Utah Demonstration Project:

Route 6 Spanish Fork Bridge Deck Replacement

Final Technical Brief
August 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 HfL initiative, the FHWA provided a $500,000 grant to the Utah Department of Transportation (UDOT) to replace a structurally deficient deck of bridge C-679 that carries US-6 over the D&RGW railroad line near the US-6 and I-15 interchange south of the Provo area. The railroad carried approximately 8 to 25 trains every day. The existing US-6 bridge is located just west of the US-6/US-89 intersection (Moark Junction) at approximately milepost (MP) 177.88. This portion of US-6 serves as a gateway between the Wasatch Front, recreational areas, and transportation corridors like I-70. The C-679 bridge, located at the mouth of Spanish Fork Canyon and spanning two sets of Union Pacific railroad tracks, provided connectivity to I-15 for recreational vehicles, commuters, and commerce.

Ultra-high-performance fiber-reinforced concrete (UHPC) was the primary innovation on this project, which faced some design challenges that resulted from the bridge skew of approximately 46 degrees and the bridge reverse superelevation because of its location at the intersection of two reverse horizontal curves. The large skew, varying superelevation, and three-span configuration made this bridge a good candidate for the use of ultra-high-performance fiber-reinforced concrete (UHPC) at the joints and closure pours between precast deck panels to provide a new deck for the bridge. The project involved 2 construction phases, Phase I and Phase II, wherein existing bridge decks, asphalt overlay, and parapets were removed, and new precast concrete parapet and deck panels placed.

There were no worker injuries reported during the construction period. Thus, the contractor exceeded the HfL goal for worker safety (incident rate of less than 4.0 based on the OSHA 300 rate). There was one work zone related crash/motorist injury during construction. However, the crash was unrelated to the work zone features or the work done during construction. The total funding on this project was $3,059,468, and project expenditures totaled $2,891,688.

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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
m	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

AADT	annual average daily traffic
CATEX	Categorical Exclusion
FHWA	Federal Highway Administration
HfL	Highways for LIFE
IRI	International Roughness Index
OBSI	onboard sound intensity
OSHA	Occupational Safety and Health Administration
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
UDOT	Utah Department of Transportation
UHPC	ultra-high-performance concrete

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:

1. **Safety**

    a. Work zone safety during construction—Work zone crash rate equal to or less than the preconstruction rate at the project location.

    b. 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.

    c. Facility safety after construction—Twenty percent reduction in fatalities and injuries in 3-year average crash rates, using preconstruction rates as the baseline.

2. **Construction Congestion**

    a. Faster construction —Fifty percent reduction in the time highway users are impacted, compared to traditional methods.

    b. Trip time during construction — Less than 10 percent increase in trip time compared to the average preconstruction speed, using 100 percent sampling.

    c. 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).

3. **Quality**

    a. Smoothness—International Roughness Index (IRI) measurement of less than 48 inches/mile.

    b. Noise—Tire-pavement noise measurement of less than 96.0 A-weighted decibels (dB(A)), using the onboard sound intensity (OBSI) test method.

4. **User Satisfaction**

    a. 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, the FHWA provided a $500,000 grant to the Utah Department of Transportation (UDOT) to replace a structurally deficient deck of bridge C-679 that carries US-6 over the D&RGW railroad line near the US-6 and I-15 interchange south of the Provo area. Ultra-high-performance fiber-reinforced concrete (UHPC) was the primary innovation on this project. The project involved 2 construction phases, Phase I and Phase II, wherein existing bridge decks, asphalt overlay, and parapets were removed, and new precast concrete parapet and deck panels placed.

PROJECT DETAILS

PROJECT BACKGROUND AND LOCATION

This project entails replacing a structurally deficient deck of bridge C-679 that carries US-6 over the D&RGW railroad line near the US-6 and I-15 interchange south of the Provo area. The railroad carried approximately 8 to 25 trains every day. The existing US-6 bridge is located just west of the US-6/US-89 intersection (Moark Junction) at approximately milepost (MP) 177.88. This portion of US-6 serves as a gateway between the Wasatch Front, recreational areas, and transportation corridors like I-70. The C-679 bridge, located at the mouth of Spanish Fork Canyon and spanning two sets of Union Pacific railroad tracks, provided connectivity to I-15 for recreational vehicles, commuters, and commerce. Figure 1 presents the approximate bridge location.

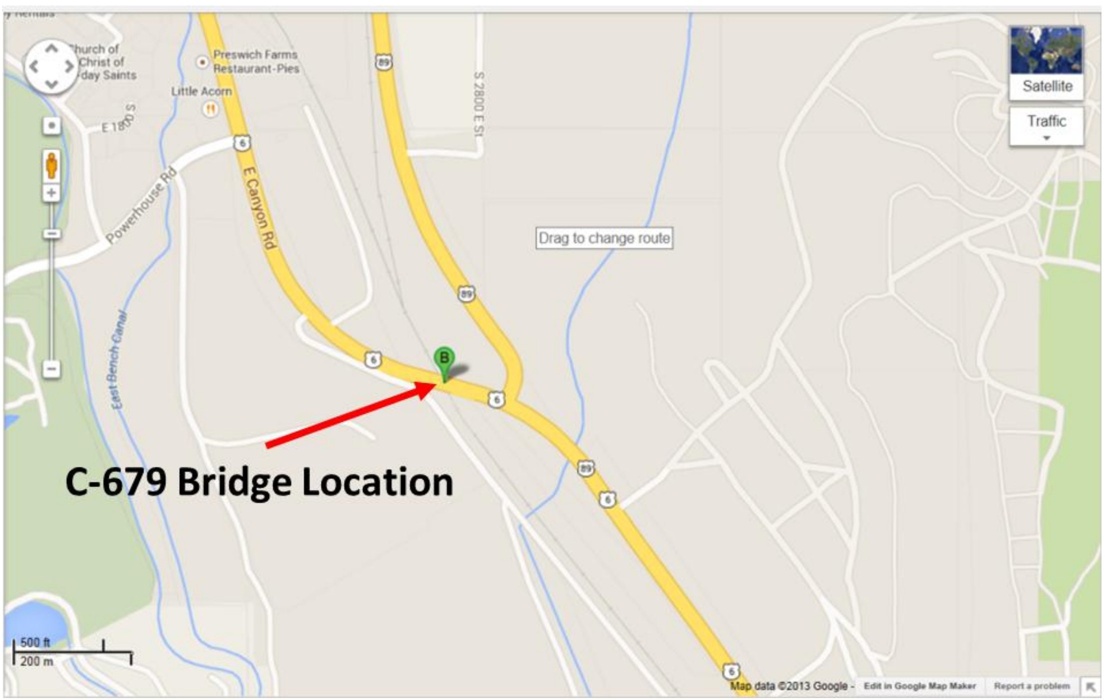


Figure 1. Map. Approximate bridge location (coordinates: 40°04'56" N, 111°35'21" W).

