Idaho Demonstration Project:

Replacement of SH 75 East Fork Salmon River Bridges

Final Technical Brief
May 2015

HIGHWAYS FOR LIFE
Accelerating Innovation for the American Driving Experience.

U.S.Department of Transportation
Federal Highway Administration

FOREWORD

The purpose of the Highways for LIFE (HfL) pilot program is to accelerate the use of innovations that improve highway safety and quality while reducing congestion caused by construction. **LIFE** is an acronym for **L**onger-lasting highway infrastructure using **I**nnovations to accomplish the **F**ast construction of **E**fficient and safe highways and bridges.

Specifically, HfL focuses on speeding up the widespread adoption of proven innovations in the highway community. Such “innovations” encompass technologies, materials, tools, equipment, procedures, specifications, methodologies, processes, and practices used to finance, design, or construct highways. HfL is based on the recognition that innovations are available that, if widely and rapidly implemented, would result in significant benefits to road users and highway agencies.

Although innovations themselves are important, HfL is as much about changing the highway community’s culture from one that considers innovation something that only adds to the workload, delays projects, raises costs, or increases risk to one that sees it as an opportunity to provide better highway transportation service. HfL is also an effort to change the way highway community decision makers and participants perceive their jobs and the service they provide.

The HfL pilot program, described in Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Section 1502, includes funding for demonstration construction projects. By providing incentives for projects, HfL promotes improvements in safety, construction-related congestion, and quality that can be achieved through the use of performance goals and innovations. This report documents one such HfL demonstration project.

Additional information on the HfL program is at www.fhwa.dot.gov/hfl.

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16. Abstract

As a part of the Highways for LIFE initiative, the Federal Highway Administration provided a $1.38 million grant to the Idaho Transportation Department (ITD) to replace two bridges on SH 75 in Custer County. One of the bridge structures crosses over the Salmon River, and the other crosses over the East Fork of the Salmon River, between mile post 226.6 and mile post 227.4.

The project's innovative aspects included the use of precast bridge elements and system (PBES) and accelerated bridge construction (ABC), which enabled completion of construction and opening of the new bridges to traffic in one construction season and provided ITD personnel with valuable experience in this technology.

The project was let on January 14, 2014. The construction began in spring 2014 and was completed and open to traffic in fall 2014. The traffic volume on this rural roadway was very small, and because the two bridges were constructed on new alignments, there was minimal impact on the traveling public.

The total construction cost incurred by ITD on this project, including mobilization, was $7,367,883. The overall experience of the project was positive, as it enabled completion of two bridges in one construction season with minimal change orders. As a consequence of the experience gained on this project, ITD plans to specify precast abutments and columns where practical in the future.

17. Key Words	18. Distribution Statement
Highways for LIFE, ABC, PBES	No restriction. This document is available to the public through the Highways for LIFE website: http://www.fhwa.dot.gov/hfl/

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Unclassified	Unclassified	22	

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SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
(none)	mil	25.4	micrometers	μm
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	millimeters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela per square meter	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	Newtons	N
lbf/in^2 (psi)	poundforce per square inch	6.89	kiloPascals	kPa
k/in^2 (ksi)	kips per square inch	6.89	megaPascals	MPa
		DENSITY		
lb/ft^3 (pcf)	pounds per cubic foot	16.02	kilograms per cubic meter	kg/m^3
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
μm	micrometers	0.039	mil	(none)
mm	millimeters	0.039	inches	in
	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela per square meter	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	Newtons	0.225	poundforce	lbf
kPA	kiloPascals	0.145	poundforce per square inch	lbf/in^2 (psi)
MPa	megaPascals	0.145	kips per square inch	k/in^2 (ksi)

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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ABBREVIATIONS AND SYMBOLS

ABC	Accelerated bridge construction
AADT	Average annual daily traffic
FHWA	Federal Highway Administration
HfL	Highways for LIFE
IRIInternational Roughness Index	
ITD	Idaho Transportation Department
OBSI	On-board sound intensity
OSHA	Occupational Safety and Health Administration
PBES	Prefabricated bridge elements and systems
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users

INTRODUCTION

HIGHWAYS FOR LIFE DEMONSTRATION PROJECTS

Highways for LIFE (HfL) is the Federal Highway Administration's (FHWA) initiative to advance longer-lasting and promote efficient and safe construction of highways and bridges using innovative technologies and practices. The HfL program provides incentive funding to highway agencies to try proven but little-used innovations on eligible Federal-aid construction projects. The HfL team prioritizes projects that use innovative technologies, manufacturing processes, financing, contracting practices, and performance measures that demonstrate substantial improvements in safety, congestion, quality, and cost-effectiveness. An innovation must be one the applicant State has never or rarely used, even if it is standard practice in other States. Recognizing the challenges associated with deployment of innovations, the HfL program provides incentive funding for up to 15 demonstration construction projects a year. The funding amount typically totals up to 20 percent of the project cost, but not more than $5 million.

