented on 3/31/2021. 15 DOT maintenance members were present at the meeting.)
  - Virtual meeting held on June 30, 2022,) with 4 Technical Champions and representatives from the CT DOT, Metro-North Railroad Co., and Polytec Inc., and 2 research partners from Amtrak and Genesee and Wyoming Inc., provide project update and receive feedback.
  
3. Did you host/participant in any K-12 education outreach activities? If so, what was the activity? What was the target age/grade level of the participants? How many students/teachers attended? When was the activity held? (i.e. 25 8<sup>th</sup> graders and 2 teachers visited the concrete lab and created small concrete trinkets like Legos on 3/31/2021. They learned about the different types of fibers that can be used in the concrete.)
  - Presented Early College Innovation Panel, virtual presentation on the topic related to the railroad transportation infrastructure to K -5 students on June 24, 2022, and K-12 students on June 25, 2022, through Connecticut Invention Convention (CIC), an internationally recognized non-profit educational organization based in Hartford, CT. A promotional flyer was prepared and shared with the CIC student list widely through e-mail and its social media platforms (See Appendix A). Students learned about different types of railroad bridges, different parts in railroad bridges, different material used in railroad bridge construction, different types of trains operated in New England, challenges railroad bridges facing and their remedies. The research team also conveys a message of need of more research and innovation to enhance the life of more than 115 years old railroad bridges in New England. The presentation sessions have been video recorded and are being made available to watch by the CIC students from around the State of Connecticut.

**Technology Transfer:**

*Complete all of the tables below and provide additional information where requested. Please provide ALL requested information as this is one of the most important sections for reporting to the USDOT. **ONLY provide information relevant to this reporting period.***

*Use the table below to complete information about conference sessions, workshops, webinars, seminars, or other events you led/attended where you shared findings as a result of the work you conducted on this project:*

**Table 4: Presentations at Conferences, Workshops, Seminars, and Other Events**

Type	Title	Citation	Event & Intended Audience	Location	Date(s)
<i>i.e. Conference, Symposium, DOT/AOT presentation, Seminar, etc.</i>	<i>Presentation Title</i>	<i>Full Citation</i>	<i>Name of event (i.e. TIDC 1<sup>st</sup> Annual Conference) or who was the presentation given to?</i>		
Graduate Seminar	Model Update of Old Truss Railroad Bridge using Laser Doppler Vibrometers – Case Study of Devon Railroad Bridge in Connecticut	Celso de Oliveira, C, and Ramesh B Malla, “Model Update of Old Truss Railroad Bridge using Laser Doppler Vibrometers – Case Study of Devon Railroad Bridge in Connecticut”, SOE Structure and Applied Mechanics Seminar, April 08, 2022, Oral.	University of Connecticut, School of Engineering, Structure and Applied Mechanics Graduate Seminar; Audience: Graduate students	Storrs, CT	April 08, 2022
Presentation	Railroad Transportation: Trains, Bridges, and Tracks	Max Raha, Santosh Dhakal, Celso Cruz De Oliveira, Prof. Ramesh Malla, “Railroad Transportation: Trains, Bridges, and Tracks,” Oral presentation/video recording, K - 5 students’ program, Connecticut Invention Convention (CIC), Hartford, CT (Virtual), June 24, 2022 (4:30 PM – 5:30 PM)	Connecticut Invention Convention (CIC) <i>Early College Innovation Panel: K-5 Students</i>	Connecticut Invention Convention (CIC), Hartford, CT (Virtual)	June 24 2022
Presentation	Railroad Infrastructure: USDOT Railroad Bridge Research Project at UConn	Max Raha, Santosh Dhakal, Celso Cruz De Oliveira, Prof. Ramesh Malla, “Railroad Infrastructure: USDOT Railroad Bridge Research Project at UConn,” Oral presentation/video recording, K -12 students’ program, Connecticut Invention Convention (CIC),	Connecticut Invention Convention (CIC) <i>Early College Innovation Panel Grade 6-12 Students</i>	Connecticut Invention convention (CIC), Hartford, CT (Virtual)	June 25 2022

		Hartford, CT (Virtual), June 25, 2022 (4:30 PM-5:30 PM)			
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Use the table below to report any publications, technical reports, peer-reviewed articles, newspaper articles referencing your work, graduate papers, dissertations, etc. written as a result of the work you conducted on this project. Please list only completed items and exclude work in progress.