PROJECT DESCRIPTION

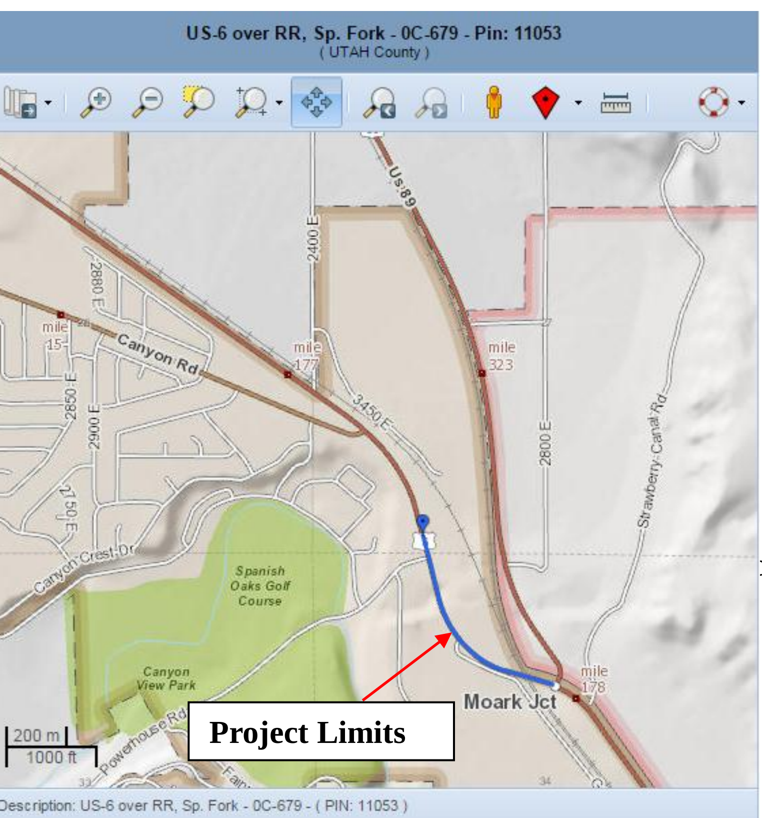
Existing Bridge Information

The bridge consists of a three-span configuration, 65 feet – 110 feet – 55 feet, with a cast-in-place concrete deck and steel girder superstructure. The bridge, originally constructed in 1978, has a width of 58 feet and carries one median lane and two lanes of through traffic. The bridge has a large skew of about 45 degrees as well as a reverse superelevation because of its location at the intersection of two reverse horizontal curves. The geometrics and the bridge were not changed as part of this project. The only replacement on this project was the bridge deck.

According to UDOT's inspection records, the bridge deck had a rating of 4, which indicated that the bridge was in a poor and structurally deficient condition (see figure 2). The bridge had deteriorated to the extent that it required an replacement, which had to be accelerated due to traffic impacts..

Figure 2. Photos. C-679 bridge condition prior to reconstruction. (courtesy: UDOT)

The project extended from milepost 177.47 to milepost 177.94. Figure 3 presents the location of the project.



t Location (courtesy: UDOT).

UDOT maintained an Automated Traffic Recorder (ATR) on US-6 approximately 4.5 miles east of the project site. The ATR-312 traffic data indicated that the traffic volume around the project location was around 9,000 vehicles per day, and the total truck traffic around 38 percent. Tables 1 and 2 show the annual average daily traffic (AADT) and truck traffic information for the nearest location around the project.

Table 1. AADT data from near the project location (for US-6 and SR 89).

Route Name	**Beg. Accum. Mileage**	**End Accum. Mileage**	**Location Description**	**2012 AADT**	**2011 AADT**	**2010 AADT**
US-6	177.950	187.467	SR 89 Moark Junction Left *ATR 312*	9,180	9,165	9,350

Table 2. Truck traffic data from near the project location (at SR 89 Moark Junction).

2011	**2011**	**2010**	**2010**
Single	**Combo**	**Single**	**Combo**
23%	15%	29%	16%

Project Innovations

There were some design challenges on this project that resulted from the bridge skew of approximately 46 degrees and the bridge reverse superelevation because of its location at the intersection of two reverse horizontal curves. The large skew, varying superelevation, and three-span configuration made this bridge a good candidate for the use of ultra-high-performance fiber-reinforced concrete (UHPC) at the joints and closure pours between precast deck panels to provide a new deck for the bridge.

According to UDOT, the UHPC technology was expected to offer the following benefits:

1. Eliminate the need for post-tensioning.
2. Reduce specialized construction equipment and labor.
3. Reduce joint size.
4. Improve bridge durability and continuity.
5. Extend bridge life.
6. Reduce the on-site construction time.

Design Specifications

The deck replacement for the new three-span bridge consisted of the following:

1. New full-depth precast panels for the deck and approach slabs.
2. Cast-in-place parapets.
3. Field cast transverse and longitudinal joints using UHPC.
4. Use of UHPC for the girder haunches and shear stud blockouts.

Approximately 70 cubic yards of UHPC was required on this project.

One of the key decisions for UDOT on this project was to determine whether the requirements on the UHPC mix would be performance-based or prescriptive. UDOT opted for the prescriptive requirement criteria, as the State had no prior experience with batching, producing, or testing UHPC. UDOT selected Lafarge North America to manufacture the UHPC, and the contractor was required to obtain all UHPC components from the manufacturer. The UHPC mix requirements included the use of Ductal® JS 1000 Concrete with the proportions of premix, water, superplasticizer liquid, and steel fibers based on UDOT's approval and the manufacturer's recommendations. The contractor had to submit test results to confirm compliance to UDOT's UHPC requirements on this project.

