

Quarterly Progress and Performance Indicators Report:

Project Number and Title: Wireless Joint Monitoring System for Large Movement Expansion Joints for Highway Bridge Resilience

Research Area: Thrust 1 Transportation infrastructure monitoring and assessment for enhanced life.

PI: *Shinae Jang, Ph.D., P.E, Professor In-Residence, School of Civil & Environmental Engineering, University of Connecticut, Storrs, CT*

Co-PI(s): *Song Han, Ph.D., Associate Professor, School of Computing, University of Connecticut; and*

Ramesh B. Malla, Ph.D., F. ASCE, F. EMI; Professor, School of Civil & Environmental Engineering University of Connecticut

Reporting Period: 7/1/2024– 9/30/2024

Submission Date: 9/30/2024

*****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 each row 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. This summary should be written in lay terms for a general audience to understand. This should not be an extensive write-up of findings (those are to be included in the final report), but a high-level overview of the activities conducted during the last three months **no more than 3 bullet points at no more than 1 sentence each***

- The Research Team completed monitoring of expansion joint from skewed bridge and prepared logistics for next deployment in large-movement expansion joint.
- The Research Team presented the research findings at national and international conferences and published a journal paper in an open-access journal
- The Research Team met technical champions on 30th Sept 2024 and selected the bridge testbed, the Founders Bridge in Hartford, CT.

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.

- Continuous monitoring of in-service bridges summer is essential to understanding their thermal response; preparing long-term monitoring databases helps assess the health of test bridges, and moving the monitoring system to large movement expansion joints will help understand behavior and performance of different types of expansion joints
- Presentations at the conference and seminar help spread research findings and incorporate industry interests into the project, and the research team has provided a standard method to evaluate bearing health through paper publication.
- Meeting with DoT helped to report research findings to the deploying agency and obtain their feedback and permission for next deployment.

Accomplishments:

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

- The Research Team collected the movement data from the skewed girder bridge
- The Research Team prepared the logistics for a large-movement expansion joint and acquired necessary permissions.
- The Research Team met on a bi-weekly basis from 7/1/2024 to 9/30/2024.

Task, Milestone, and Budget Progress:

Complete the following tables to document the work toward each task and budget (add rows/remove rows as needed, make sure you complete the Overall Project progress row and include all tasks even if they have ended or have not been started) ...

Table 1: Task Progress			
Task Number: Title	Start Date	End Date	% Complete
Task 1 Sensor Upgrade and Performance Validation Tests	10/1/2023	6/30/2024	90%
Task 2 Field Data Collection	1/1/2024	5/15/2024	40%
Task 3 Data Analysis and Assessment	1/1/2024	7/31/2024	35%
Overall project			45 %

Table 2: Milestone Progress			
Milestone #: Description	Corresponding Deliverable	Start Date	End Date
Milestone 1: Upgraded Sensor Development	New Upgraded sensor prototype (version 2)	10/1/2023	02/08/2024
Milestone 2: Field Deployment	Monitoring database and results	02/08/2024	5/15/2024
Milestone 3: Quarterly Report submission	Quarterly Progress Report		9/30/2024

Table 3: Budget Progress		
Project Budget	Spend – Project to Date	% Project to Date (include the date)
To be provided separately by UConn PI/Lead	To be provided separately	To 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 interrupt 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.)

We had a meeting with CTDOT on 9/30/2024 to update the project progress, select the long-term testbed, and discuss the logistics of the sensor deployment. The meeting was online via Microsoft Teams. A total of 8 people attended the meeting including 3 PIs, 2 UConn students, and 3 DOT experts including technical champions.

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 8th 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.)

N/A

Technology Transfer:

*Complete all 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)

Seminar	Expansion joint monitoring using real-time wireless sensing for highway bridge resilience	Jang, S.(2024). "Expansion joint monitoring using real-time wireless sensing for highway bridge resilience", <i>Civil Engineering Graduate Seminar, School of Civil & Environmental Engineering, University of Connecticut</i>	Invited to CE 5010 Civil Engineering Graduate Seminar & Graduate Students and Faculty in the School of CEE	Castleman 204, University of Connecticut	9/20/2024
---------	---	--	--	--	-----------

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.

Table 5: Submitted/Accepted Publications, Technical Reports, Theses, Dissertations, Papers, and Reports

Type	Title	Citation	Date	Status
Conference presentation	Monitoring Thermal Movement of Highway Bridge Expansion Joints for Safety and Health Diagnosis	Bhandari, P., Jang, S., Malla, R. B., & Han, S. (2024). <i>Monitoring Thermal Movement of Highway Bridge Expansion Joints for Safety and Health Diagnosis</i> [Poster presentation]. 2024 TIDC Annual Conference, University of Maine, Orono, ME, August 6-8.	Aug 6-8, 2024	Presented
Journal paper	ANN-based Bridge Support Fixity Quantification using Thermal Response	Bhandari, P., Jang, S., Malla, R. B., & Han, S. (2024). ANN-Based Bridge Support Fixity Quantification Using Thermal Response Data from Real-Time Wireless Sensing. <i>Sensors</i> , 24(16), 5350. https://doi.org/10.3390/s24165350	19 Aug 2024	Published
Conference presentation	Bridge Bearing Fixity Evaluation Using ANN and Low-Cost Wireless Sensing Systems	Bhandari, P., Jang, S., Han, S., Malla, R. B., & Reichenberger, R. (2025). <i>Bridge Bearing Fixity Evaluation Using ANN and Low-</i>	30 Sept 2024	Abstract Submitted

		<p><i>Cost Wireless Sensing Systems.</i> [Poster presentation] at SPIE Smart Structures + Nondestructive Evaluation Conference, Vancouver, Canada, March 2025.</p>		
--	--	---	--	--

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?

