PREFABRICATION FOR FASTRACK CONSTRUCTION: MITCHELL GULCH BRIDGE

Rick Lawrence, Lawrence Construction, Littleton, Colorado

ABSTRACT

A 2002 project to replace a 1953 Colorado bridge saved users of the busy road over two months of construction-based detouring. A value-engineering proposal changed the initial box-culvert design to a single-span bridge with all prefabricated elements. The bridge was closed to traffic on Friday evening after commuters had used it, replaced over the weekend, and reopened to traffic on Sunday evening well before users needed it for their Monday morning commute.

Keywords: Culvert, Fast-track, Rapid replacement, Detour, Prefabrication.

INTRODUCTION

Prefabrication of bridge elements and systems facilitates fast-track construction of bridges and offers numerous advantages to bridge owners, bridge builders, and bridge users, advantages that include minimized effect on traffic, increased work-zone safety, improved constructibility, reduced environmental impact, and increased quality. When highway user costs and traffic detours are factored in, cost savings can be another advantage.

In 2002, a project to replace a 1953 wooden bridge crossing Mitchell Gulch on State Highway 86 between Castle Rock and Franktown Colorado saved users of the busy road over two months of construction-based detouring.

THE PROJECT

The Colorado Department of Transportation's (CDOT's) initial plans called for three concrete box culverts to replace the old timber bridge. Project plans included two-to-three months of construction detours. After succeeding as low bidder on the $365,000 project, Lawrence Construction offered a value-engineering proposal to eliminate the detour by changing the structure to a prefabricated bridge.

Fig. 1 Mitchell Gulch Bridge before Replacement

CDOT accepted the proposal and worked closely with Lawrence and designers from Wilson and Company to develop a full design that would enable fast-track bridge replacement. The new bridge would be a single-span structure, 40 ft. curb to curb, with precast slab girders welded onto precast abutments and wings welded to driven steel H-piles.

PREFABRICATED ELEMENTS

The new bridge substructure consisted entirely of prefabricated elements, precast concrete for all but the steel H-pile supports. Each abutment included a lower and upper backwall unit, and each of the four wingwalls was a separate precast piece. Plans called for the precast substructure units to be attached in the field by welding together of

embedded plates that had been precast into the elements. The substructure design placed the steel H-piles outside the footprint of the existing bridge, allowed them to be driven before removal of the existing structure.

The superstructure consisted of eight precast deck girder units each 5 ft. 4 in. wide, 1 ft. 6 in. deep, and 38 ft. 4 in. long. The deck girders were placed on the abutments and then transversely post-tensioned and grouted together. Bridge railing was precast into the outside deck girders to avoid a separate field installation of the railing.

TIMELINE

The highway was closed to traffic at 7 PM on Friday evening, August 23rd. It had to be opened to traffic before morning traffic the following Monday.

CONSTRUCTION

Extensive planning and coordination ensured the success of the construction weekend, and much work was done before the bridge closure. Advance work included:

- Precasting of concrete elements
- Construction of the detour that would handle traffic for the two weekend days
- Driving of the H-piles
- Relocation of underground utility lines

State Highway 86 is a primary transportation corridor in the region, and closing the route for any amount of time was not allowed. The fast-track proposal significantly reduced the bridge-closure time, allowing CDOT to be more flexible in its detour requirements: the detour had a reduced design speed of 25 mph, and the detour surface was stabilized with aggregate base instead of bituminous pavement.

The fast-track replacement work began at 7 PM Friday evening as traffic was rerouted onto the detour around the bridge, and dismantling of the old bridge and excavation commenced.

Fig. 2 Demolition of the Old Mitchell Gulch Bridge

Within 6 hours the first piece of precast abutment was set on the west side, and wingwalls were welded to the abutment backwalls. By 6 AM Saturday morning, the first piece of precast abutment was set on the east side, and wingwalls were welded to the abutment backwalls.

Fig 3 Both Abutments in Place

The construction crew was setting deck girder panels by noon Saturday and continued grouting between deck girder panels and post-tensioning the deck during the afternoon. Work stopped for the night at 11 PM, resuming at 7 AM on Sunday.

Fig 4 Outside Girder with Curb and Railing

During the day on Sunday, the crew did earthwork, backfilling, and asphalt paving on the bridge and its approaches. Paving was completed by 4:30 PM, and the bridge was opened to traffic at 5 PM on Sunday afternoon, just 46 hours after the road had been closed. State Highway 86 is a commuter route, and commuters who drove over the old bridge on their way home for the weekend used the new bridge the following Monday morning.

Fig 5 New Mitchell Gulch Bridge Open to Traffic

CHALLENGES AND LESSONS

The construction operations were not problem-free, but intensive advance planning and crack coordination among Lawrence construction personnel, Wilson and Company design staff, and CDOT oversight personnel met all challenges. Substructure units did not fit together as anticipated, the grouting process had to be modified, and minor design adjustments were necessary. The design included welding, which consumed time.

CDOT is particularly interested in fast-track bridge replacement processes. Based on lessons learned from this project, CDOT estimates that a similar bridge could now probably be erected in less than 24 hours.

CONCLUSION

The use of prefabricated bridge elements in the Mitchell Gulch Bridge project facilitated benefits for the bridge owner, bridge users, and the construction teams:

- The owner, CDOT, gained a proven fast-track bridge replacement process, and the process offers potential for reducing the total cost of similar projects. Although actual construction costs are similar, significant savings are available from traffic control and other administrative costs.
- Bridge users saved more than two months of inconvenient detouring and potential risk from ongoing construction.
- Construction personnel were required to work next to traffic on a commuter highway for less than two days instead of more than two month, and the traffic was minimal because work occurred over a weekend.

This could not have been a fast-track project without prefabrication. However, its success is also the result of a strong partnership among Lawrence Construction Company, CDOT, and Wilson and Company, a collaboration characterized by effective advance planning, efficient on-site coordination, and smooth responses to on-site needs for design change.