The HfL program promotes project performance goals that focus on the expressed needs and wants of highway users. They are set at a level that represents the best of what the highway community can do, not just the average of what has been done. The goals are categorized into the following categories:

- **Safety**
  - Work zone safety during construction—Work zone crash rate equal to or less than the preconstruction rate at the project location.
  - Worker safety during construction—Incident rate for worker injuries of less than 4.0, based on incidents reported on Occupational Safety and Health Administration (OSHA) Form 300.
  - Facility safety after construction—Twenty percent reduction in fatalities and injuries in 3-year average crash rates, using preconstruction rates as the baseline.
- **Construction Congestion**
  - Faster construction —Fifty percent reduction in the time highway users are impacted, compared to traditional methods.
  - Trip time during construction — Less than 10 percent increase in trip time compared to the average preconstruction speed, using 100 percent sampling.
  - Queue length during construction—A moving queue length of less than 0.5 miles in a rural area or less than 1.5 miles in an urban area (in both cases at a travel speed 20 percent less than the posted speed).

- **Quality**
  - Smoothness—International Roughness Index (IRI) measurement of less than 48 in/mi.
  - Noise—Tire-pavement noise measurement of less than 96.0 A-weighted decibels (dB(A)), using the onboard sound intensity (OBSI) test method.
- **User Satisfaction**
  - An assessment of how satisfied users are with the new facility compared to its previous condition and with the approach used to minimize disruption during construction. The goal is a measurement of 4 or more on a 7-point Likert scale.

PROJECT OVERVIEW

As a part of the HfL initiative, FHWA provided a $1.38 million grant to the Idaho Transportation Department (ITD) to replace two bridges on SH 75 in Custer County. One of the bridge structures crosses over the Salmon River, and the other crosses over the East Fork of the Salmon River, between mile post 226.6 and mile post 227.4.

The project's innovative aspects included the use of precast bridge elements and system (PBES) and accelerated bridge construction (ABC), which enabled completion of construction and opening of the new bridges to traffic in one construction season and provided ITD personnel with valuable experience in this technology.

PROJECT DETAILS

PROJECT BACKGROUND AND LOCATION

The East Folk Salmon River bridges project is located on SH 75 approximately 37 miles east of Stanley, in a remote part of Idaho that is popular with summer tourists. SH 75, with current average annual daily traffic (AADT) of 690 with 14 percent trucks at this location, is designated as the Salmon River Scenic Byway, with the crossings approximately 5,500 feet above sea level. As shown in figure 1, in this remote location there is no practical alternate route to avoid construction; avoiding this area would involve a 99-mile detour.

The project replaced both existing bridges, which were built in 1938. In addition to being past their service life of 50 years, the existing bridges did not meet ITD's current standards.

The new bridges are built on a new alignment centered approximately 45 feet upstream from the existing bridges centerline. The edges of the new bridges are approximately 8 feet upstream of the existing bridges. ITD considered half-width staged construction, with one lane of traffic open at all times. One traffic signal would be placed on the north end of the East Fork of the Salmon River Bridge and the another about 1,000 feet away on the south end of the main Salmon River Bridge, spanning the construction zone. Instead, they opted for the new alignment, to avoid or minimize impacts on traffic.

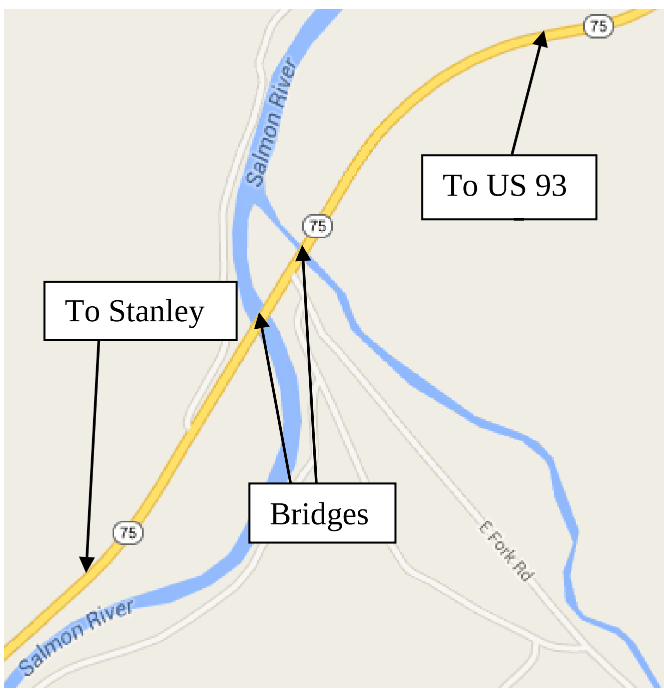

Figure 1. Map. Project location of the structurally deficient bridges.