Table 3 shows the UHPC mix requirements for this project.

Table 3. UDOT's UHPC mix requirements.

Property	Test Method	UDOT Requirement
Minimum Compressive Strength		
A-Heat-Treated	AASHTO T 22	≥ 25 ksi
B-Not Heat-Treated		≥ 20 ksi @ 28 days
C-Not Heat-Treated		≥ 14 ksi @ 4 days
Split Cylinder Cracking Strength	ASTM C 496	≥ 800 psi @ 28 days
Long-Term Shrinkage	ASTM C 157	≤ 766 microstrain; initial reading after set
Chloride Ion Penetrability	ASTM C 1202	≤ 250 coulombs
Freeze-Thaw Resistance	ASTM C 666A	RDM > 96%; 600 cycles
Slump Flow Field Test	Per Provider QC Procedures	Per Provider QC Procedures
Steel-Bond Test (Pull-Out Test)	Per Provider QC Procedures	Per Provider QC Procedures
* Heat-Treated – According to manufacturer's recommendation, temperature not to exceed 250°F		

For quality control and acceptance during production and placement on-site, UDOT required the contractor to submit quality control procedures, establish minimum sampling and testing requirements, and provided an allowance for verification testing at UDOT's discretion.

Field Demonstration and UDOT Project Requirements

To ensure quality of the product and worker safety, UDOT wanted to conduct a field demonstration on this project (see Figure 4). The demonstration was intended to provide all parties involved in the various aspects of the work with an opportunity to work with the UHPC material in advance of the material placement on the structure, and to familiarize themselves with the UHPC process in the absence of any traffic or time restrictions prior to the actual material placement.

UDOT's criteria for the field demonstration included creating a mock-up to replicate the joint between precast panels. The mock-up needed to match the actual precast concrete panel depths to be used in the structure. The width of the panel, measured perpendicular to the joint, had to be a minimum of 1.5 feet, and the length of the panel, measured along the joint, had to be a minimum of 5 feet. The intent was to, as much as possible, replicate field conditions for surface preparation and panel installation.

Figure 4. Photo. Mock Up UHPC during Field Demonstration. (courtesy: UDOT)

UDOT and the contractor were required to use the same personnel and similar equipment on the field demonstration as they would during the actual construction efforts. The contractor was required to produce and place a minimum of three batches of UHPC to demonstrate continuous batching, placing, curing, and finishing of the field cast joints. To demonstrate quality control procedures for sampling and testing, the contractor had to conduct the following minimum required testing at the field demonstration:

1. Slump flow test.
2. Compressive strength test for four sets of three 3-in by 6-in cylinders. The contractor was required to test the first set at 4 days and the second set at 28 days. While the third set was to be heat-treated and tested, the fourth set was reserved for UDOT verification testing.
3. Steel bond test (pull-out test).
4. Chloride ion permeability check.

The contractor was required to conduct the field demonstration 30 days prior to the UHPC placement on the bridge. This was done to allow the contractor time before full production for any modifications to processes or adjustments resulting from testing issues/results.

During the on-site placement, UDOT requirements for quality control included the following:

1. A technical representative was required to be available on site at all times.

2. Slump flow tests had to be conducted for each batch of concrete.
3. Compressive strength test had to be conducted with four sets of cylinders for each production shift, which was defined as material batched or tested by the same personnel for not more than 10 hours.

To have a better understanding of the contractor's work plan, UDOT also sought an installation plan as a part of the contractor's submittal. The components of the installation plan included the following:

1. On-site staging plan.
2. Bulkhead forming plan.
3. Underside of joint forming plan.
4. Camber strip forming plan.

The sequence of UHPC placement was intended to control the quantity of UHPC placed in each pour by upfront planning of how each pour would be isolated. This was done to ensure that any problem with a particular batch or formwork leaks could be limited and controlled. Figure 5 shows the UHPC placement.

Figure 5. Photo. UHPC placement (courtesy: UDOT).

Maintenance of Traffic (MOT)

Due to maintenance of traffic limitations, the construction was carried out in two phases. Two lanes of traffic were kept open during Phase I of the construction.

During Phase II of the construction, the traffic was reduced to one-way, one-lane signalized traffic, across the bridge for a two-week period. The eastbound and westbound traffic alternatively used the single lane that was controlled using a temporary traffic signal. As the US-6/US-89 intersection was closer to the bridge, the westbound stop line was placed upstream of the intersection to ensure smooth movement of vehicles to and from US-89. The traffic movements to and from US-89 were controlled by the temporary traffic signal.

UDOT's phasing plan for the temporary traffic signal is presented below:

1. Phase A: Eastbound traffic was allowed across bridge, while westbound vehicles could tum onto US-89.
2. Phase B: Westbound traffic was allowed across bridge, while eastbound vehicles could turn onto US-89.

UDOT's phasing plan for the temporary traffic signal accommodated right-turns-on-red from westbound US-6 to northbound US-89, and signage was provided to reinforce that right-turns-on-red should yield to the left turns from eastbound US-6 during Phase 1. To allow vehicles to cross the one-lane area, the all-red time (clearance interval) for Phase A and Phase B were substantially longer than a typical intersection.

Construction

Phase I involved construction of 40 percent of the deck width and required less UHPC than Phase II, thereby allowing the contractor additional time to get processes and placement working with less UHPC. The project plans included constructing full-depth precast panels using conventional high performance concrete (HPC) and stainless steel rebar to provide extended life usage. However, epoxy-coated rebars were used instead of the stainless steel rebars during construction. The full depth deck panels were match-cast near the bridge site (see Figure 6).