<b>Table 5: Submitted/Accepted Publications, Technical Reports, Theses, Dissertations, Papers, and Reports</b>				
<b>Type</b>	<b>Title</b>	<b>Citation</b>	<b>Date</b>	<b>Status</b>
<i>i.e. Peer-reviewed journal, conference paper, book, policy paper, magazine/newspaper article</i>	<i>Publication title</i>	<i>Full citation</i>		<i>i.e. Submitted, accepted, under review (by org. submitted to)</i>
N/A	N/A	N/A	N/A	N/A

Answer the following questions (N/A if there is nothing to report):

1. Did you deploy any technology during the reporting period through pilot or demonstration studies as a result of this work? If so, what was the technology? When was it deployed?
  - N/A
2. Was any technology adopted by industry or transportation agencies as a result of this work? If so, what was the technology? When was it adopted? Who adopted the technology?
  - N/A
3. Did findings from this research project result in changing industry or transportation agency practices, decision making, or policies? If so, what was the change? When was the change implemented? Who adopted the change?
  - N/A
4. Were any licenses granted to industry as a result of findings from this work? If so, when? To whom was the license granted?
  - N/A
5. Were any patent applications submitted as a result of findings from this research? If so, please provide a copy of the patent application with your report.
  - N/A
6. Did industry organizations or DOTs provide cost-share (cash or in-kind) to your research during the reporting period? Who was the organization? Please provide an in-kind support invoice from the organization with your report (this is kept confidential and used for record keeping purposes only).

- N/A

Please add figures/images that can be included on the website and/or in marketing/social media materials to further clarify your research to the general public. This is very important to our Technology Transfer initiatives.

Insert figures here

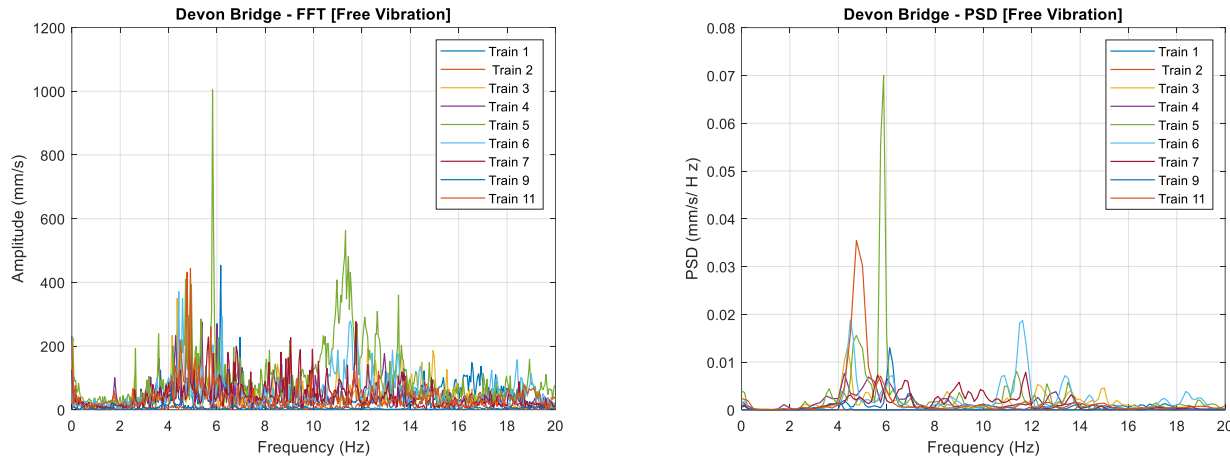


Figure 1 – Devon Bridge, CT, frequency-domain response under free vibration, FFT in left plot, and PSD in right plot

