South Carolina Demonstration Project: Black River Bridge Replacements on SC 377 in Williamsburg County

Final Report
October 2011

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. “Innovations” is an inclusive term used by HfL to 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 decisionmakers 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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1. Report No.	2. Government Accession No	3. Recipient's Catalog No

3. Title and Subtitle
South Carolina Demonstration Project: Black River Bridge Replacements on SC 377 in Williamsburg County

5. Report Date
October 2011

6. Performing Organization Code

7. Authors
Jagannath Mallela, Gary Hoffman, P.E., R.L.S., Paul Littleton, P.E.

8. Performing Organization Report No.

9. Performing Organization Name and Address
Applied Research Associates, Inc.
100 Trade Centre Drive, Suite 200
Champaign, IL 61820

10. Work Unit No. (TRAIS) C6B

11. Contract or Grant No.

12. Sponsoring Agency Name and Address
Office of Infrastructure
Federal Highway Administration
1200 New Jersey Avenue, SE
Washington, DC 20590

13 Type of Report and Period Covered
Final Report
May 2007–October 2011

14. Sponsoring Agency Code

15. Supplementary Notes
Contracting Officers Technical Representatives: Byron Lord, Mary Huie

16. Abstract
As part of a national initiative sponsored by the Federal Highway Administration under the Highways for LIFE program, the South Carolina Department of Transportation (SCDOT) was awarded a $1 million grant to demonstrate the use of proven, innovative technologies for accelerated bridge replacement. This report documents the contracting methods and construction techniques used to replace four consecutive bridges over the Black River in Williamsburg County.

This report includes construction details of A+B+C contract bidding with built-in no-excuse incentives and precast bridge beams made with self-consolidating concrete used to replace the existing bridges rapidly, safely, and with less negative impact on the traveling public than using conventional construction methods.

Under conventional construction, the impact of this project on travelers was estimated at 28 months, but with the use of innovative contracting and construction methods, the impact was reduced to 14 months. This is a 50 percent reduction in the time required to complete the project. In addition, the contractor finished the bridge portion of the project in about 180 days, 185 days sooner than the maximum allowable time set by SCDOT or 50 percent sooner than projected.

Using innovative contracting techniques added an estimated $1.5 million to the initial construction cost of the project, compared with the trailing bid for this project. However, a more comprehensive economic analysis that included a closer look at the construction cost shows that the project potentially saved highway users about $6.9 million (or about 40 percent of the total $17.1 million project costs). Because of the success of this project, SCDOT plans to encourage project managers to apply these contracting methods to future projects.

17. Key Words
A+B+C contracting, Highways for LIFE, no-excuse incentives, performance-based contracting, prefabricated bridge elements and systems, self-consolidating concrete

18. Distribution Statement
No restriction. This document is available to the public through the National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

Security Classif.(of this report)	19. Security Classif. (of this page)	20. No. of Pages	21. Price
Unclassified	Unclassified	38	

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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 yard	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	milliliters	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 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 (metric tons)	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/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lb	pounds	4.45	Newtons	N
lb/in^2 (psi)	pounds 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	35.71	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 (metric tons)	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	Newtons	0.225	pounds	lb
kPa	kiloPascals	0.145	pounds per square inch	lb/in^2 (psi)
MPa	megaPascals	0.145	kips per square inch	k/in^2 (ksi)
		DENSITY		
kg/m^3	pounds per cubic foot	0.062	kilograms per cubic meter	lb/ft^3 (pcf)

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised September 1993)

ACKNOWLEDGMENTS

The project team would like to acknowledge the invaluable insights and guidance of Federal Highway Administration (FHWA) Highways for LIFE Team Leader Byron Lord and Program Coordinators Mary Huie and Kathleen Bergeron, 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 South Carolina Department of Transportation Engineers Jason Thompson, Randy Cannon, and Bener Amado for their tireless assistance and coordination during this project.