The new main Salmon River Bridge, shown in figure 2, is a three-span bridge (90 feet, 120 feet, 50 feet). It is 43 feet, 6.5 inches wide (a total of 40 feet, 7.5 inches curb to curb), with two piers in the river approximately 30 feet from each bank. It replaced a bridge 240 feet long by 26 feet wide, 24 feet curb to curb that had three piers in the water.

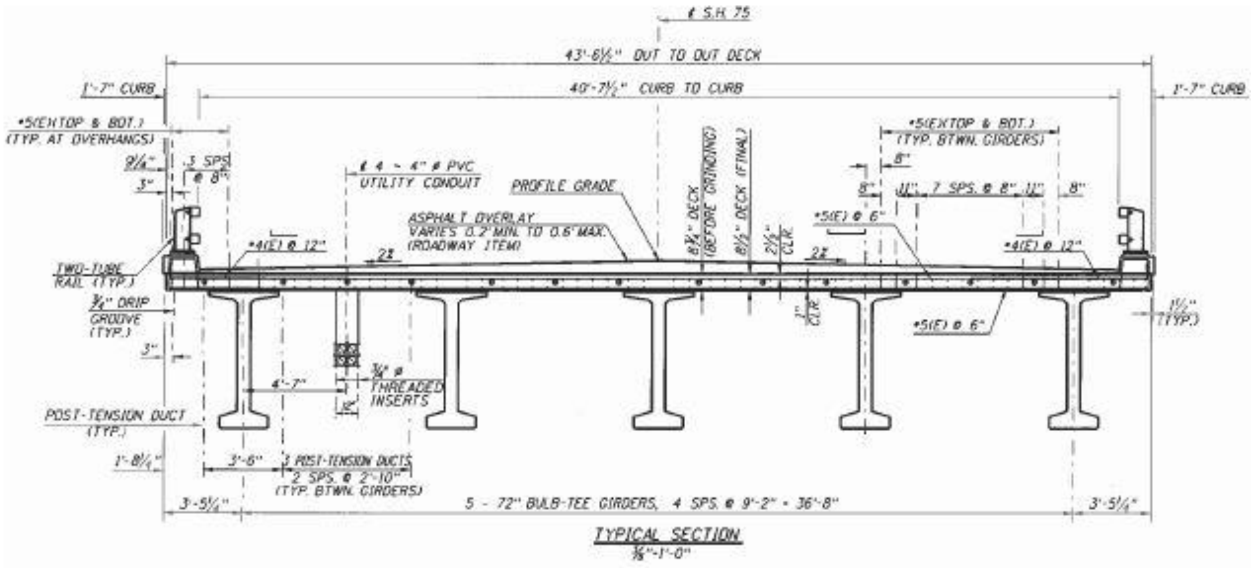

Figure 2. Diagram. Typical section of the new main Salmon River Bridge.

The new East Fork Salmon River Bridge is approximately 140 feet long and 43 feet, 9.5 inches wide (a total of 40 feet, 7.5 inches curb to curb) and replaced a bridge of similar width as the old main river bridge. Figure 3 shows the typical section of the new single-span bridge.

