FHWA 693JJ3-23-D-000001

Kickoff Meeting: Development of Countermeasure Strategies for Protecting Bridge Girders against Overheight Vehicle Impacts – Phase I

1. Meeting Minutes

Location: Virtual WebEx Meeting

Date: October 16, 2023

Time: 10:00 AM EDT to 11:10 AM EDT

Attendees: B. Benton, R. Bocchieri, V. Chiarito, B. Commander, V. Phan, J. Purdy, X. Qin, D. Soden, L. Warren, and W. Williams

2. Agenda

Item	Time (min)	Lead
FHWA team introductions	5	FHWA
ARA team introductions	5	ARA Team
Project objectives	5	ARA Team
Roles and responsibilities	5	ARA Team
Discuss report review process	5	FHWA
Discuss report requirements	5	FHWA
Task approach and Q/A		ARA Team
Task 1.2: Literature review and synthesis	5	
Task 1.3a: Develop energy absorbing concept systems	10	
Task 1.3b: Develop plan to design and evaluate performance	10	
Task 1.3c: Organize and host a technical panel	5	

3. Discussion

1. FHWA Team Introduction
    - Senior Bridge and Tunnel Construction Engineer and Project Contract Officer Representative (COR): Linh Warren
    - Senior Bridge Engineer, Project Technical Lead, and Project Technical POC: Vince Chiarito
        - Security and safety of bridges and tunnels (includes collisions and fire)
    - Structural Engineering Team Leader: Derek Soden
    - Freight Programs Team Leader: Jeff Purdy
        - Truck size, weight regulations, and oversize and overweight permitting
    - Bridge and Tunnel Engineer and Alternate Technical Lead: Calvin Chong
2. ARA Project Team Leads
    - ARA
        - Project Manager: Bob Bocchieri
        - Assistant Project Manager: Virginia Phan
        - Project Reviewer: Dan D'Angelo
        - Crash Analysis and Simulation Leads:
          Bob Bocchieri, Michael Erekson
        - Prototype Construction and Mechanical Design Lead: Jason Rittenhour
    - Texas A&M Transportation Institute (TTI)
        - William Williams
            - Structural engineer at TTI. Involved in prototypes, crash-testing, bridges, retrofits
    - GPI
        - Barry Benton
            - Bridge engineer at Delaware Department of Transportation for 25 years, served on AASHTO Subcommittee for Bridges and Structures, familiar with bridge code, worked with ARA on various FHWA projects
    - University of Wisconsin-Milwaukee (UWM)
        - Xiao Qin
            - Professor at UWM, Principal Investigator on NCHRP project 08-139 Guide for Preventing and Mitigating the Risk of Bridge and Tunnel Strikes by Motor Vehicle
    - Bridge Diagnostics (BDI)

- Brett Commander
  - Vice President and Principal Engineer at BDI, specialty is instrumentation for structural evaluation and evaluating structural conditions through various NDE techniques

3. Project Reports
   - R. Bocchieri, L. Warren, and V. Chiarito to have separate meeting on FHWA publishable report requirements
   - L. Warren has sent R. Bocchieri a package on report requirements for the separate discussion after R. Bocchieri's review
   - ARA has produced those type of documents in the past and has a reviewer in the company for these kind of reports
4. Bridge Strikes
   - Video of bridge strike videos including crane hit, which lifts bridge
5. Project Tasks and Objectives
   - Project Aims
     - Design and develop a cost-effective energy-dissipative system prototype for mitigating damages to vulnerable bridges girders or support systems
     - Design full-scale testing program and selection of bridge site for field installation
     - Custom construction and installation of the full-scale system
     - Full-scale testing and evaluation of the system
   - Phase 1
     - Task 1.2: Literature review and synthesis
     - Task 1.3a: Develop energy absorbing (EA) concept systems
     - Task 1.3b: Develop plan to design and evaluate performance
     - Task 1.3c: Organize and host a technical panel
6. ARA Project Team Roles in Phase 1
   - ARA
     - Prime Contractor
     - Lead all research, analysis and design efforts and responsible for all deliverables to FHWA
   - Texas A&M Transportation Institute (TTI)
     - Task 1.2: Conduct a literature search
   - University of Wisconsin-Milwaukee (UWM)

