

Accelerated Bridge Construction

Abstract

The goal of this project is to have the bridge completely prefabricated off-site and will be replaced beginning spring 2018 while the roadway will be closed for 30 working days for the bridge replacement, traditional construction methods would have required the partial or complete closure of the road for several months, resulting in substantial traffic disruption.

Project description

This project is intended to increase the safety and efficiency of highway 20, as well as help provide important economic development opportunities for the surrounding communities.

The project to replace the bridge on U.S. 20 over Middle Logan Creek in Cedar County is part of seven miles of highway pavement repairs and asphalt overlay and is designed to increase the bridge's structural capacity, increase the water way area and eliminate existing and any future scour issues, improve roadway conditions, and widen the bridge and approaching roadway to enhance safety. The Nebraska DOT desires to receive this grant from FHWA to use a variety of innovations on the project.

The bridge replacement project on Highway 20 over Middle Logan Creek will employ the first full accelerated construction technique in Nebraska. Instead of taking the typical six months of detours and road construction, the project will inconvenience travelers for about 30 days by using about a 7 miles detour.

Most of the bridge will be pre-cast meaning, the abutment cap substructure; the deck, approach slabs with integrated concrete rail and other parts of the installation will be formed off-site, likely at a location near the bridge site. The precast deck will also have the concrete barrier precast onto the precast panels, which eliminates the need for cast-in-place and cure times after the precast panels are installed. The precast deck integrated with concrete rail will be formed and delivered by certified precaster/prestress plant which is about 140 miles away.

Nebraska department of transportation is not new to this technology in fact NDOT has used and built lots of precast elements in bridge construction but never used a full precast system. NDOT has collected a lot of accelerated bridge construction details from projects around the country and try to take the best of the ideas and combine into one project.

This project takes the approach that for ABC to be successful; ABC Designs should allow maximum opportunities for the general contractor to do its own precasting at a staging area adjacent to the project site or in the contractor's yard with its own crews. This is particularly true for substructure components that have traditionally been constructed by contractor crews.

Substructure components are made of conventional reinforced concrete and can be precast by the general contractor.

Components will be designed to allow the contractor to self-perform the precasting by paying special consideration to the following:

- Components that is simple enough to fabricate.
- Components that allow some tolerance for erection.
- Maximum repetition of components to reduce formwork cost.
- Component weights do not exceed 50 tons.
- Substructure components that do not need prestressing or posttensioning.

Additional reasons for accelerating the construction of this bridge:

- The bridge construction requires a full closure and detour of all traffic
- This highway was closed and detoured recently because of a bridge construction project (fall of 2014) and the department does not want to cause the neighborhoods residents and businesses additional inconvenience and detour delay.
- This ABC method will allow the road to be reopened in about 30 days
- NDOR has used prestressed deck panels on other projects, so this is not new to Nebraska contractors and fabricators.
- NDOR has not used precast elements for substructures but this method has been used by many other States and is proven to be effective
 - The bridge contractor will be allowed to build the precast elements (but not the prestressed deck panels)
- This project will be the first use of precast approach slabs in Nebraska
 - NDOT intend to continue using precast approach slabs for accelerated construction on I-80 in and around Omaha and Lincoln areas where the traffic is very congested and overnight approach slab replacement is very desirable.
 - These Omaha area projects will be let starting in 2018

Performance Goals/Measures

NDOT shall work with FHWA on the development and implementation of a plan to collect information and report on the project's performance with respect to the relevant outcomes that are expected to be achieved through the innovation in the project. NDOT shall report on the specified performance indicators below. Those Performance indicators are established to track 1) speed, quality and efficiency of ABC, 2) public and workers safety, and 3) public satisfaction. Those Performance indicators are considered as the project's stated goals. NDOT will include baseline measures from previous experience and lesson learned as well as post-project outputs, and will inform the AID Demonstration in working toward best practices, programmatic performance measures, and future decision making guidelines. NDOR will submit a final report to FHWA within 6 months of project completion which documents the process, benefits, and lessons learned including development and/or refinement of guidance, specifications, or other tools and methods to support rapid adoption of the innovation(s) as standard practice.

Project Expectation and goals

- Using traditional cast-in-place construction methods would have required a six-month road closure and detour to do the job, the Nebraska DOT estimated, rather than the 30 days it will take to remove the old bridge and install the new one with accelerated methods. As a result, the project performance goal is reducing the time traffic is impacted by more than 50 percent. NDOT has been engaging the AGC in Nebraska and the neighboring states and will hold another contractor /AGC meeting after the completion of the project seeking feedback and lessons learned on how to improve /simplify the strategy and details on future implementation.
- By closing the bridge for ABC traffic the risk of incidents or worker injuries will be minimized therefore safety improvement is expected during the project. Widening the bridge and updating the side barriers and beam guards are expected to improve future safety on the bridge.
- Motorists will notice a smoother ride across the bridge than in the past, since asphalt overlay over waterproof membrane will also be used as part of future and “deck for life” preservation strategy. The Department already had done public involvement and intends to survey the residents, farmers and businesses before and after the project to seek any feedback and measure their satisfaction.

Project cost

Conventional construction 6 months: \$1.1M

Duration for ABC: 30 days

Project cost ABC: \$1.78M (see attached bid tab under group 6A)

This cost was based primarily on previous projects which precast deck elements were used such as NUDECK on Kearney East project and usage of UHPC connection on precast superstructure modular built on geosynthetic abutment on Primrose.

