AASHTO
AASHTO INNOVATION INITIATIVE

# AASHTO Innovation Initiative

[Proposed] Nomination of Innovation Ready for Implementation

## Sponsor

Nominations must be submitted by an AASHTO member DOT willing to help promote the innovation. If selected, the sponsoring DOT will be asked to promote the innovation to other states by participating on a Lead States Team supported by the AASHTO Innovation Initiative.

1. Sponsoring DOT (State): Connecticut DOT

2. Name and Title: Bartholomew P. Sweeney / Transportation Division Chief – Bridges

Organization: Connecticut DOT

Street Address: 2800 Berlin Turnpike

City: Newington

State: CT

Zip Code: 06111

Email: Bartholomew.Sweeney@ct.gov

Phone: (860) 594-3272

Fax: (860) 594-3218

## Innovation Description (10 points)

The term “innovation” may include processes, products, techniques, procedures, and practices.

3. Name of the innovation:

Beam End Repair Using Ultra-High Performance Concrete

4. Please describe the innovation.

The rehabilitation of aging steel bridges demands significant resources from many Departments of Transportation. The magnitude of this challenge demands advancement of alternative repair options.

This innovation entails extending the application of Ultra-High Performance Concrete (UHPC) to repair deteriorated steel beam ends to restore the strength to an undamaged state. The repair involves welding shear studs to the intact portions of the web plate and encasing the beam end with UHPC. This creates an alternate load path for bearing forces that bypasses the corroded portion of the beam. In addition, unique durability characteristics of UHPC protect the region against future deterioration. This repair approach presents significant versatility for complex geometries and severe deterioration levels.

5. What is the existing baseline practice that the innovation intends to replace/improve?

The conventional repair involves removing damaged beam sections and replacing them with new steel.

6. What problems associated with the baseline practice does the innovation propose to solve?

The conventional repair requires frequent maintenance as the new steel material remains susceptible to corrosion damage. Traditional methods are typically labor-intensive, costly, and time-consuming as they require jacking of the bridge to reduce in-situ stresses in members or allow for the removal of damaged portions.

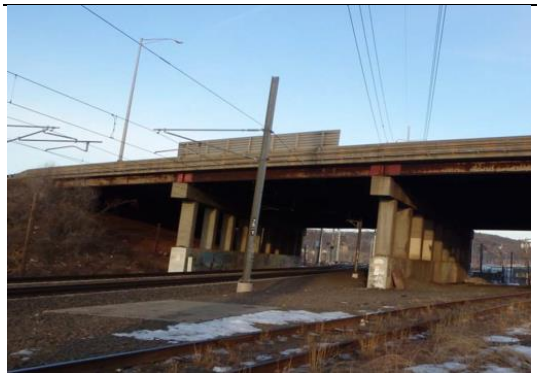
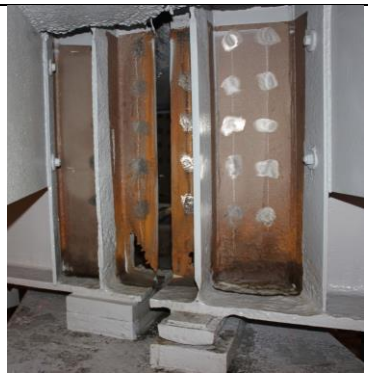
7. Briefly describe the history of its development.