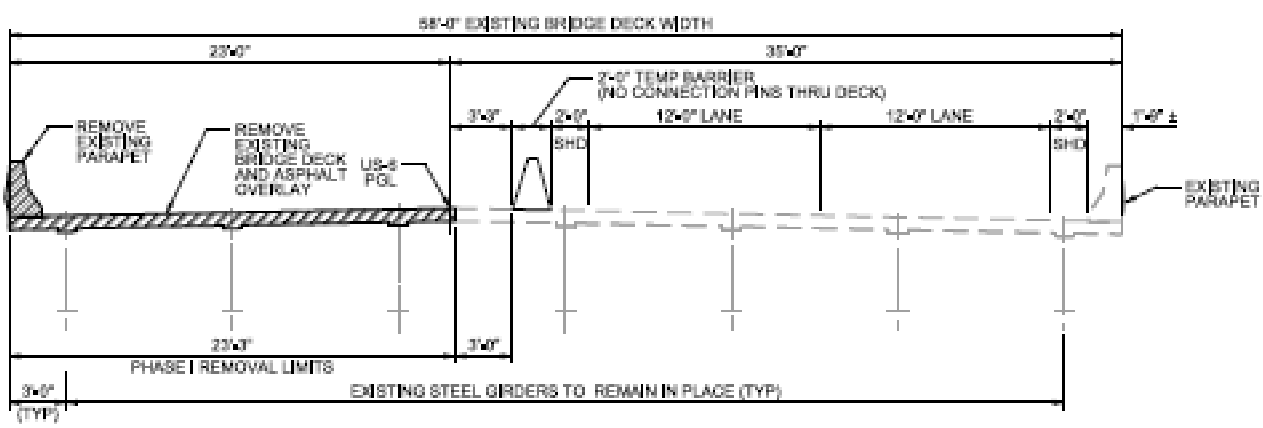
Figure 6. Photo. Precast Deck Panels. (courtesy: UDOT)

The construction activities included the following activities:

1. Removal of existing bridge deck, asphalt overlay, and parapet
2. Placement of full-depth concrete deck panels
3. Parapets cast in-place
4. Removal of temporary barriers.

Figure 7 through Figure 10 presents phases I-A, I-B, II-A, and II-B of the construction.

Figure 7. Diagram. Construction Phase I-A



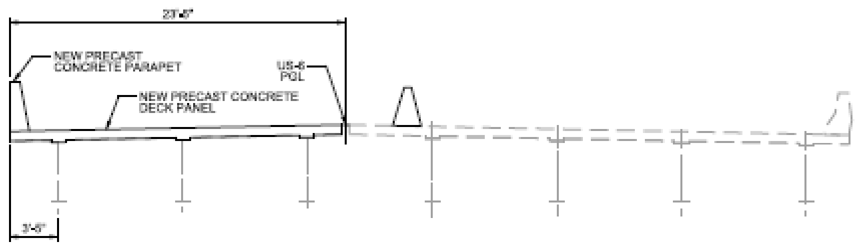


Figure 8. Diagram. Construction Phase I-B

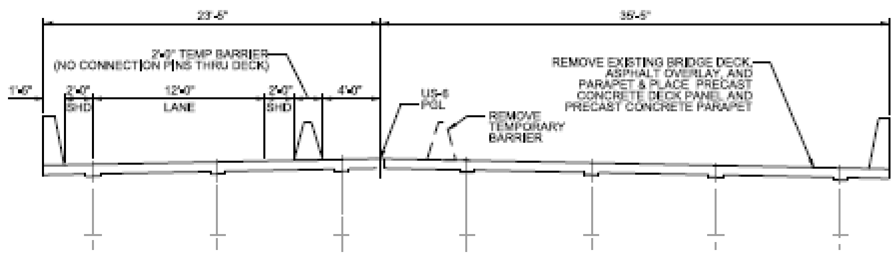


Figure 9. Diagram. Construction Phase II-A

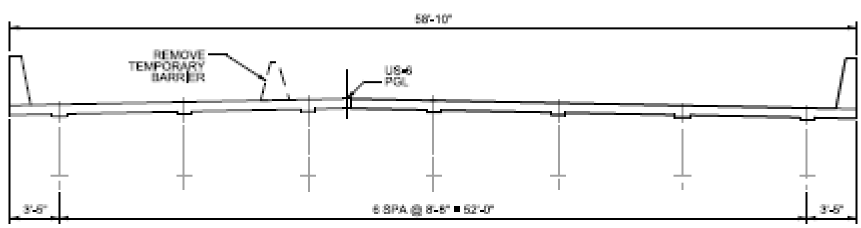


Figure 10. Diagram. Construction Phase II-B

Differential Deflection

To address differential deflection as a result of the phased construction and the need to pour the longitudinal deck closure joint under live load, UDOT modeled the effect of the live load with respect to anticipated deflection. This was primarily because there was no opportunity to support girders from below since there was a railroad crossing underneath. For the initial set of UHPC, UDOT considered the following options:

1. 24-hour closure of the structure, with a detour route for all vehicles.
2. Detouring of all trucks over 10,000 pounds for a 24-hour period, while maintaining Phase II traffic control.
3. Adding a Phase III with one-way, one-lane signalized traffic to allow all the vehicles to be moved as far as possible from the longitudinal joint.

The 24-hour closure option was not considered feasible, as the traffic had to be maintained during all times. UDOT decided to implement the second option.

Design Detailing

As a result of the geometrics of the structure and the panel layout to accommodate the phased construction, UDOT ended up with a variety of joints, including longitudinal deck joints (between girders, over girders, and within the approach slab), transverse deck joints, approach slab-deck joints, and approach slab joints. Figure 11 presents an image of the transverse deck joint.

Figure 11. Photo. Transverse Deck Joint. (courtesy: UDOT)

One of the major challenges that UDOT faced was the width of the longitudinal closure pour joint. Per design, the joint was supposed to be 6 inches wide. However, because of the existing girder locations and panel fabrication tolerances, the maintenance of a 6-inch joint width was difficult. The transverse and longitudinal joints, and associated closure pours, between the precast deck panels were filled with UHPC (see Figure 12).

Measurement and Payment

UDOT had multiple pay items for each type of joint to avoid any contention in the field on quantification of waste in the mixer or buggies, leaks, or blowouts.

Environmental Impact

The project was environmentally processed as a Categorical Exclusion (CATEX).