- Task 1.2: Identify potential sources based on related research and review of the literature review results
- Task 1.3b: Assist in developing the bridge strike scenarios and plan for performance evaluation
  - Evaluate bridge strike database to identify the bridge type(s) most likely to be hit and to identify the vehicle type(s) or load type(s) most likely to strike a bridge

- GPI
  - Task 1.3a
    - ID advantages of EA systems proposed based on bridge design and construction expertise
    - Lead the identification of key inspection requirements
  - Task 1.3b
    - Support design plan for the connections, minimize live load, aesthetic for the three energy absorbing systems to ensure proper installation and to minimize traffic disruption after impacts
- Bridge Diagnostics (BDI)
  - Task 1.2: Advise on advantages/disadvantages with respect to instrumentation and inspection requirements for existing systems identified
  - Task 1.3a: Advise on instrumentation and inspecting requirements for the concept systems developed by the project team
  - Task 1.3B: Advise on instrumentation to measure energy absorption and dissipation performance as well as post-strike inspection and maintenance

7. Discussion
   - V. Chiarito
     - Noticed there was a strike beam in the earlier videos
     - The trailers that hit, did not look like much response from the bridge, the trailer box not as stiff as the crane, concerned that mitigation designed for a tractor trailer, but the higher loads coming from the boom crane
     - For the strike beam, the first girder is probably as stiff as the first protective strike beam
     - Maybe the tractor trailer does not cause as much damage to the bridge as the boom cranes and dump trucks
   - J. Purdy
     - A couple of years ago in DC, a pedestrian bridge got completely pulled down by a dump truck that had a raised boom, that happens a lot
     - It seems like the damage done by that type of crash is pretty significant

  - There was also a truck hauling a dump truck (oversized load) and caused bridge collapse
- V. Chiarito
  - Shipping container is lot stiffer that tractor trailer, possibility that shipping container is overheight, a lot of shipping containers are moved on the highways
- R. Bocchieri
  - Use bridge strike database to quantify type of bridges getting damaged, what the impactors are and what the corresponding level of damage so we can target our analyses
  - Big variation in load types: wide load distribution, long duration and localized load, short impact
  - A challenge to protect against both, but maybe if something works for localized hit, it will work on low load hit, long duration
- V. Chiarito
  - Reporting aspects lacking, on federal level not required unless it becomes a critical finding
  - Soft hit might not even be reported
- J. Purdy
  - There are systems out there put on bridges that detect when a bridge is hit
  - Not sure if you were thinking of using a system in conjunction with this to notify a crash has occurred
- R. Bocchieri
  - Capture in literature search – what those warning systems are currently
  - From diagnostic side, at least indicator there was a hit
- B. Benton
  - Former bridge owner, don't find out about a lot of hits that happen
  - Think the reason is, when the bridges are hit, they need to be repaired and it costs a lot of money for the insurance companies to repair
- R. Bocchieri
  - Any comments on how the bridge strike database might be biased based on what has been reported
- X. Qin
  - During nation-wide survey, found that very few states had a bridge strike database
  - The practice of reporting varies
  - Identifying the type of hit or the type of vehicle, only available in crash narratives

- Crash database is not something you can easily search
- The underreporting is an issue
- Challenging to find the load causing the damage, need the crash narrative to identify

- R. Bocchieri
  - From design side, trying to characterize what's hitting and what we're protecting, ex: what type of impactor
- X. Qin
  - Depends on who reports (law enforcement officers, bridge engineers, traffic engineers), and varies from region to region

8. Task 1.2: Literature review and synthesis
   - Comprehensive national/international literature review
     - Check contacts with DOT
   - Organize into categories for the structural approach for EA
   - Summary of the potential merits of each approach
     - EA capabilities, lifecycle, installation methods, and operating loads.
     - Applicability for different types of bridge girder (e.g., steel, RC I-beam, RC U-shape)

9. Discussion
   - V. Chiarito
     - Receptiveness of owners, there was a study in Ohio and there was a concern about liability of part falling down
     - Included some in scope, except did not include liability
   - R. Bocchieri
     - Try to find out what will drive bridge owners' resistance
   - X. Qin
     - Load carrier perspective – very hard to get opinions, or keeping good record
     - Bridge owner perspective – survey did not specify liability.
       - After raising bridge height, received more hits, because truckers know this route is more passable
   - J. Purdy
     - Another type of strike: low railroad bridges, or longer trucks topping out
   - R. Bocchieri