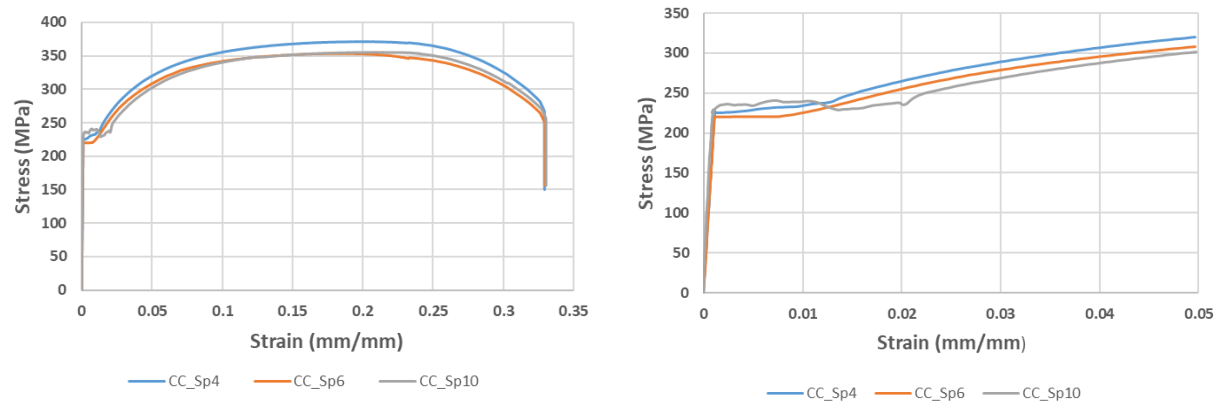


Figure 2 – Tensile Stress-strain diagram, Cos Cob Bridge, CT, monotonic loading to failure in left plot, enlarged scale up to strain 0.05 mm/mm in right plot. loading rate: 4mm/min. (Unit Conversion: 1 ksi = 6.9 MPa; 36 ksi = 248.2 MPa; 1 in = 25.4)

Describe any additional activities involving the dissemination of research results not listed above under the following headings:

**Outputs:**

*Definition: Any new or improved process, practice, technology, software, training aid, or other tangible product resulting from research and development activities. They are used to improve the efficiency, effectiveness, and safety of transportation systems. List any outputs accomplished during this reporting period:*

- N/A

**Outcomes:**

*Definition: The application of outputs; any changes made to the transportation system, or its regulatory, legislative, or policy framework resulting from research and development activities. List any outcomes accomplished during this reporting period:*

- N/A

**Impacts:**

*Definition: The effects of the outcomes on the transportation system such as reduced fatalities, decreased capital or operating costs, community impacts, or environmental benefits. The reported impacts from UTCs are used for the assessment of each UTC and to make a case for Federal funding of research and education by demonstrating the impacts that UTC funding has had on technology and education. NOTE: The U.S. DOT uses this information to assess how the research and education programs (a) improve the operation and safety of the transportation system; (b) increase the body of knowledge and technologies; (c) enlarge the pool of people trained to develop knowledge and utilize technologies; and (d) improves the physical, institutional, and information resources that enable people to have access to training and new technologies. List any outcomes accomplished during this reporting period:*

- N/A

**Participants and Collaborators:**

*Use the table below to list individuals (compensated or not) who have worked on the project other than students.*

<b>Table 6: Active Principal Investigators, faculty, administrators, and Management Team Members</b>				
<b>Individual Name &amp; Title</b>	<b>Dates involved</b>	<b>Email Address</b>	<b>Department</b>	<b>Role in Research</b>
Dr. Ramesh B. Malla, Professor (Principal Investigator)	Apr.-Aug. 2022	Ramesh.Malla@UConn.EDU	Civil & Environmental Engineering, University of Connecticut, Storrs, CT	Principal Investigator (PI)/ TIDC Institutional Lead, UConn