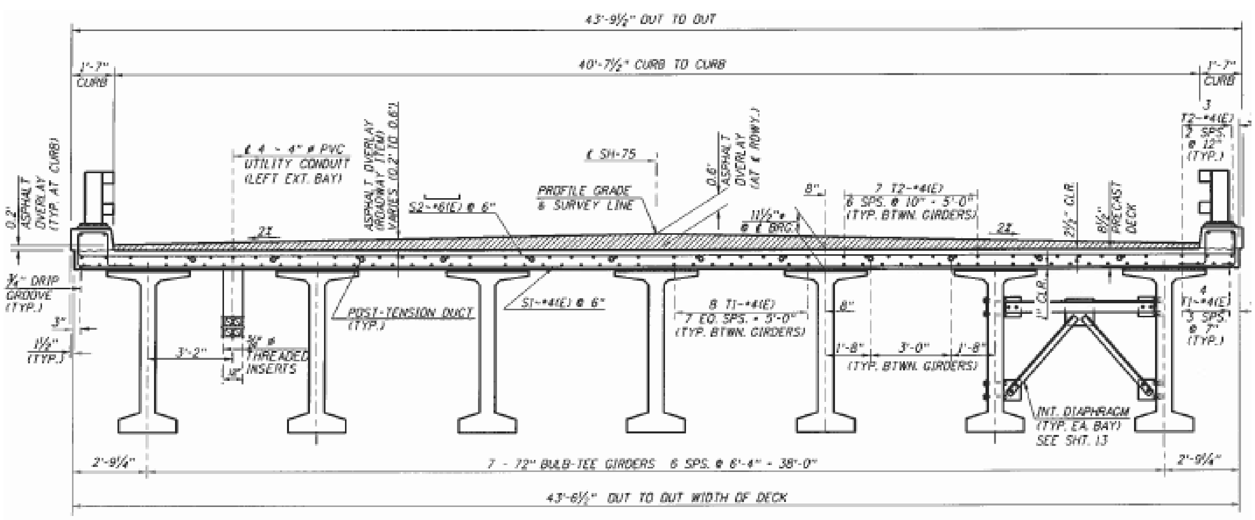

Figure 3. Diagram. Typical section of new East Fork Salmon River Bridge.

Both bridges replaced were considered as narrow bridges by ITD criteria, with load capacity limitations, and were therefore candidates for replacement, widening, or strengthening.

INNOVATIONS

This project utilized ABC through use of precast bridge elements for abutments, piers, girders, and deck. The technology had not been previously used by ITD; however, by 2011, the agency believed that it had developed sufficiently enough to try it at this remote location and would save about 3 to 4 months, making it possible to complete both bridges in one construction season.

Additional motivating factors for this project, and to use ABC to reduce construction time, included:

- Enhanced safety with design features that included crash tested railings and end treatments, wider bridges and shoulders, new signs and pavement markings, reduced risk to workers by avoidance of building and stripping forms for piers, and reduced exposure of travelers to work zone hazards due to shortened construction time.
- Elimination of one construction season and one winter shutdown.
- Improved quality due to precast construction methods in a controlled environment, a better curing environment, and easier access to bridge elements during manufacturing.
- Improved ride surface due to a new asphalt surface placed over deck panels finished with diamond grinding.
- Potential for an HfL grant that would partially cover the cost of the project.

PROJECT INITIATION PROCESS

ITD applied for an HfL grant of $1,380,000 in June 2011 for the East Fork Salmon River Bridge, and an announcement on the project's selection in the full amount requested was made in August of the same year. The agency subsequently decided to expand use of ABC on both bridges instead of limiting it to the East Fork Salmon River Bridge alone. The project was initially expected to be built during the 2013 construction season, but it was postponed because the initial lowest bid was substantially higher than the engineer's estimate. It was rebid and constructed in 2014.

PROJECT CONSTRUCTION

The contractor was required to complete in-stream work (i.e., installation and removal of work platforms, cofferdam installation and removal, and pier construction) by August 15 and also complete abutment construction, installation of girders, and diaphragms. No in-stream work was permitted after this date without first confirming the absence of Chinook salmon or bull trout redds within the action area.

Abutments for both bridges are supported on H piles and placed out of the river channel (see figure 4). The lower portion of the abutments, shown in figure 5, and wing walls were precast. The upper portion of the abutments and the deck ends were formed and cast in place.

Figure 4. Photo. Piling for abutment.

Figure 5. Photo. Precast abutment.

Sheet pile cofferdams (about 30 feet in the direction of the river and about 25 feet wide) were placed around the foundation area for each pier of the main Salmon River Bridge to separate the flowing river from the pier. The enclosed area was dewatered, and H piles were driven into rock to anchor the piers. Figure 6 shows the cofferdam, piling, and forming for the cast-in-place footing for the piers. Rebars from the pier footing (figure 7) were spaced to fit into sleeves at the bottom of the precast pier column (figure 8). The alignment of the rebars with the sleeves is shown in figure 9.

Figures 8 and 9 also highlight the importance of proactively ensuring the accuracy of connecting elements. Although alignment of the connecting elements was not an issue on this project, the contractor on at least one occasion lifted the pier column off the rebars due to concerns that the rebars and the sleeves were not lined up properly. The contractor chose to round off the top edges of the exposed rebars to resolve this concern.

The caps for the piers were cast in place. The forms for the pier caps were lifted as shown in figure 10 and placed on the precast columns. Pre-tied rebars were then placed in the forms and concrete was pumped into the forms. The completed pier is shown in figure 11.