We deployed the real-time wireless joint monitoring system on the first testbed.

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

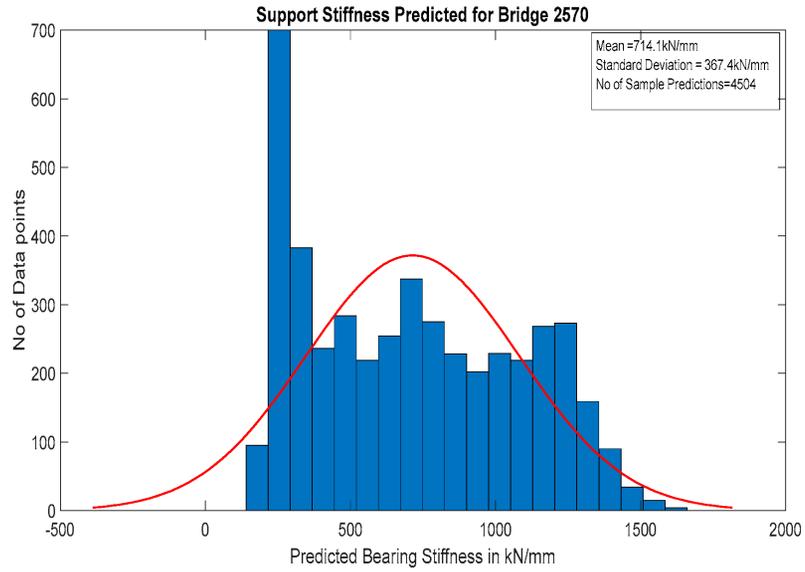
5. Were any patent applications submitted as a result of findings from this research? If so, please provide a copy of the patent application with your report.

N/A

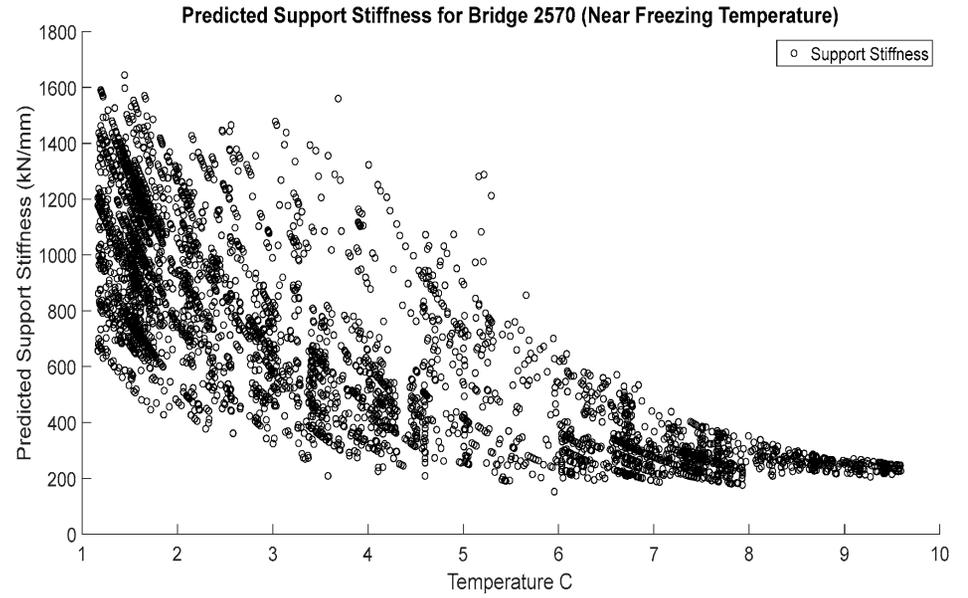
6. Did industry organizations or DOTs provide cost-share (cash or in-kind) to your research during the reporting period? Who was the organization? Please provide an in-kind support invoice from the organization with your report (this is kept confidential and used for record keeping purposes only).

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.



(a)



(b)

Figure 1: Histogram and temperature dependence of bearing stiffness predicted using ANN for monitored bridge (CT2570)



Figure 2: Field Monitoring campaign on the in-service bridge (CT2570) by research team

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

N/A

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:

- Examples: New sensing technology was developed. This technology will... A UAV was created to hold new monitoring technology. This will allow maintenance crews to... A new college course was created based on the research findings. This will train future transportation professionals to...