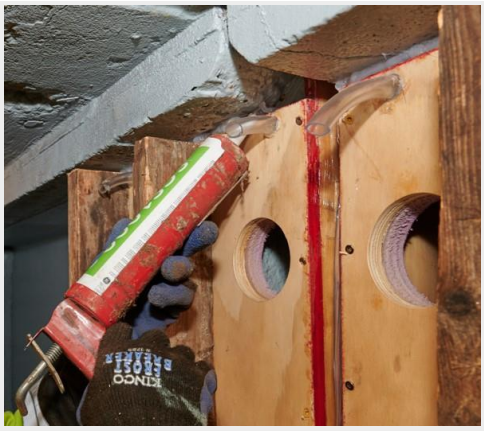
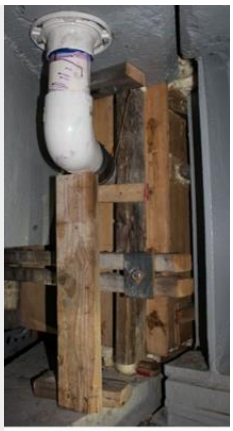
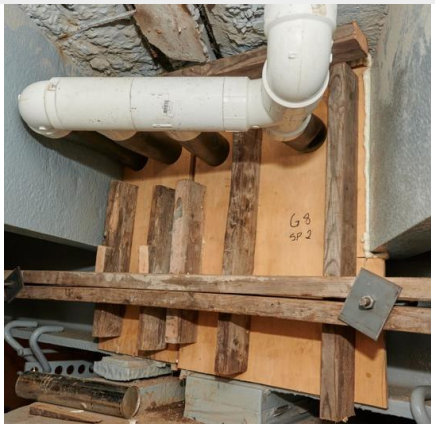
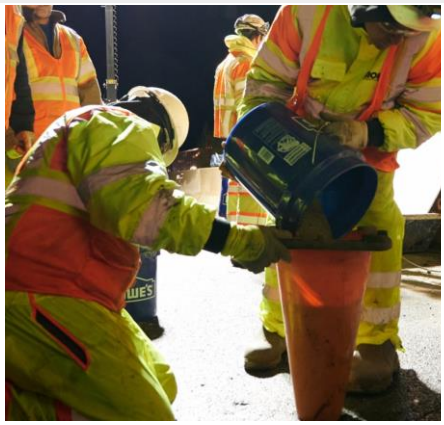
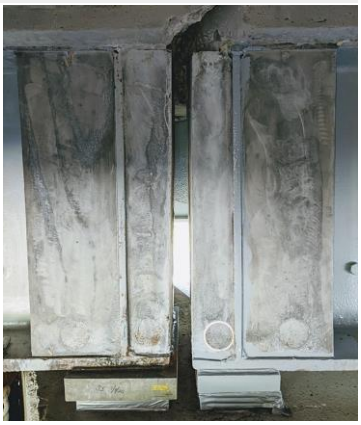
To tackle the challenges of rapid deterioration of steel infrastructure, the Connecticut Department of Transportation (CTDOT) has partnered with the University of Connecticut to develop a repair method that benefits from the superior mechanical and durability characteristics of ultra-high performance concrete (UHPC) material. The applicability of this repair method was investigated through a two-phase experimental and analytical research project. Phase I was a proof-of-concept study that demonstrated the repair is structurally effective and a practical alternative repair strategy. Phase II investigated the application and performance of the repair for full-scale girders and developed a methodology for designing the repair for target performance levels. Following the successful completion of the experimental studies, CTDOT selected a bridge for the first large-scale implementation of the repair. This four-span bridge located east of New Haven, spans three railroad tracks and carries the heavily trafficked Interstate-91. A tradition repair was not desired because of several design and construction challenges including complex geometry of beams, active electric rail tracks, and high ADT. The repair was successfully implemented on the bridge in 2019. Four of the repaired ends in the field implementation were fully instrumented. This data confirmed the repair was successful in generating an alternate load path through the headed shear studs and UHPC panels.

8. What resources—such as technical specifications, training materials, and user guides—have you developed to assist with the deployment effort? If appropriate, please attach or provide weblinks to reports, videos, photographs, diagrams, or other images illustrating the appearance or functionality of the innovation (if electronic, please provide a separate file). Please list your attachments or weblinks here.

Construction specifications and a comprehensive design guide have been developed to assist with the deployment effort. The design guide is currently being used by CTDOT engineers to design repairs for a second bridge in the state. UConn research reports as well as journal publications and conference presentations have been published to provide technical basis for this innovative repair method.

Attach photographs, diagrams, or other images here. If images are of larger resolution size, please provide as separate files.

## State of Development (40 points)

Innovations must be successfully deployed in at least one State DOT. The AII selection process will favor innovations that have advanced beyond the research stage, at least to the pilot deployment stage, and preferably into routine use.