The contractor then set the 6-ft-deep bulb tee precast, prestressed girders on bearing pads placed on the substructure as shown in figure 12. After setting the intermediate diaphragms, the contractor installed full-depth 11-ft-wide precast deck panels over the girders (see figure 13) and adjusted them to grade. The layout plan of girders for the main Salmon River Bridge is shown in figure 14.

The deck was then prepared for grout, and posttensioning strands were installed in ducts. Once shear studs were installed, the shear keyways between panels were grouted. After sufficient grout strength was achieved, the posttensioning strands shown in figure 15 were stressed.

Once the abutments and the decking were connected, approach slab work was performed, curbs were formed and cast in place, and the deck was ground for smoothness. A photograph of the milled deck with the grouted blocked out areas for shear connectors is shown in figure 16. Finally, the deck was covered with waterproofing membrane and overlaid with asphalt as shown in figure 17. The remaining work on the bridges and approach roadways was then completed, and the new bridges were opened to traffic on schedule. The old bridges were demolished.

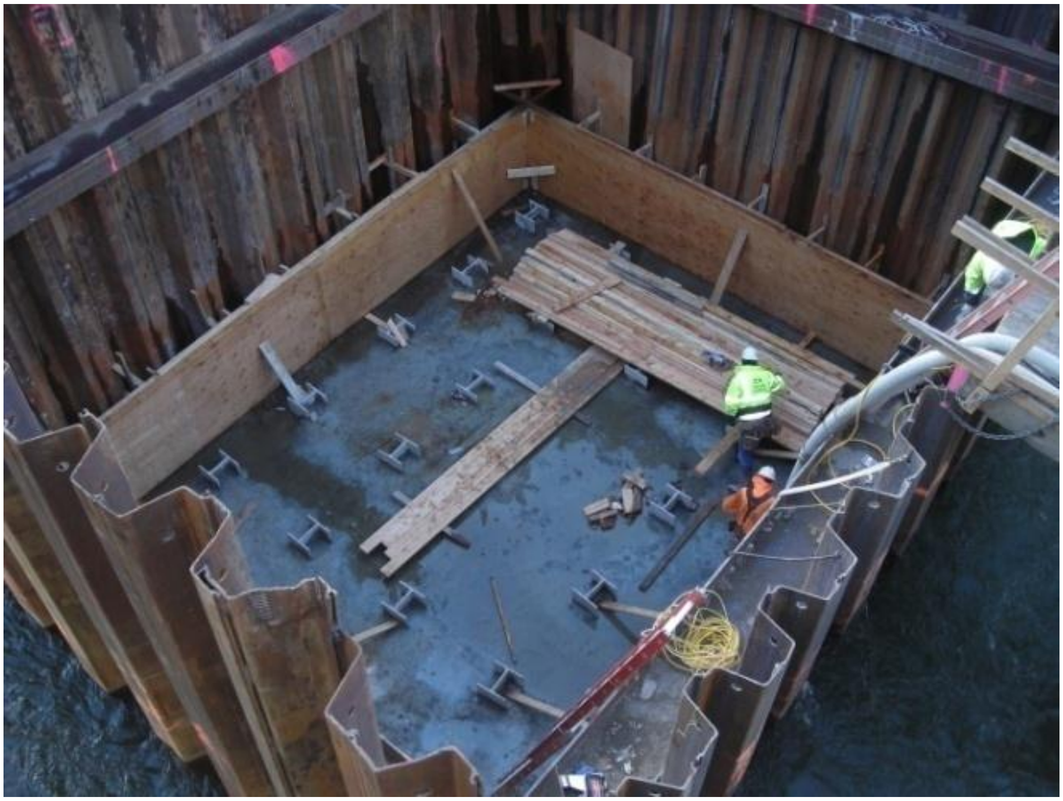

Figure 6. Photo. Pile cap for pier.