Figure 12. Photo. Longitudinal deck joint after being filled with UHPC. (courtesy: UDOT)

Buy America Waiver

At the time of the planning and construction of this project there were no domestic suppliers of the steel fibers. UDOT applied for a Buy America waiver to use the reinforcing steel fibers provided by suppliers outside the US. The request and a computer screen shot of the waiver information are provided in the appendix.

Bidding Information

Three bids were received for this project; the winning bid was $2,648,533.25. Table 4 presents a bid comparison summary.

Table 4. Bid comparison summary.

Bidder	Bid Amount	% of Engineer's Estimate
Engineer's Estimate	$2,605,660.40	-
Granite Construction Company	$2,648,533.25	101.65%
Gerber Construction, Inc.	$2,743,408.97	103.58%
Dry Creek Structures LLC	$2,965,230.50	108.09%

Project Schedule Information

Construction started in June 2014 and was completed in September 2014. A detailed project schedule is provided in the appendix.

Lessons Learned

Through this project, UDOT gained valuable insights with regard to the innovative construction techniques and materials used. Following are some of the lessons learned:

Design

- There is a need to develop a performance-based mix design with owner-performed testing and acceptance.
- During design, when laying out the panels, it would be good to consider locations to block off pours to easily isolate the pours during construction.
- There is a need to look at the use of post-tensioning and UHPC in combination.
- The use of regular grout in haunch and block outs needs to be considered.
- The noncontact lap splice needs to be defined.

Construction

- Field demonstration was valuable on this project and is expected to help on future projects.
- There was a lot of complexity with the joints between the deck and abutment. The joints were difficult to form, and with the skew, the joints were very long and difficult to block off to isolate pours. UDOT is of the opinion that the joints should be simplified as much as possible on the future projects.
- The longitudinal closure joint needs to be sized up to handle construction tolerances.
- Differential deflection of the joint under live loads needs to be evaluated.

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:

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

The following subsections provide additional information on the 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.

There were no worker injuries reported during the construction period. Thus, the contractor exceeded the HfL goal for worker safety (incident rate of less than 4.0 based on the OSHA 300 rate).

There was one work zone related crash/motorist injury during construction. However, the crash was unrelated to the work zone features or the work done during construction.

TRAFFIC TIME

Although no travel time data was collected during construction, UDOT estimated the queuing time on the project site to be around 4-5 minutes.

CONSTRUCTION CONGESTION

Accelerated, phased construction allowed UDOT to maintain two lanes of traffic to operate on half of the bridge while the other half was being demolished and reconstructed. The traffic was re-routed to the newly constructed half of the bridge while demolition and construction continued on the remaining half of the bridge. This process enabled the continued use of the structure without requiring any bridge closures and disruption to traffic.

CONSTRUCTION COSTS

The total funding on this project was $3,059,468, and project expenditures totaled $2,891,688. A breakdown of the project costs is provided in table 5.

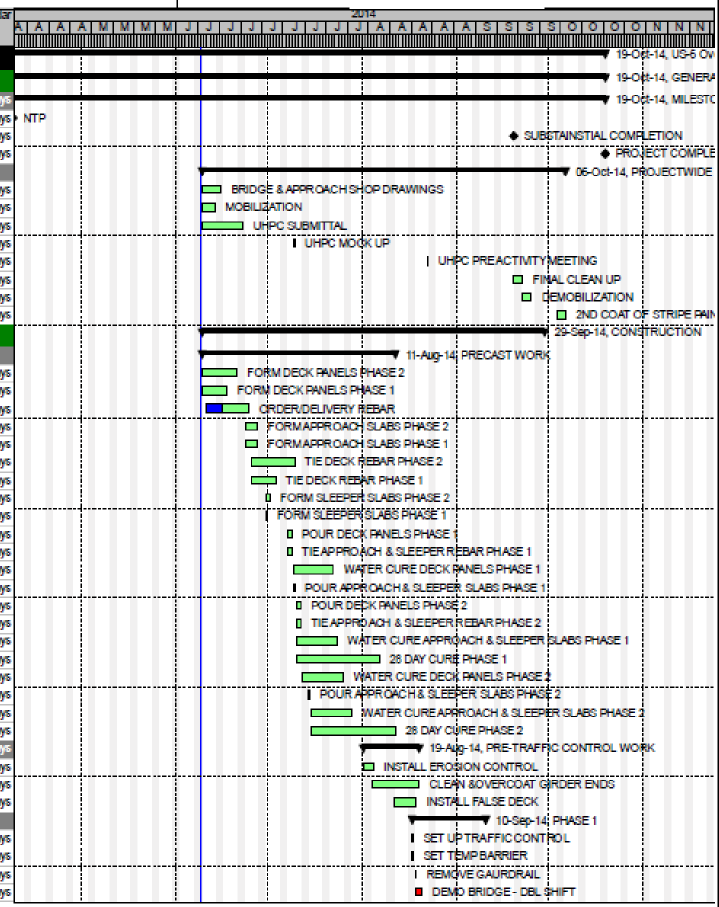
Table 5. Project costs.

Project Phase	**Expenditure**
Concept Development	$0
Construction Management	$168,356
Construction	$2,258,102
Environmental	$0
Preliminary Engineering	$409,085
Right of Way	$0
Utilities	$53,906
Miscellaneous	$2,240
Non-Phase	$0
Total Project Expenditures	**$2,891,688**