*Use the table below to list **all** students who have participated in the project during the reporting period. (This includes all paid, unpaid, intern, independent study, or any other student that participated in this project.) **ALL FIELDS ARE REQUIRED.***

**Table 7: Student Participants during the reporting period**

Student Name	Start Date	End Date	Advisor	Email Address	Level	Major	Funding Source	Role in research
				<i>Email is not included in the external report and is only used for internal purposes.</i>	<i>(i.e. UG, MS, PhD)</i>		<i>(i.e. TIDC, Other university funds, unpaid intern, etc.)</i>	<i>What work are they conducting? Please be descriptive. Student research assistant is not enough info.</i>
Celso de Oliveira	Apr. 01, 2022	June 30, 2022	Dr. Ramesh Malla		Ph.D.	Civil Eng.	TIDC/UConn	Field Test and FEM
Santosh Dhakal	Apr. 01, 2022	June 30, 2022	Dr. Ramesh Malla		M.S.	Civil Eng.	TIDC/UConn	Material Test and FEM
Max Raha	May 15, 2022	Jun. 30, 2022	Dr. Ramesh Malla		B.S.	Civil Eng.	TIDC/UConn	Literature Search

Use the table below to list any students who worked on this project and graduated or received a certificate during this reporting period. Include information about the student's accepted employment during the reporting period (i.e. the student is now working at MaineDOT) or if they are continuing their students through an advanced degree (list the degree and where they are attending).

**Table 8: Students who Graduated During the Reporting Period**

Student Name	Degree/Certificate Earned	Graduation/Certification Date	Did the student enter the transportation field or continue another degree at your university?
			<i>Please list the organization or degree</i>
Celso de Oliveira	Graduate Certificate in Bridge Engineering	05/08/2022	Attending Ph.D. at University of Connecticut

Use the table below to list any students that participated in Industrial Internships during the reporting period:



**Table 9: Industrial Internships**

Student Name	Degree/Certificate Earned	Graduation/Certification Date	Did the student enter the transportation field or continue another degree at your university?
			<i>Please list the organization or degree</i>
N/A	N/A	N/A	N/A

Use the table below to list **organizations** that have been involved as partners on this project and their contribution to the project during the reporting period.

**Table 10: Research Project Collaborators during the reporting period**

Organization	Location	Contribution to the Project				
		Financial Support	In-Kind Support	Facilities	Collaborative Research	Personnel Exchanges
		<i>List the amount</i>	<i>List the amount</i>	<i>Mark with an "x" where appropriate</i>		
<b>Conn DOT</b> Contact persons: (1) Haresh Dholakia- Transportation Engineering Supervisor, Rail Design <i>(Technical Champion)</i> (2) Mr. Manesh Dodia- Supervising Rail Officer, Rail Construction <i>(Technical            Champion)</i>	Newington, CT		X		X	
<b>Metro-North Railroad Co.</b> Contact persons: (1) Warren Best-Assistant Deputy Director- Structures <i>(Technical Champion)</i> (2) Ms. Hong McConnell, Senior Structural Engineer	Bridgeport, CT		X		X	
<b>Polytec, Inc.,</b> Contact Person:	Hudson, MA		X		X	

Mr. Mario Pineda, Territory Manager						
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Use the table below to list **individuals** that have been involved as partners on this project and their contribution to the project during the reporting period. (**List your technical champion(s) in this table.** This also includes collaborations within the lead or partner universities who are not already listed as PIs; especially interdepartmental or interdisciplinary collaborations.)