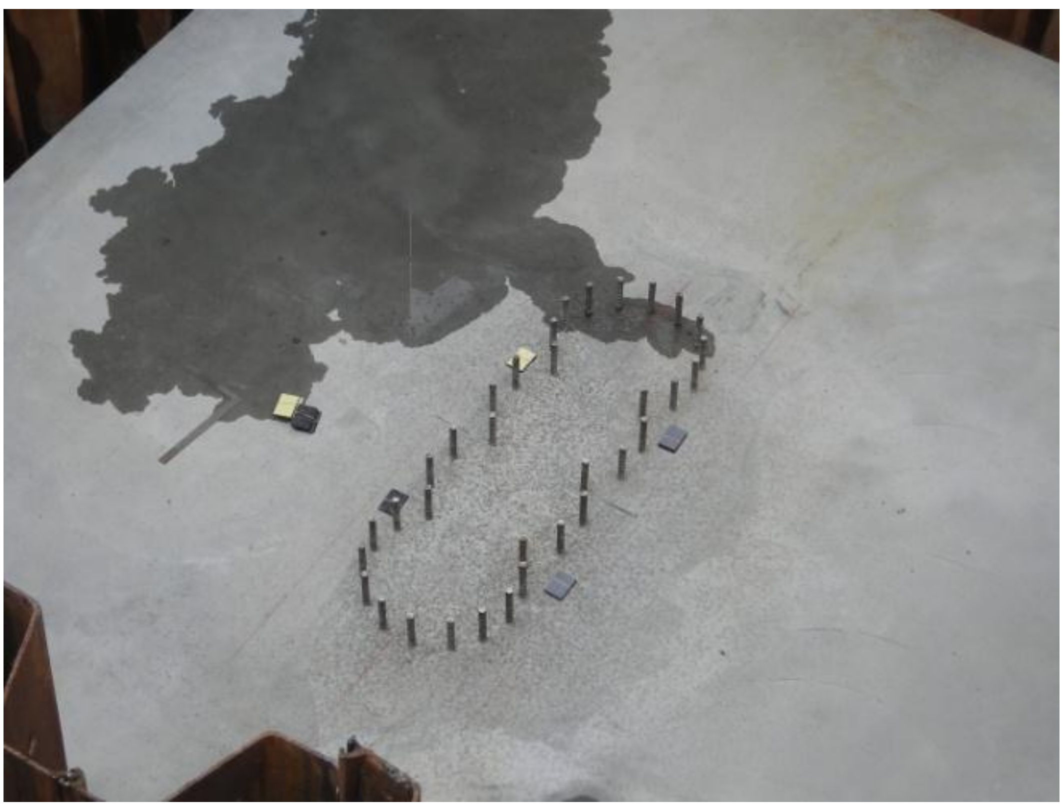

Figure 7. Photo. Pier footing rebars.

Figure 8. Photo. Pier column sleeves.

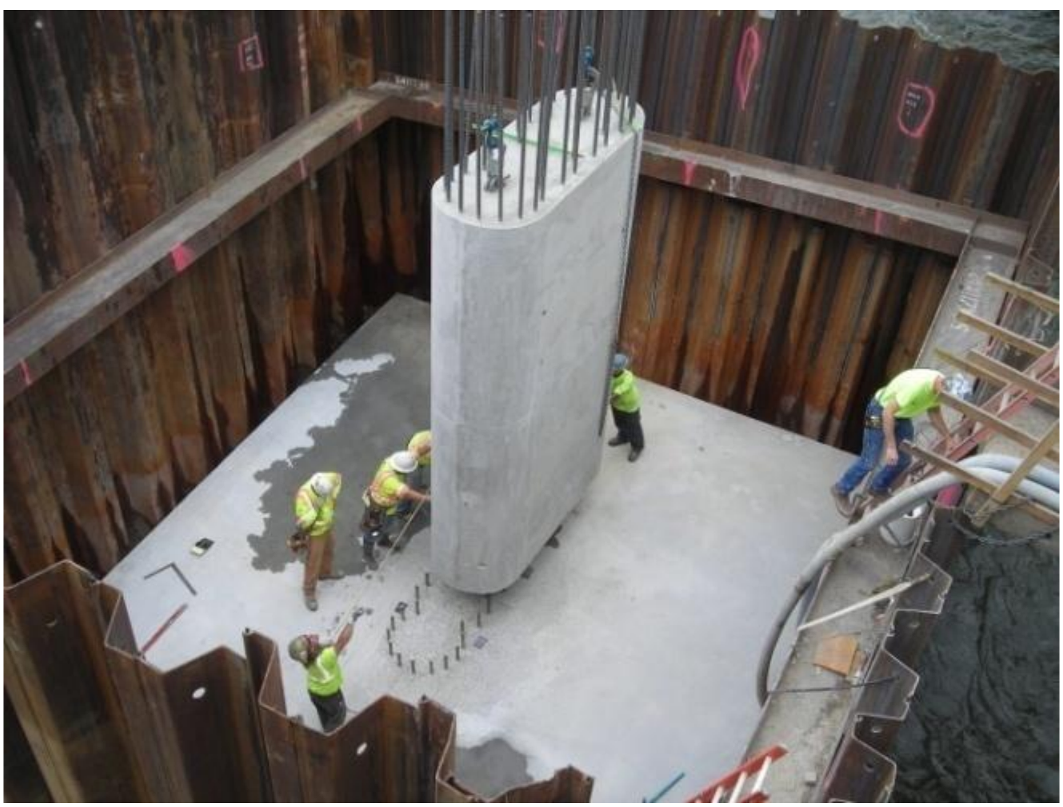
Figure 9. Photo. Aligning rebars in sleeves.

