Quarterly Progress and Performance Indicators Report:
Project Number and Title: Project C19.2020: Damage Modeling, Monitoring, and Assessment of Bridge Scour and Water Borne Debris Effects for Enhanced Structural Life
Research Area: Thrust 1 -Transportation Infrastructure Monitoring & Assessment for Enhanced Life
PI: Wei Zhang, Ph.D., P.E., Associate Professor, Department of Civil & Environmental Engineering, University of Connecticut
Co-PI(s): Ramesh B. Malla, Ph.D., F. ASCE, F. EMI, Professor, Department of Civil & Environmental Engineering, University of Connecticut; and Nalini Ravishanker, Ph.D., Professor, Department of Statistics, University of Connecticut
Reporting Period: Oct. 01, 2021 to Dec. 31, 2021
Submission Date: Dec. 31, 2021

****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 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. 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** ….*

- A risk debris prediction model was generated following the March meeting with technical advisors.
- Collaboration with VTrans and Maine DOT has been maintained.
- A meeting with project technical champions Messrs. Jeff DeGraff of VTrans and Benjamin Foster of Maine DOT took place on Dec. 10, 2021
- With additional discussion with project technical champions, the project is suggested to go with a new research approach toward possible regression equations for debris mass and their associated composite drag coefficients.

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.

- Key parameters were determined for statistical analysis of the project for bridge scour and waterborne debris impacts in the risk prediction model. Major data information includes: 1) dimensions for the accumulated debris, length and width; 2) how are these data related to channel width, water shed area, water speed, and drag coefficient.
- The research team has obtained the data for the tree species in the area and the flooding information for the rivers, such as the basic flooding elevations. The research team has conducted a sample case study of a selected bridge to illustrate the process of estimating the debris size.
- The research team has been conducting more literature review on waterborne debris dimensions and analysis following the new research directions.

Accomplishments:
List any accomplishments achieved under the project goals in bullet point form…

- One Ph.D. student graduated in the May of 2021.
- Our project poster wins the 3rd place in poster completion in Dec. 2021.

- One paper got accepted in one of the top journals in this field. Ma, X., Zhang, W. (2022) "Dynamic Amplification Effects of Scour and Debris Impacts for Short Span Bridges", *Engineering Structures*, 252(1), February 2022, 113644 https://doi.org/10.1016/j.engstruct.2021.113644

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**
PHASE I			
Task 1: Literature Review and data collection.	Oct. 20, 2020	Jan. 31, 2021	100%
Task 2: Statistical Analysis	Dec. 1, 2020	Jun. 30, 2021	100%
Task 3: Debris Dimension analysis	Feb. 1, 2020	Sep. 30, 2021	80%
PHASE II			
Task 4: Debris Impact Simulations	Oct. 1, 2021	Mar. 31, 2021	0%
Task 5: Data collection for scour	Oct. 1, 2021	July 31, 2021	0%
Task 6: Scour Simulations	Jan. 1, 2022	Dec. 31, 2022	0%
Task 7: Fragility Analysis	Sep. 1, 2022	May 31, 2022	0%
Task 8: Resilient Options	Jan. 1, 2023	Sep. 30, 2023	0%
Overall Project:	*Oct. 20, 2020*	*Sep. 30, 2023*	
Phase 1 Overall	Oct. 20, 2020	Dec. 31, 2021	80%
Phase 2 Overall	Jan. 1, 2021	Sep. 30, 2023	0%

Table 3: Budget Progress		
Project Budget	**Spend – Project to Date**	**% Project to Date (include the date)**
$139,000 for 1 year (including 1:1 Cost share match)	$66,000	80%
$261,000 for 2 years (including 1:1 Cost share match)	0	0

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.)
   N/A

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 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)
Conference	Framework for prediction of accumulated bridge debris dimensions and scour	W. Hughes, Q. Lu, W. Zhang, R. Malla, (2021) Framework fro prediction of accumulated bridge debris dimensions and	2021 TIDC Student Poster Contest	Online	12/1/2021

		scour, 2021 TIDC student Poster Contest.			

