Top 20 Innovations for Rural Bridge Replacement & Repair

Iowa DOT Freight Advisory Council

March 26, 2021

SOY TRANSPORTATION COALITION

Rural Bridges – The Problem…

- Challenge facing rural America: The area of the country in which our bridge problem is most severe also happens to be the area of the country in which resources are most limited.
- A typical rural county can often have 100-300 bridges. Replacing a single bridge via traditional methods can often cost $250,000 - $500,000. Many rural counties will only have $500,000 - $1.5 million available annually to repair and replace their bridges.
- Therefore, our options are:

  1.) Close the bridge or impose load restrictions

  2.) Spend more of our own money (if available)

  3.) Hope for more funding from other sources

  4.) Embrace opportunities to decrease costs
- Question for rural policymakers/stakeholders: To what extent are we embracing innovation to make the taxpayer $ stretch further?

SOY TRANSPORTATION COALITION

The Top 20 Innovations for Rural Bridge Replacement and Repair

- Goal: Highlight a relatable number of innovative concepts that 1.) Will provide initial or lifecycle cost savings, 2.) Have been validated by a credible engineering entity or organization, and 3.) Are accessible in a large section of rural America.
- STC assembled a group of 13 bridge engineers and experts (county engineers, state DOTs, LTAP programs, universities, engineering firms) from the 13 states that comprise the organization. Three engineers served as principal analysts for the project with the remaining ten engineers or experts serving as advisory committee members.
- STC and farmers can play a role in 1.) Increasing awareness, 2.) Increasing understanding, and 3.) Increasing motivation

SOY TRANSPORTATION COALITION

Principal Analysts & Advisory Committee Members

Principal Analysts:

- Indiana: Pat Conner, P.E. (Lead Engineer, Asset Management, Local Technical Assistance Program at Purdue University)
- Iowa: Brian Keierleber, P.E. (County Engineer, Buchanan County, Iowa; President of the National Association of County Engineers – 2017-2018)
- North Dakota: Kelly Bengtson, P.E. (Bridge and Pavement Engineer – Upper Great Plains Transportation Institute at North Dakota State University)

Advisory Committee Members:

- Illinois: Duane Ratermann, P.E. (County Engineer, Knox County, Illinois; President of the National Association of County Engineers – 2015-2016; President of the Illinois Association of County Engineers – 2019-2020)
- Kansas: Calvin Reed, P.E. (Director of Engineering and Design – Kansas Department of Transportation)
- Kentucky: Duane Campbell, P.E. (County Engineer, Boyle County, Kentucky; President of the Kentucky Association of County Engineers and Road Supervisors)
- Michigan: Dave Juntunen, P.E. (former Bridge Engineer – Michigan Department of Transportation; Bridge Management Practice Lead – The Kercher Group)
- Minnesota: Dave Conkel, P.E. (State Aid Bridge Engineer – Minnesota Department of Transportation)
- Missouri: Derin Campbell, P.E. (former County Engineer, Boone County, Missouri; Project Manager – Allstate Consultants, LLC)
- Nebraska: Josh Steelman, P.E. (Associate Professor, Civil Engineering – University of Nebraska)
- Ohio: Warren Schlatter, P.E. (County Engineer, Defiance County, Ohio)
- South Dakota: Andrew Peterson (Field Services Manager – Local Technical Assistance Program at South Dakota State University)
- Tennessee: Matt Cate, P.E. (Director, Tennessee Transportation Assistance Program – University of Tennessee)

SOY TRANSPORTATION COALITION

The Top 20 Innovations for Rural Bridge Replacement and Repair

Bridge Replacement Innovations

- Railroad Flat Car Bridges
- Geosynthetic Reinforced Soil – Integrated Bridge System (GRS-IBS)
- Vibratory H-Piling Drivers
- Buried Soil Structures
- All Steel Piers
- Galvanized H-Piling
- Press Brake Tub Girders
- Galvanized Steel Beams
- Prestressed Precast Double Tees
- Precast Inverted Tee Slab Span Bridges

Bridge Repair Innovations

- Piling Encasements
- Concrete Pier Piling Repairs
- Driving Piling through Decks
- Epoxy Deck Injections
- Deck Overlays with Type O Concrete and Plasticizers
- Deck Patching
- Thin Polymer Concrete Overlays
- Penetrating Concrete Sealers
- Spot Cleaning Painting Steel Beams
- Concrete Overlay on Adjacent Box Beams

SOY TRANSPORTATION COALITION

Railroad Flat Car Bridges

Railroad flatcars can be an attractive option for bridge superstructures – particularly for lower volume roads. Railroad flatcar bridges are quick and easy to install; can be placed on existing abutments; are available in a variety of lengths; require minimal maintenance; and are very economical. The availability of retired railroad flat cars can fluctuate and should be considered. Railroad flatcars utilized for bridges should be designed to accommodate 80 or more tons per car. Railroad flatcar bridges do not require more frequent inspection.