Figure 10. Photo. Pier cap form.

Figure 11. Photo. Completed pier.

Figure 12. Photo. Girder placement.

Figure 13. Photo. Deck panel placement.

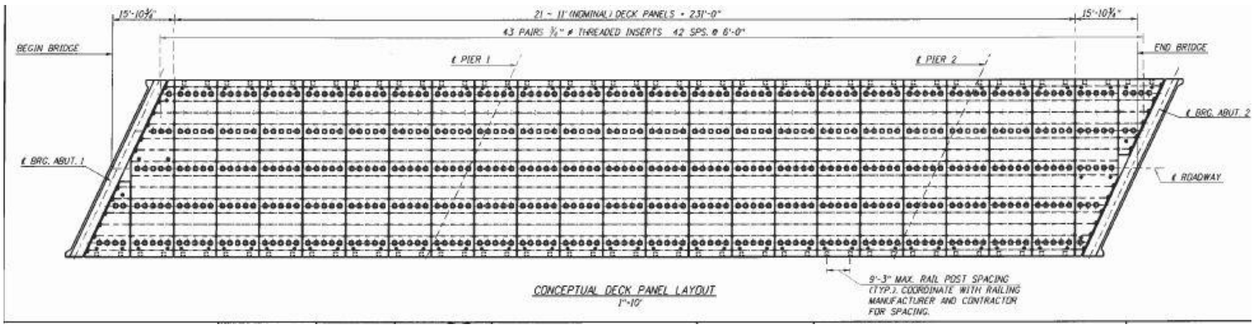

Figure 14. Diagram. Deck plan for main Salmon River Bridge.

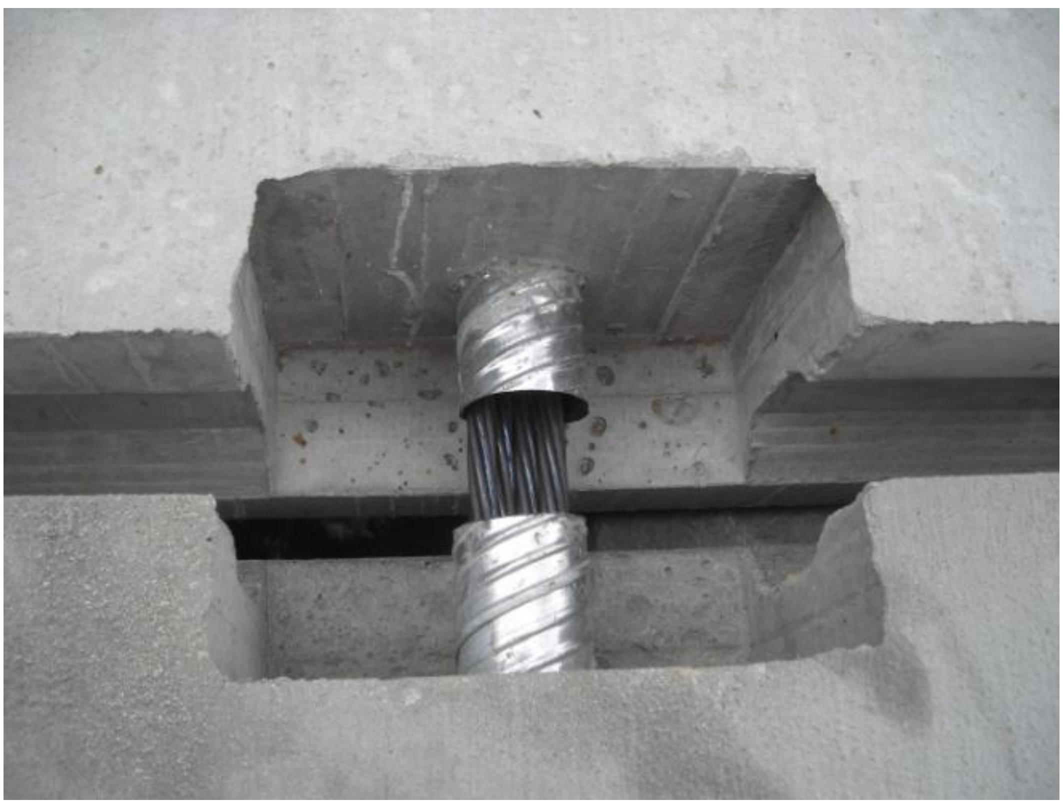

Figure 15. Photo. Posttensioning ducts between deck panels.