APPENDIX

US-6 Over RR; Sp. Fork - 0C679

Activity ID	Activity Name	OD	Start	Finish	Total Float	Calendar
US-6 Over RR; Sp. Fork - 0C679		195.00	08-Apr-14 A	19-Oct-14	0.00	
GENERAL		195.00	08-Apr-14 A	19-Oct-14	0.00	
MILESTONES		195.00	08-Apr-14 A	19-Oct-14	0.00	us6 7D w/o Holidays
G-M-1000	NTP	0.00	08-Apr-14 A			us6 7D w/o Holidays
G-M-1010	SUBSTAINSTIAL COMPLETION	0.00		19-Sep-14	0.00	us6 7D w/o Holidays
G-M-1020	PROJECT COMPLETION	0.00		19-Oct-14	0.00	us6 7D w/o Holidays
PROJECTWIDE		120.00	09-Jun-14	06-Oct-14	11.00	
G-P-1040	BRIDGE & APPROACH SHOP DRAWINGS	7.00	09-Jun-14	15-Jun-14	14.00	us6 7D w/o Holidays
G-P-1000	MOBILIZATION	5.00	09-Jun-14	13-Jun-14	42.00	us6 5D w/Holidays
G-P-1050	UHPC SUBMITTAL	14.00	09-Jun-14	22-Jun-14	13.00	us6 7D w/o Holidays
G-P-1060	UHPC MOCK UP	1.00	09-Jul-14	09-Jul-14	13.00	us6 7D w/o Holidays
G-P-1070	UHPC PRE ACTIVITY MEETING	1.00	22-Aug-14	22-Aug-14	0.00	us6 5D w/Holidays
G-P-1010	FINAL CLEAN UP	1.00	19-Sep-14	22-Sep-14	16.13	us6 5D w/Holidays
G-P-1020	DEMOBILIZATION	3.00	22-Sep-14	25-Sep-14	16.13	us6 5D w/Holidays
G-P-1030	2ND COAT OF STRIPE PAINT	1.00	03-Oct-14	06-Oct-14	9.13	us6 5D w/Holidays
CONSTRUCTION		113.00	09-Jun-14 A	29-Sep-14	3.00	
PRECAST WORK		64.00	09-Jun-14 A	11-Aug-14	26.00	
C-PW-1100	FORM DECK PANELS PHASE 2	10.00	09-Jun-14	20-Jun-14	24.00	us6 5D w/Holidays
C-PW-1000	FORM DECK PANELS PHASE 1	7.00	09-Jun-14	17-Jun-14	14.00	us6 5D w/Holidays
C-PW-1200	ORDER/DELIVERY REBAR	10.00	11-Jun-14 A	24-Jun-14	10.00	us6 5D w/Holidays
C-PW-1120	FORM APPROACH SLABS PHASE 2	5.00	23-Jun-14	27-Jun-14	24.00	us6 5D w/Holidays
C-PW-1040	FORM APPROACH SLABS PHASE 1	5.00	23-Jun-14	27-Jun-14	14.00	us6 5D w/Holidays
C-PW-1110	TIE DECK REBAR PHASE 2	10.00	25-Jun-14	09-Jul-14	17.00	us6 5D w/Holidays
C-PW-1020	TIE DECK REBAR PHASE 1	7.00	25-Jun-14	03-Jul-14	10.00	us6 5D w/Holidays
C-PW-1130	FORM SLEEPER SLABS PHASE 2	2.00	30-Jun-14	01-Jul-14	24.00	us6 5D w/Holidays
C-PW-1050	FORM SLEEPER SLABS PHASE 1	1.00	30-Jun-14	30-Jun-14	14.00	us6 5D w/Holidays
C-PW-1010	POUR DECK PANELS PHASE 1	2.00	07-Jul-14	08-Jul-14	11.00	us6 5D w/Holidays
C-PW-1090	TIE APPROACH & SLEEPER REBAR PHASE 1	2.00	07-Jul-14	08-Jul-14	10.00	us6 5D w/Holidays
C-PW-1030	WATER CURE DECK PANELS PHASE 1	14.00	09-Jul-14	22-Jul-14	15.00	us6 7D w/o Holidays
C-PW-1060	POUR APPROACH & SLEEPER SLABS PHASE 1	1.00	09-Jul-14	09-Jul-14	10.00	us6 5D w/Holidays
C-PW-1160	POUR DECK PANELS PHASE 2	2.00	10-Jul-14	11-Jul-14	18.00	us6 5D w/Holidays
C-PW-1140	TIE APPROACH & SLEEPER REBAR PHASE 2	2.00	10-Jul-14	11-Jul-14	17.00	us6 5D w/Holidays
C-PW-1070	WATER CURE APPROACH & SLEEPER SLABS PHASE 1	14.00	10-Jul-14	23-Jul-14	14.00	us6 7D w/o Holidays
C-PW-1080	28 DAY CURE PHASE 1	28.00	10-Jul-14	06-Aug-14	14.00	us6 7D w/o Holidays
C-PW-1180	WATER CURE DECK PANELS PHASE 2	14.00	12-Jul-14	25-Jul-14	29.00	us6 7D w/o Holidays
C-PW-1150	POUR APPROACH & SLEEPER SLABS PHASE 2	1.00	14-Jul-14	14-Jul-14	17.00	us6 5D w/Holidays
C-PW-1170	WATER CURE APPROACH & SLEEPER SLABS PHASE 2	14.00	15-Jul-14	28-Jul-14	26.00	us6 7D w/o Holidays
C-PW-1190	28 DAY CURE PHASE 2	28.00	15-Jul-14	11-Aug-14	26.00	us6 7D w/o Holidays
PRE-TRAFFIC CONTROL WORK		13.00	01-Aug-14	19-Aug-14	0.00	us6 5D w/Holidays
C-TC-1020	INSTALL EROSION CONTROL	2.00	01-Aug-14*	04-Aug-14	0.00	us6 5D w/Holidays
C-TC-1010	CLEAN &OVERCOAT GIRDER ENDS	12.00	04-Aug-14	19-Aug-14	0.00	us6 5D w/Holidays
C-TC-1000	INSTALL FALSE DECK	6.00	11-Aug-14	18-Aug-14	0.00	us6 5D w/Holidays
PHASE 1		25.00	17-Aug-14	10-Sep-14	7.00	
C-P1-1000	SET UP TRAFFIC CONTROL	1.00	17-Aug-14*	17-Aug-14	0.00	us6 7D w/Holidays
C-P1-1010	SET TEMP BARRIER	1.00	17-Aug-14	17-Aug-14	0.00	us6 7D w/Holidays
C-P1-1180	REMOVE GAURDRAIL	1.00	18-Aug-14	18-Aug-14	2.00	us6 7D w/Holidays
C-P1-1020	DEMO BRIDGE - DBL SHIFT	3.00	18-Aug-14	20-Aug-14	0.00	us6 7D w/Holidays