9. How ready is this innovation for implementation in an operational environment? Please select from the following options. Please describe.

☐ Prototype is fully functional and yet to be piloted

☐ Prototype has been piloted successfully in an operational environment

☒ Technology has been deployed multiple times in an operational environment

☐ Technology is ready for full-scale implementation

This repair technique has been implemented by CTDOT, Texas DOT and RIDOT in an emergency project.

10. What additional development is necessary to enable implementation of the innovation for routine use?

Testing of non-proprietary UHPC products and un-painted steel members will expand DOTs' options and lower the cost.

11. Are other organizations using, currently developing, or have they shown interest in this innovation or of similar technology?? ☒ Yes ☐ No

If so, please list organization names and contacts. Please identify the source of this information.

| Organization | Name | Phone | Email |
|---|---|---|---|
| FHWA | Zach Haber | (202) 493-3469 | Zachary.haber@dot.gov |
| New York DOT | Jim Scarlata | (518) 485-0848 | Jim.Scarlata@dot.ny.gov |
| Texas DOT | Zhanfei "Tom" Fan | (712) 802-5390 | Tom.Fan@txdot.gov |

## Potential Payoff (30 points)

Payoff is defined as the combination of broad applicability and significant benefit or advantage over baseline practice.

12. How does the innovation meet customer or stakeholder needs in your State DOT or other organizations that have used it?

It provided another tool to repair deteriorated steel beam ends in a durable manner. It also opens potential mechanism for State forces to address structural deficiency.

13. Identify the top three benefit types your DOT has realized from using this innovation. Describe the type and scale of benefits of using this innovation over baseline practice. Provide additional information, if available, using quantitative metrics, to describe the benefits.

| Benefit Types | Please describe: |
|---|---|
| Improved Asset Performance | Impermeability of the repair material protects steel element. |
| Cost Savings | Low recurrence of repair |
| Improved Quality | Provides redundant load path for beam end forces |

Provide any additional description, if necessary:

Click or tap here to enter text.

14 How broadly might this innovation be deployed for other applications. in the transportation industry (including other disciplines of a DOT, other transportation modes, and private industry)?

This repair has the potential to be deployed in flexural repairs and capacity improvements for steel beams, and for rail and pedestrian structures.

## Market Readiness (20 points)

The AII selection process will favor innovations that can be adopted with a reasonable amount of effort and cost, commensurate with the payoff potential.

15. What specific actions would another organization need to take along each of the following dimensions to adopt this innovation?

| Check boxes that apply | Dimensions | Please describe: |
|---|---|---|
| ☐ | Gaining executive leadership support | Click or tap here to enter text. |
| ☐ | Communicating benefits | Click or tap here to enter text. |
| ☒ | Overcoming funding constraints | Initial high upfront cost of UHPC. Life cycle cost savings with a long-term benefit due to durability. |
| ☒ | Acquiring in-house capabilities | Training and increasing familiarity with the UHPC material |
| ☐ | Addressing legal issues (if applicable) (e.g., liability and intellectual property) | Click or tap here to enter text. |
| ☐ | Resolving conflicts with existing national/state regulations and standards | Click or tap here to enter text. |
| ☐ | Other challenges | Click or tap here to enter text. |

16. Please provide details of cost, effort, and length of time expended to deploy the innovation in your organization.

**Cost**: $1,288,326 – Cost for complete research program

**Level of Effort**: Medium

**Time**: 7 years from start of proof-of-concept research to completed field implementation

17. To what extent might implementation of this innovation require the involvement of third parties, including vendors, contractors, and consultants? If so, please describe. List the type of expertise required for implementation.

Testing facilities have to be accredited. Material testing of UHPC cylinders requires different practices compared to conventional or high-performance concrete. This should be considered by states with limited experience using UHPC. The ends of cylinders must be ground to be flat and flush, which requires an end grinding machine. In addition, the high-strength of the UHPC may exceed the capacity of the available testing machines. There are testing sites that have the capacity to complete the required testing, and these should be identified prior to implementation. If there are not locally available testing facilities, coordination for shipping test samples should be considered early in the project.