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
Peer-reviewed journal	Dynamic Amplification Effects of Scour and Debris Impacts for Short Span Bridges	Ma, X., Zhang, W. (2022) "Dynamic Amplification Effects of Scour and Debris Impacts for Short Span Bridges", *Engineering Structures,* 252(1), February 2022, 113644 https://doi.org/10.1016/j.engstruct.2021.113644	Feb. 2022	Published online.

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 is 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

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:

- 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…

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 in town, state on 1/1/2021… The newly created college course was taken/completed by __ students in the 2021 fall semester.

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…

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**
Dr. Wei Zhang, Associate Professor	Oct. 1 – Dec. 31, 2021	wzhang@uconn.edu	Civil & Environmental Engineering, University of Connecticut, Storrs	Principal Investigator (PI)
Dr. Ramesh B. Malla, Professor	Oct. 1 – Dec. 31, 2021	Ramesh.Malla@UCONN.EDU	Civil & Environmental Engineering, University of Connecticut, Storrs	Co-Principal Investigator (PI)/ TIDC Institutional Lead, UConn
Dr. Nalini Ravishanker	Oct. 1 – Dec. 31, 2021	Ravishanker, Nalini	Statistics, University of Connecticut, Storrs	Co-Principal Investigator (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 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**
William Hughes	Oct. 1, 2021	Dec. 31, 2021	Wei Zhang		Ph.D.	Civil Engr.	Department of Education	Graduate Assistant
Qin Lu	Oct. 1, 2021	Dec. 31, 2021	Wei Zhang		Ph.D.	Civil Engr.	Eversource	Graduate Assistant
Matthew Wendland	Oct. 1, 2021	Dec. 31, 2021	Wei Zhang		Undergraduate	Civil Eng.		undergraduate Assistant

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?**
			Please list the organization or degree

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?**
			Please list the organization or degree

*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**
Vermont Agency of Transportation	Barre, VT		X			X
Maine Department of Transportations	Augusta, ME		X			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**
Benjamin Foster, State Bridge & Structures Maintenance Engineer/ Deputy Chief Engineer,	Ben.Foster@maine.gov	Bureau of Maintenance & Operations, Maine Department of Transportation (Maine DOT),	Technical Champion	Benjamin Foster, State Bridge & Structures Maintenance Engineer/ Deputy Chief Engineer,

Mr. Jeff DeGraff, P.E., Hydraulics Project Engineer	Jeff.DeGraff@vermont.gov	Vermont Agency of Transportation (VTrans)	Technical Champion	Mr. Jeff DeGraff, P.E., Hydraulics Project Engineer
Mr. Andrew Mroczkowski	Andrew.Mroczkowski@ct.gov	Connecticut DOT	Collaborator	Mr. Andrew Mroczkowski

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
CE3995/CE5090	Coastal hazards and engineering	Grad/ undergrad	University of Connecticut	Wei Zhang	Fall 2021	7

Changes:

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

- As our projects start with Coronavirus outbreak, the University of Connecticut was partially closed and faculty, staff and students are teleworking when the project got started.
- The data collection process was slow and not successful. Several NE DOTs have not responded to the request sent by the researchers. We have received some information from Maine DOT, VTrans, and CT DOT. However, the images for debris are very limited. That has delayed our tasks related to machine learning to determine water born debris size. As a result, based on March 2020 meeting, the project shifted to a risk based model to predict the debris dimensions. The project poster won the 3rd place for student poster competition based on the research results.

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

- As later discussed with our technical champions, they proposed another new research approach toward possible regression equations for debris mass and their associated composite drag coefficients. We have drafted a new technical plan for the new research effort. Therefore, Phase 1 of this project will continue toward phase 2 for this new research effort. However, the 100% finish of Phase I will be reduced to 80% to accommodate this new effort to continue toward Phase 2 of this project.

Planned Activities:

List the activities planned during the next quarter.

- The research team will continue to maintain communication with DOTs and industry regarding potential future research topics so that the research will be relevant and of great importance to the DOTs and industry.
- With the new research plan, our team will work closely with our technical champions for waterborne debris analysis to get the appropriate regression equations for debris.
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