Remaining Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | Summary

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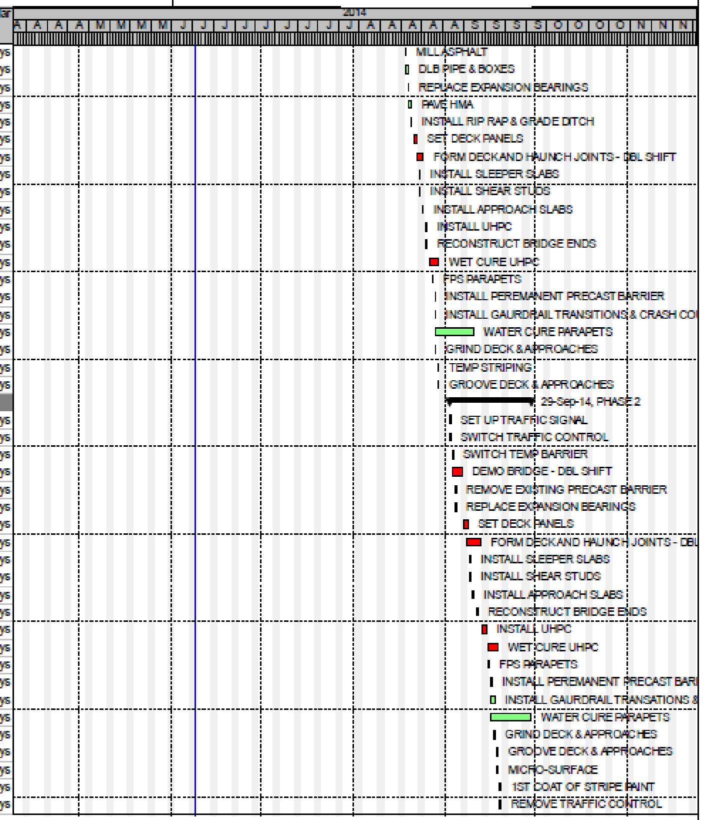
Figure 13. Chart. Project schedule.

US-6 Over RR; Sp. Fork - 0C679

GRANITE

Activity ID	Activity Name	OD	Start	Finish	Total Float	Calendar
C-P1-1120	MILL ASPHALT	1.00	18-Aug-14	18-Aug-14	25.00	us6 7D w/Holidays
C-P1-1150	DLB PIPE & BOXES	2.00	18-Aug-14	19-Aug-14	9.00	us6 7D w/Holidays
C-P1-1030	REPLACE EXPANSION BEARINGS	1.00	19-Aug-14	19-Aug-14	1.00	us6 7D w/Holidays
C-P1-1130	PAVE HMA	2.00	19-Aug-14	20-Aug-14	25.00	us6 7D w/Holidays
C-P1-1160	INSTALL RIP RAP & GRADE DITCH	1.00	20-Aug-14	20-Aug-14	9.00	us6 7D w/Holidays
C-P1-1040	SET DECK PANELS	2.00	21-Aug-14	22-Aug-14	0.00	us6 7D w/Holidays
C-P1-1050	FORM DECK AND HAUNCH JOINTS - DBL SHIFT	3.00	22-Aug-14	24-Aug-14	0.00	us6 7D w/Holidays
C-P1-1060	INSTALL SLEEPER SLABS	1.00	23-Aug-14	23-Aug-14	0.00	us6 7D w/Holidays
C-P1-1140	INSTALL SHEAR STUDS	1.00	23-Aug-14	23-Aug-14	1.00	us6 7D w/Holidays
C-P1-1070	INSTALL APPROACH SLABS	1.00	24-Aug-14	24-Aug-14	0.00	us6 7D w/Holidays
C-P1-1080	INSTALL UHPC	1.00	25-Aug-14	25-Aug-14	0.00	us6 7D w/Holidays
C-P1-1110	RECONSTRUCT BRIDGE ENDS	1.00	25-Aug-14	25-Aug-14	4.00	us6 7D w/Holidays
C-P1-1090	WET CURE UHPC	4.00	26-Aug-14	29-Aug-14	0.00	us6 7D w/o Holidays
C-P1-1100	FPS PARAPETS	1.00	27-Aug-14	27-Aug-14	1.00	us6 7D w/Holidays
C-P1-1190	INSTALL PEREMANENT PRECAST BARRIER	1.00	28-Aug-14	28-Aug-14	1.00	us6 7D w/Holidays
C-P1-1200	INSTALL GAURDRAIL TRANSITIONS & CRASH COUSHINS	1.00	28-Aug-14	28-Aug-14	1.00	us6 7D w/Holidays
C-P1-1210	WATER CURE PARAPETS	14.00	28-Aug-14	10-Sep-14	4.00	us6 7D w/o Holidays
C-P1-1170	GRIND DECK & APPROACHES	1.00	28-Aug-14	28-Aug-14	0.00	us6 7D w/Holidays
C-P1-1220	TEMP STRIPING	1.00	29-Aug-14	29-Aug-14	0.00	us6 7D w/Holidays
C-P1-1230	GROOVE DECK & APPROACHES	1.00	29-Aug-14	29-Aug-14	0.00	us6 7D w/Holidays
PHASE 2		28.00	02-Sep-14	29-Sep-14	3.00	
C-P2-1220	SET UP TRAFFIC SIGNAL	1.00	02-Sep-14	02-Sep-14	0.00	us6 7D w/Holidays
C-P2-1000	SWITCH TRAFFIC CONTROL	1.00	02-Sep-14	02-Sep-14	0.00	us6 7D w/Holidays
C-P2-1010	SWITCH TEMP BARRIER	1.00	03-Sep-14	03-Sep-14	0.00	us6 7D w/Holidays
C-P2-1020	DEMO BRIDGE - DBL SHIFT	4.00	03-Sep-14	06-Sep-14	0.00	us6 7D w/Holidays
C-P2-1170	REMOVE EXISTING PRECAST BARRIER	1.00	04-Sep-14	04-Sep-14	12.00	us6 7D w/Holidays
C-P2-1030	REPLACE EXPANSION BEARINGS	1.00	04-Sep-14	04-Sep-14	2.00	us6 7D w/Holidays
C-P2-1040	SET DECK PANELS	2.00	07-Sep-14	08-Sep-14	0.00	us6 7D w/Holidays
C-P2-1050	FORM DECK AND HAUNCH JOINTS - DBL SHIFT	5.00	08-Sep-14	12-Sep-14	0.00	us6 7D w/Holidays
C-P2-1060	INSTALL SLEEPER SLABS	1.00	09-Sep-14	09-Sep-14	2.00	us6 7D w/Holidays
C-P2-1130	INSTALL SHEAR STUDS	1.00	09-Sep-14	09-Sep-14	3.00	us6 7D w/Holidays
C-P2-1070	INSTALL APPROACH SLABS	1.00	10-Sep-14	10-Sep-14	2.00	us6 7D w/Holidays
C-P2-1110	RECONSTRUCT BRIDGE ENDS	1.00	11-Sep-14	11-Sep-14	6.00	us6 7D w/Holidays
C-P2-1080	INSTALL UHPC	2.00	13-Sep-14	14-Sep-14	0.00	us6 7D w/Holidays
C-P2-1090	WET CURE UHPC	4.00	15-Sep-14	18-Sep-14	0.00	us6 7D w/o Holidays
C-P2-1100	FPS PARAPETS	1.00	15-Sep-14	15-Sep-14	1.00	us6 7D w/Holidays
C-P2-1180	INSTALL PEREMANENT PRECAST BARRIER	1.00	16-Sep-14	16-Sep-14	1.00	us6 7D w/Holidays
C-P2-1190	INSTALL GAURDRAIL TRANSATIONS & CRASH COUSHINS	2.00	16-Sep-14	17-Sep-14	1.00	us6 7D w/Holidays
C-P2-1200	WATER CURE PARAPETS	14.00	16-Sep-14	29-Sep-14	3.00	us6 7D w/o Holidays
C-P2-1140	GRIND DECK & APPROACHES	1.00	17-Sep-14	17-Sep-14	0.00	us6 7D w/Holidays
C-P2-1150	GROOVE DECK & APPROACHES	1.00	18-Sep-14	18-Sep-14	1.00	us6 7D w/Holidays
C-P2-1120	MICRO-SURFACE	1.00	18-Sep-14	18-Sep-14	0.00	us6 7D w/Holidays
C-P2-1160	1ST COAT OF STRIPE PAINT	1.00	19-Sep-14	19-Sep-14	0.00	us6 7D w/Holidays
C-P2-1210	REMOVE TRAFFIC CONTROL	1.00	19-Sep-14	19-Sep-14	0.00	us6 7D w/Holidays