Cost Savings: 50% – 60%

COST PER BRIDGE:
$120,000
vs. $275,000 – $350,000 (prevailing method)

APPLICABLE:
Low volume roads throughout rural America

STRUCTURAL INTEGRITY:
Can support loads far in excess of legal loads

CONSTRUCTION TIME:
15% – 25% faster

TIME TO CONSTRUCT:
6 weeks
vs. 7 – 8 weeks (prevailing method)

Research source(s): Iowa State University Bridge Engineering Center; https://bec.iastate.edu/research/completed/field-testing-of-railroad-flatcar-bridges-tr-498/

SOY TRANSPORTATION COALITION

Railroad Flatcar Bridges

Railroad Flatcar Bridge – Buchanan County, Iowa;
Photo credit: Brian Keierleber

Railroad Flatcar Bridge – Buchanan County, Iowa;
Photo credit: Mike Steenhoek

Vibratory H-Piling Drivers

Vibratory pile driving is an alternative pile installation method in which a vibrator hammer grabs a pile and inserts it into the ground by vertical vibration. The vibrator hammer is attached to a hydraulic excavator. The prevailing method of utilizing a crane to drive piling is not necessary. In contrast to the traditional method of impact pile driving, vibratory pile driving produces less noise and damage to the pile. Perhaps most consequentially, vibratory pile driving can result in significantly faster penetration. Vibratory pile driving has been successfully used in most types of soils, including sands and clays. Worker safety is enhanced by no longer needing to climb the leads as required in traditional pile driving. Adapting a drop hammer to the hydraulic excavator alleviates any concerns with achieving complete load bearing.

Cost Savings: 90%

COST PER BRIDGE:
(to drive 10 piling, e.g.) **$2,000**
vs. $25,000 – $40,000 (prevailing method)

APPLICABLE:
Most types of soils, including sands and clays

STRUCTURAL INTEGRITY:
Equal to prevailing method

CONSTRUCTION TIME:
50% faster

TIME TO CONSTRUCT:
(to drive 10 piling, e.g.) **4 – 6 hours**
vs. two days (prevailing method)

Research source(s): Hindawi Journals;
https://www.hindawi.com/journals/sv/2017/7236956/#abstract

SOY TRANSPORTATION COALITION

Vibratory H-Piling Drivers

Vibratory H-pile driving – Howard County, Iowa;
Photo credit: Nick Rissman

Buried Soil Structures

Buried soil structures are arch, three-sided, or box-shaped structures with unsupported spans greater than 20 ft. that rely on soils for support. Buried soil structures are economical to construct and quick to install, result in significantly reduced maintenance, and offer enhanced durability. Buried soil structures can result in increased load capacity compared to conventional bridges due to load sharing with the soil embedment. While periodic inspection may be necessary, buried soil structures do not include bridge decks or approaches, which can be expensive to clean, maintain, or replace. On the underside of the bridge, routine maintenance involves removing debris or vegetation – similar to other bridges.

Cost Savings: 50% – 60%

COST PER BRIDGE:
$75,000 – $95,000
vs. $150,000 – $200,000 (prevailing method)

APPLICABLE:
Throughout rural America

STRUCTURAL INTEGRITY:
Equal to prevailing method

CONSTRUCTION TIME:
20% – 25% faster

TIME TO CONSTRUCT:
6 – 8 weeks
vvs. 8 – 10 weeks (prevailing method)

Research source(s): Transportation Research Board; http://onlinepubs.trb.org/onlinepubs/webinars/160623.pdf; National Council of Structural Engineers Associations; https://www.structuremag.org/?p=12752

SOY TRANSPORTATION COALITION

Buried Soil Structures

Buried soil structure – Appanoose County, Iowa;
Photo credit: CONTECH Engineered Solutions, LLC

Buried soil structure – Houston County, Minnesota;
Photo credit: CONTECH Engineered Solutions, LLC

Thank You

Soy Transportation Coalition

1255 SW Prairie Trail Parkway

Ankeny, Iowa 50023

515-727-0665

www.soytransportation.org

Mike Steenhoek, Executive Director

msteenhoek@soytransportation.org

SOY TRANSPORTATION COALITION