Using prefabricated bridge systems and innovative materials nearly will double the cost of building the bridge compared to traditional construction, but a preliminary economic analysis that included user costs estimate that overall, the project may cost about the same or maybe less than a project using conventional methods. User cost savings on the project totaled estimated to be \$300,000 because the shorter bridge closure time resulted in lower vehicle operating costs and delay costs.

Incremental Innovation

NDOT innovation philosophy is:

- _ integrating diverse structural systems Innovation
- _ Incremental improvement in a number of specific bridge details to fully leverage previously successful work.

Project Innovations

- _ Precast NUDECK
- _ Superstructure units create a full integral abutment for rapid construction
- _ SCC precast and CIP mix
- _ SCC joints
- _ UHPC mix
- _ UHPC joints
- _ Durable, moment-resisting joint between deck panels and approach slab panels.
- _ Durable, moment-resisting joint between the 42" concrete rail segments.

Project Innovations

- _ NUDECK which is a precast deck panel system researched and implemented successfully last year with FHWA and University of Nebraska partnership. (See attached Kearney Bridge presentation) .
- _ Use of 48" panel to girder pocket spacing connection instead the traditional 24" (see narrative attachment for more information and details of the NUDECK system).
- _ Use of UHPC for panel to panel transverse connection, also, to connect NUDECK, precast approach slab to integral abutment at the end floor. (See attached presentation and plans).
- _ SCC will be used to improve consolidation and increase the speed of construction for:
 - 1- Precast Abutment cap to piles connections,
 - 2- Precast/prestressed NU girder to precast deck panel connections longitudinally
 - 3- Approach slabs connections.

Nebraska ABC Project information

Existing bridge

US 20

Bridge over

Middle Logan creek

Cedar County, NE

3-spans steel girder bridge- 100ft

Built in 1938

Replacement design by Nebraska DOT (see attached plans)

- _ Single simple span 130 ft long
- _ Bridge width 42'-8" out to out
- _ 7- Prestressed NU 1100 (43.3")
- _ 22- half NU panels 12 ft x 21'-8" integrated with 42" concrete rail
- _ 8- approach slab panels- 10'-8" x 23'-3" integrated with 42" concrete rail
- _ 8- paving section panels- 10'-8" x 33'-6" integrated with 42: buttress rail

ABC Stages

Stage 1 work (Prior to bridge closure)

- _ Precast the NUDECK panels and NU girders by certified precaster
- _ precast abutment cap and wing wall on site or close to the site

Stage 2 work (30-day “ABC” period)

- _ Close Bridge / Demolish existing bridge
- _ Drive piles and steel sheetpiles
- _ Assemble precast wings (4 pieces)
- _ Assemble integral abutments cap (2 pieces)
- _ Assemble Grade beam cap (2 pieces)

Stage 3 work (30-day “ABC” period)

- _ Erect NU girders (7 girders)
- _ provide NUDECK seat after shim shots (7 girders)
- _ Assemble NU precast deck (11 x 2 pieces for both sides)
- _ Assemble precast approach slabs (4 approach slab pieces and 4 paving section pieces total of 16 pieces for both sides)
- _ Cast SCC deck panel closure pour over center girder and fill SCC in the 4” hole to connect the precast deck panels to the girders.
- _ Cast UHPC closure transverse joints and grind precast deck
- _ Re-open Bridge to traffic – end ABC period

- _ Apply asphalt overlay with water proof membrane under roadway work phasing plans

ABC SUPPLEMENTAL SPECIFICATIONS

Special Provisions

- _ Precast Concrete Substructure Elements
- _ Prefabricated Superstructure NUDECK
- _ Precast Approach Slab Elements
- _ UHPC Infill Joints
- _ Removal of Existing Structure

- _ SCC mix field application

- _ Performance base UHPC specifications

Nebraska DOT Commitment:

NDOT is aware of the required commitments to the project and accept the willingness to:

(1) Participate in monitoring and assessment activities regarding the effectiveness of the innovation(s) and subsequent technology transfer and information dissemination activities associated with the project;

(2) Accept FHWA oversight of the project; project is already a PODI (so this is a good first step)

(3) Conduct before and after customer satisfaction determinations; and

(4) Commit to deployment of the innovation as standard practice in the future, if the deployment is successful.

(5) NDOT and FHWA Colorado/Nebraska Office are planning to show case this project by inviting around 20 officials including the neighboring states state bridge Engineers to witness the erection and the grouting of the substructure and the precast deck panels

Nebraska Department of transportation, NDOT met with FHWA Nebraska division and plan to apply for Accelerated Innovation Deployment (AID) Demonstration funds

- Nebraska understands that these funds may be awarded up to the full cost of the innovation (not just the delta costs) up to a maximum of \$1 Mill
- In the application NDOT will include:
 - Prefabricated Bridge Elements and Systems – EDC 1
 - Accelerated Bridge Construction (ABC) – EDC 2
 - Ultra-High Performance Concrete Connections for Prefabricated Bridge Elements (UHPC) – EDC 3 & 4
- To provide concrete evidence of project milestones, financial capacity, and commitment in order to support project readiness, the department already established the following:
 - The project utilizes federal fund 80-20 split
 - The project letting is October,2017
 - Construction to start in April , 2018
 - The design plans are already at 100% completion and was let February 2018 (see attached)
 - Completion date of the bridge part is June,2018