    - Need to put something completely different than front of girder if being hit from underneath (lose more height)
    - Need to focus on strikes to the front face, but even with the crane hit, there is a lifting mode of the bridge
- X. Qin
    - Hard to tell whether highway or railroad bridge hit (two separate databases)
    - Crash database will not tell whether railroad or highway bridge
    - Many state DOTs do not have location of railroad bridge, not part of national bridge inventory

10. Task 1.3a: Develop energy absorbing concept systems

- Development of Potential Concept Systems
    - Adjustable crush force
    - Good actuation with high off-axis loading
    - Good structural stiffness/strength in general service
    - Maintains structural integrity and do not create debris post-actuation
    - Proven performance at high loads and stroke rate
    - Easily replaced after actuation
    - Withstand harsh environments
- Discussion
    - V. Chiarito
        - Be very open to beyond honeycomb aluminum, such as structural foam
        - Another idea: water. If water freezes, can add denatured alcohol to keep from freezing.
        - Honeycomb needs to be confined and surrounding the material in something stronger. Example, confining concrete with steel plates
        - Confirmed yes, focus will not be changing the structure of the bridge
    - R. Bocchieri
        - Success in the past using honeycomb aluminum when confined
        - Maybe a combination of technologies
        - Assumption is that the focus will be not changing the structure of the bridge to encourage adoption
    - W. Williams
        - Need to sandwich honeycomb between two stiff membranes
- Concept Ranking

    - EA performance with consideration for weight (e.g., specific performance)
    - Commercial off the shelf (COTS) or custom
    - Cost (including construction, maintenance, and lifetime)
    - Structural (e.g., crush element) or non-structural
    - Need for confinement in off-axis loading (e.g., HC, inversion tubes, etc.)
    - Difficulty of design, analysis and experiments
    - Ease of construction, maintenance and ease of replacement
    - Environmental
    - Use as retrofit or new construction
- Discussion
    - R. Bocchieri
        - Retrofit vs. new construction?
    - V. Chiarito
        - Most of these solutions may be for retrofit conditions
        - Assume in new construction, the retrofits will still apply
        - Minimize modifications to the bridge girder and the bridge itself
- Inspection Requirements
    - connections, supports, anchors, fatigue cracking, corrosion, coatings, and collision damage
- Post-event Evaluation
    - Potential debris
    - Estimate of the quantity of material that could be displaced
    - Estimate of the equipment and manpower necessary for clean-up
    - Replace or reuse

11. Task 1.3b: Develop plan to design and evaluate performance
    - Evaluate Available Bridge Strike Data
    - Define Threat to Bridges Through Bridge Impact Analysis
    - Metrics for energy absorption and damage reduction
    - EA structure resilience and restoration
    - Inspection, Maintenance, and Life cycle costs
12. Schedule
    - No comments made

13. General Discussion

- V. Chiarito
    - Group awareness of publication Transportation Pooled Fund Study TPF-5(462) “Assessment and Repair of Prestressed Bridge Girders Subjected to Over-Height Truck Impacts (OHTI)
    - https://www.pooledfund.org/Details/Study/689
        - https://www.bing.com/ck/a?!&&p=4f5f7ddbda47cc27JmltdHM9MTY5NzUwMDgwMCZpZ3VpZD0yOWJmNDEwZi1lNDNkLTZiZjEtMzk0NC01MGU3ZTU1MjZhZGImaW5zaWQ9NTE4NA&ptn=3&hsh=3&fclid=29bf410f-e43d-6bf1-3944-50e7e5526adb&psq=TPF-5(462)+Assessment+and+Repair+of+Prestressed+Bridge+Girders+Subjected+to+Over-Height+Truck+Impacts&u=a1aHR0cHM6Ly93d3cucG9vbGVkZnVuZC5vcmcvRG9jdW1lbnQvRG93bmxvYWQ_aWQ9ODgyNg&ntb=1
    - If this group has any questions about this publication/project, V. Chiarito can forward questions to that research team
    - From risk assessment point of view, do insurance companies accept the cost of the repair, or is it more cost effective to install mitigation?
- R. Bocchieri
    - This project can provide insight on the cost of repair associated with various types of damage and what type of damage is acceptable or repairable

4. Action Items

1. R. Bocchieri to review reporting requirements package sent over by L. Warren
2. R. Bocchieri to set up separate call on reporting requirements between R. Bocchieri, L. Warren, and V. Chiarito