Remaining Level of Effort | Remaining Work | Milestone
Actual Work | Critical Remaining Work | Summary

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Figure 13. Chart. Project schedule.

U.S. Department of Transportation
Federal Highway Administration

Memorandum

Subject: **<u>ACTION</u>:** Buy America Waiver Request from Utah Department of Transportation for the Use of Ultra High Performance Concrete

Date: July 8, 2013

From: James C. Christian
Division Administrator
Salt Lake City, UT

In Reply Refer To:
HDA-UT

To: Edwin Okonkwo
Contract Administration Engineer - HIPA-30
Washington, DC

The Utah Department of Transportation (UDOT) is requesting a waiver of Buy America requirements to use Ultra High Performance Concrete (UHPC) containing steel reinforcing fibers that are not domestically produced. The UDOT proposes to use UHPC in closure pour connections on a bridge deck replacement project using precast deck panels. The project was selected by Highways for Life as a candidate for the use of this innovative product. Using UHPC will help overcome the challenges of replacing a bridge deck on a large skew, and allow for smaller closure pours and increased durability. The approval of this waiver will allow for the efficient and safe construction of a durable deck on a highly travelled route. Please see the attached waiver request and original Highways for Life application for more details.

The FHWA Utah Division Office recommends timely approval of the attached waiver request for the following reasons:

- The UHPC steel fibers are not currently produced domestically. Other waivers for the same product have been submitted and no domestic supplier has been secured.
- The project was selected from a number of applications as a worthy candidate for the use of this specific innovative material though the Highways for Life program.
- Failure to use UHPC on this project will jeopardize approved Highways for Life funding, and eliminate the opportunity for innovation.
- Using alternative materials on this project will limit the feasibility of accelerated construction, and potentially provide a less durable final product.

In order to fulfill the intent of the Highways for Life initiative and promote the use of this innovative product, and accommodate the scheduling and construction durability requirements of the project, UHPC must be used on this project.

Figure 14. Memo. Buy America waiver request.

www.gpo.gov/fdsys/pkg/FR-2013-10-24/html/2013-24974.htm

[Federal Register Volume 78, Number 206 (Thursday, October 24, 2013)]
[Notices]
[Page 63563]
From the Federal Register Online via the Government Printing Office [www.gpo.gov]
[FR Doc No: 2013-24974]

DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

Buy America Waiver Notification

AGENCY: Federal Highway Administration (FHWA), DOT.

ACTION: Notice.

SUMMARY: This notice provides information regarding the FHWA's finding that a Buy America waiver is appropriate for the use of 0.5 in. x 0.008 in. steel fibers with ultimate tensile strength of 290 ksi. in Ultra High Performance Concrete (UHPC) at the joints and closure pours between deck pours of a Federal-aid project; US-6 over D&RGW Railroad in Utah.

DATES: The effective date of the waiver is October 25, 2013.

FOR FURTHER INFORMATION CONTACT: For questions about this notice, please contact Mr. Gerald Yakowenko, FHWA Office of Program Administration, (202) 366-1562, or via email at gerald.yakowenko@dot.gov. For legal questions, please contact Mr. Michael Harkins, FHWA Office of the Chief Counsel, (202) 366-4928, or via email at michael.harkins@dot.gov. Office hours for the FHWA are from 8:00 a.m. to 4:30 p.m., e.t., Monday through Friday, except Federal holidays.

SUPPLEMENTARY INFORMATION:

Figure 15. Screen shot. Buy America waiver.

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 UDOT Project Manager Doug Bassett, Structures Design Manager Cheryl Hersh Simmons, Chief Structural Engineer Carmen Swanwick, and Public Involvement Coordinator Amalia Deslis, and FHWA Area Engineer Elizabeth Cramer, for their advice and assistance during this project. The team also thanks Granite Construction, the contractor on this project.