<b>Table 11: Other Collaborators</b>				
<b>Collaborator Name and Title</b>	<b>Contact Information</b>	<b>Organization and Department</b>	<b>Date(s) Involved</b>	<b>Contribution to Research</b>
	<i>For internal use only</i>			<i>(i.e. technical champion, technical advisory board, test samples, on-site equipment, data, etc.)</i>
Haresh Dholakia, Transportation Engineering Supervisor, Rail Design		Connecticut Department of Transportation (Conn DOT), Newington, CT	Apr.- Jun. 2022	Technical Champion
Manesh Dodia, Supervising Rail Officer, Rail Construction		Connecticut Department of Transportation (Conn DOT), Newington, CT	Apr.- Jun. 2022	Technical Champion
Warren Best, Assistant Deputy Director-Structures		Metro-North Railroad Company, Bridgeport, CT	Apr.- Jun. 2022	Technical Champion
McConnell Hong Sr. Structural Engineer		Metro-North Railroad Company, Bridgeport, CT	Apr.- Jun. 2022	Senior Engineer/Logistic contact
Mario Pineda, Territory Manager		Polytec Inc., Hudson, MA	Apr.- Jun. 2022	Technical/Logistics Contact person/

Use the following table to list any transportation related course that were taught or led by researchers associated with this research project during the reporting period:

**Table 12: Course List**

Course Code	Course Title	Level	University	Professor	Semester	# of Students
<i>i.e. CE 123</i>		<i>Grad or undergrad?</i>	<i>Where was the course taught?</i>	<i>Who taught the course?</i>	<i>Enter Spring, Fall, Summer, Winter and the year</i>	<i>How many students were enrolled in the class?</i>
CE 5122	Advance Mechanics of Material	Graduate	Storrs, CT	Prof. R. Malla	Spring 2022	9
CE 3630	Design of Steel Structures	Undergraduate / lab class	Storrs, CT	Celso de Oliveira (Teaching Assistant)	Spring 2022	45
CE 4510	Foundation Design	Undergraduate	Storrs, CT	Santosh Dhakal (Teaching Assistant)	Spring 2022	60

**Changes:**

List any actual or anticipated problems or delays and actions or plans to resolve them (list no-cost extension requests here) ...

- N/A

List any changes in approach and the reasons for the change...

- N/A

**Planned Activities:**

List the activities planned during the next quarter.

Research activities planned for next quarter include the following:

- Finalize and submit the Final Report.




**UCONN CIVIL & ENVIRONMENTAL ENGINEERING**

# EARLY COLLEGE INNOVATION PANEL

*Exclusively available to CIC inventors and graduates!*



**Ramesh Malla**  
*Professor*



**Celso Cruz de Oliveira**  
*Ph.D. Student*



**Santosh Dhakal**  
*M.S. Student*



**Max Raha**  
*Undergrad Student*

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K – 5<sup>TH</sup> GRADE

**June 24th, 2022 | 4:30 – 5:30pm ET**

Join us aboard for a discussion on the history of railroads and make interesting discoveries about the trains and railways of today! Hear about the major milestones of railroad infrastructure presented by UConn students and professor while answering with prizes to be awarded at the end for students with the most correct answers.

TOPICS:

- + Oldest railroads around the world
- + Different types of railroad bridges
- + Future of trains

[EarlyCollegeInnovationPanelK-5.eventbrite.com](https://www.eventbrite.com/e/early-college-innovation-panel-k-5-tickets-29888888888)

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6 – 12<sup>TH</sup> GRADE

**June 25th, 2022 | 4:30 – 5:30pm ET**

Join us to learn about the inner workings of today's railroads and to hear about one of the many research projects happening at the University of Connecticut. There will be a Q&A session at the end in which students will be given the opportunity to interact with a professor as well as undergraduate and graduate level students of UConn.

TOPICS:

- + Brief history of railroads and railroad bridges
- + UConn Railroad Bridge Research Project
- + Current Events such as railroad delays and high speed rail in the US

[EarlyCollegeInnovationPanel6-12.eventbrite.com](https://www.eventbrite.com/e/early-college-innovation-panel-6-12-tickets-29888888888)

Figure 3 – K-5 grade students and 6-12 grade students Presentation Flyer