Figure 16. Photo. Finished milled deck.

Figure 17. Photo. Paving on deck.

HIGHWAYS FOR LIFE PERFORMANCE GOALS

The primary objective of acquiring data on HfL performance goals such as safety, construction congestion, and quality is to quantify project performance and provide an objective basis from which to determine the feasibility of the project innovations and to demonstrate that the innovations can be used to do the following:

- Achieve a safer work environment for the traveling public and workers.
- Reduce construction time and minimize traffic interruptions.
- Produce a high-quality project and gain user satisfaction.

The following subsections provide additional information on some of the significant factors that influence the HfL performance goals.

SAFETY

The HfL performance goals for safety include meeting both worker and motorist safety goals during construction. During the construction of the two bridges, no workers were injured, so the contractor exceeded the HfL goal for worker safety (incident rate of less than 4.0 based on the OSHA 300 rate). ITD did not set a goal for accident rates during construction, and there were no reported work zone accidents.

TRAVEL TIME

Travel time of motorists traveling on SH 75 was not affected, as the new bridges were built on a new alignment and traffic was never restricted.

CONSTRUCTION CONGESTION

Because of lower traffic volumes across the project location and the fact that the two bridges were built on new alignments, there was no queuing on this project.

NOISE AND SMOOTHNESS

The two bridges are in a rural area with very low traffic volume. Also, the new main Salmon River Bridge has a total length of only 260 feet, while the new East Fork Salmon River Bridge has a total length of only 140 feet. OBSI and IRI data were not collected on this project, as they were not deemed relevant.

CONSTRUCTION COSTS

Four bids were received on this project, with the lowest bid being $7,367,883. The mobilization costs were $894,000. The project was a success in that it was completed on time, there were no significant change orders or cost overruns, the bridges met user and ITD expectations, and the bridges do not detract from the scenic area.

LESSONS LEARNED

Following are some of the lessons learned on this project, per the Project Delivery team:

- Use of PBES can shorten construction time over conventional methods by allowing some tasks to be performed simultaneously. ITD believes that, in the case of this project, there was the potential for a faster construction schedule but the contractor did not take advantage of it (and was not required to take advantage of it), since there was no impact on traffic.
- Use of PBES can pose additional challenges when developments during construction fall outside of fitting tolerances of the elements already fabricated. For instance, on this project, the contractor was required to build frames to ensure proper H pile alignment with the precast abutments that had already been fabricated.
- Although not a major issue on this project, it is important to ensure that precast elements are fabricated accurately, as correcting any misalignment of connecting pieces can cause significant delays. Therefore, being proactive and spending extra effort is recommended, if needed, to ensure that precast elements are built correctly.
- Precast columns for piers saved time and enabled early removal of cofferdams. The Project Delivery team liked the precast abutments and columns and will specify them wherever practical in the future.
- These two bridges along with other recent ABC projects like SH 200 over Trestle Creek (precast abutments), US 95 over Weiser River (precast pier columns and caps), I-84 over Northside Blvd and UPRR (precast deck panels), and SH3 over Swan Creek (precast rigid frame) & Willow Creek (precast abutments and wingwalls) have allowed ITD to work with the construction industry to develop new tools for their tool box. While these projects had higher initial costs as compared to conventional construction; for ITD, these projects were good test cases to look at construction issues, costs, time needed for construction, quality of materials, quality of workmanship, etc., in order to evaluate the tradeoffs and most appropriate solutions for bridge projects in the future.

PROJECT SUMMARY

Although HfL funds were less than 20% of the total project costs, in this case their use contributed to ITD’s decision to use ABC techniques on this project. Ultimately ITD’s goals for this project were accomplished and the traveling public can utilize a safe, durable and low maintenance structure for many years to come.

The overall experience of the project was positive, as it enabled completion of two bridges in one construction season with minimal change orders. As a consequence of the experience gained on this project, ITD plans to specify precast abutments and columns where practical in the future.

ACKNOWLEDGMENTS

The project team acknowledges the invaluable insights and guidance of Highways for LIFE Team Leader Byron Lord and Program Coordinator Ewa Flom, who served as the technical panel on this demonstration project. Their vast knowledge and experience with the various aspects of construction, technology deployment, and technology transfer helped immensely in developing both the approach and the technical matter for this document. The team also is indebted to Idaho Transportation Department Engineers Matt Davison and Ken Clausen and FHWA Engineer Ed Miltner, for their advice and assistance during this project.