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:

- Example: The developed sensing technology was installed in Bridge A in town, state on 1/1/2021. This installation will... The UAV was successfully used by ___ Organization to inspect ___ Bridge in town, state on 1/1/2021... The newly created college course was taken/completed by ___ students in the 2021 fall semester.

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:

- Example: The developed sensing technology’s successful deployment resulted in the adoption of the technology by the StateDOT. The technology will be installed in all new bridge installments of this type. This adoption will... The new UAV monitoring technology was adopted by ___ organization to be used for ___ bridges inspections. This will allow inspectors to... The college course has been adopted by another member university...

N/A

Participants and Collaborators:

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

Table 6: Active Principal Investigators, faculty, administrators, and Management Team Members				
Individual Name & Title	Dates involved	Email Address	Department	Role in Research
Shinae Jang, Ph.D., P.E.; Professor in residence; School of Civil & Environmental Engineering, University of Connecticut	7/1/2024– 9/30/2024	Shinae.jang@conn.edu	Civil & Environmental Engineering	PI

Song Han, Ph.D.; Associate Professor; School of Computing	7/1/2024– 9/30/2024	Song.han@uconn.edu	Computer Science and Engineering	Co-PI
Ramesh Malla, Ph.D., F. ASCE; F. EMI; Professor; School of Civil & Environmental Engineering, University of Connecticut	7/1/2024– 9/30/2024	Ramesh.malla@uconn.edu	Civil & Environmental Engineering	Co-PI

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 who 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>
Prakash Bhandari	7/1/2024	9/30/2024	Shinae Jang & Ramesh Malla	Prakash.bhandari@uconn.edu	Ph.D.	Civil & Environmental Engineering	TIDC	Field data collection and database management, manuscript writing and revision, conference presentation, monitoring system upgradation, data analysis and reporting

Romy Reichenberger	7/1/2024	9/30/2024	Shinae Jang	Romy.reichenberger@uconn.edu	UG	Civil & Environmental Engineering	TIDC	Field Deployment, poster abstract preparation, sensor casing development, UConn IDEA grant writing
--------------------	----------	-----------	-------------	------------------------------	----	-----------------------------------	------	--

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?

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

Table 9: Industrial Internships

Student Name	Internship Name/Organization	Dates of Internship	Did the student enter the transportation field or continue another degree at your university?

Use the table below to list **organizations** that have been involved as partners on this project and their contributions 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
		List the amount	List the amount	Mark with an "x" where appropriate		

CT Department of Transportation (Contacts: Andrew Cardinali, P.E., Principal Engineer; and Bao Chuong, P.E., Principal Engineer; Sangyul Cho, Ph.D., P.E., Transportation Engineer 3)	Newington, CT				X	

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.)

Table 11: Other Collaborators

Collaborator Name and Title	Contact Information	Organization and Department	Date(s) Involved	Contribution to Research
	<i>For internal use only</i>			<i>(i.e. technical champion, technical advisory board, test samples, on-site equipment, data, etc.)</i>
Bao Chuong, P.E.; Transportation Principal Engineer; Connecticut DOT – Major Structures	Connecticut DOT – Major Structures E-mail: bao.chuong@ct.gov	Connecticut Department of Transportation, Newington, CT	7/1/2024- 9/30/2024	Technical champion
Andrew Cardinali, P.E.; Transportation Principal Engineer; Connecticut DOT – State Bridge Design	Connecticut DOT – Bridge Design E-mail: Andrew.cardinali@ct.gov	Connecticut Department of Transportation, Newington, CT	7/1/2024- 9/30/2024	Provided bridge access
Sangyul Cho, Ph.D., P.E.; Transportation Engineer 3; Connecticut DOT – State Bridge Design	Connecticut DOT – Bridge Safety and Evaluation Email:	Connecticut Department of Transportation, Newington, CT	7/1/2024- 9/30/2024	Point of contact form DoT

	Sangyul.cho@ct.gov			
--	--------------------	--	--	--

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.e. CE 123		Grad or undergrad?	Where was the course taught?	Who taught the course?	Enter Spring, Fall, Summer, Winter, and the year	How many students were enrolled in the class?
CE 2110-001	Applied Mechanics I: Statics	Undergraduate	University of Connecticut, Storrs, CT	Shinae Jang (PI)	Fall 2024	184
CE 2110-002	Applied Mechanics I: Statics	Undergraduate	University of Connecticut, Storrs, CT	Shinae Jang (PI)	Fall 2024	173
CE 2110	Applied Mechanics I: Statics	Undergraduate	University of Connecticut, Storrs, CT	Prakash Bhandari (Teaching Assistant)	Fall 2024	357

Changes:

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

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

- Ultrasonic distance sensors are being replaced with high-resolution optical distance sensors, and a larger capacity power station is purchased and used to enhance the accuracy of monitoring data
- Deployment of the monitoring system has been delayed until to next quarter due to logistical complications of the new testbed bridge.

Planned Activities:

List the activities planned during the next quarter.

- Field deployment of the monitoring system for a very large movement expansion joint in Connecticut.

- Test the high resolution sensors into the monitoring system