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ABBREVIATIONS AND SYMBOLS

AASHTO	American Association of State Highway and Transportation Officials
AADT	annual average daily traffic
dB(A)	A-weighted decibels
DOT	department of transportation
FHWA	Federal Highway Administration
HfL	Highways for LIFE
HMA	hot-mix asphalt
Hz	hertz
IRI	International Roughness Index
MDSHA	Maryland State Highway Authority
OBSI	onboard sound intensity
OSHA	Occupational Safety and Health Administration
PBES	prefabricated bridge elements and systems
RSA	road safety audit
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SCC	self-consolidating concrete
SCDOT	South Carolina Department of Transportation
SI	sound intensity
SRTT	standard reference test tire
USC	University of South Carolina
VOC	vehicle operating costs

INTRODUCTION

HIGHWAYS FOR LIFE DEMONSTRATION PROJECTS

The Highways for LIFE (HfL) pilot program, the Federal Highway Administration's (FHWA) initiative to accelerate innovation in the highway community, provides incentive funding for demonstration construction projects. Through these projects, the HfL program promotes and documents improvements in safety, construction-related congestion, and quality that can be achieved by setting performance goals and adopting innovations.

The HfL program—described in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU)—may provide incentives to a maximum of 15 demonstration projects a year. The funding amount may total up to 20 percent of the project cost, but not more than $5 million. Also, the Federal share for a HfL project may be up to 100 percent, thus waiving the typical State-match portion. At the State's request, a combination of funding and waived match may be applied to a project.

To be considered for HfL funding, a project must involve constructing, reconstructing, or rehabilitating a route or connection on an eligible Federal-aid highway. It must use innovative technologies, manufacturing processes, financing, or contracting methods that improve safety, reduce construction congestion, and enhance quality and user satisfaction. To provide a target for each of these areas, HfL has established demonstration project performance goals.

The performance goals emphasize the needs of highway users and reinforce the importance of addressing safety, congestion, user satisfaction, and quality in every project. The goals define the desired result while encouraging innovative solutions, raising the bar in highway transportation service and safety. User-based performance goals also serve as a new business model for how highway agencies can manage the highway project delivery process.

HfL project promotion involves showing the highway community and the public how demonstration projects are designed and built and how they perform. Broadly promoting successes encourages more widespread application of performance goals and innovations in the future.

Project Solicitation, Evaluation, and Selection

FHWA issued open solicitations for HfL project applications in fiscal years 2006, 2007, 2008, 2009 and 2010. State highway agencies submitted applications through FHWA Divisions. The HfL team reviewed each application for completeness and clarity, and contacted applicants to discuss technical issues and obtain commitments on project issues. Documentation of these questions and comments was sent to applicants, who responded in writing.

The project selection panel consisted of representatives of the FHWA offices of Infrastructure, Safety and Operations; the Resource Center Construction and Project Management team; the Division offices; and the HfL team. After evaluating and rating the applications and supplemental information, panel members convened to reach a consensus on the projects to recommend for approval. The panel gave priority to projects that accomplish the following:

- Address the HfL performance goals for safety, construction congestion, quality, and user satisfaction.
- 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.
- Include innovations that will change administration of the State's highway program to more quickly build long-lasting, high-quality, cost-effective projects that improve safety and reduce congestion.
- Will be ready for construction within 1 year of approval of the project application. For the HfL program, FHWA considers a project ready for construction when the FHWA Division authorizes it.
- Demonstrate the willingness of the applicant department of transportation (DOT) to participate in technology transfer and information dissemination activities associated with the project.

HfL Project Performance Goals

The HfL performance goals 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. States are encouraged to use all applicable goals on a project:

- **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 via 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 mile (mi) (0.8 kilometer (km)) in a rural area or less than 1.5 mi (2.4 km) 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 inches per mile.

    - 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-plus on a 7-point Likert scale.

REPORT SCOPE AND ORGANIZATION

This report documents the successful South Carolina Department of Transportation (SCDOT) HfL demonstration project, which involved replacing four consecutive bridges over the Black River and surrounding wetlands. The report presents project details relevant to the HfL program, including innovative contracting, prefabricated bridge beams made with self-consolidating concrete, construction highlights, HfL performance metrics measurement, and economic analysis. Technology transfer activities that took place during the project and lessons learned are also discussed.

PROJECT OVERVIEW AND LESSONS LEARNED

PROJECT OVERVIEW

The project site is located on South Carolina Highway 377 south of Kingstree, SC, in Williamsburg County. The project involved replacement of four structurally deficient bridges on SC 377, along with geometric modifications to the existing roadway and the intersection of SC 377 and U.S. 521.

The project begins at the intersection of U.S. 521 and SC 377 and stretches about 1.5 mi north toward Kingstree. The main Black River Bridge is 360 feet (ft) long, with six spans of 60 ft each. The other three bridges are 420 ft long each with 30-ft spans. In addition, all bridges were widened to 44 ft from an existing width of 26 ft. The new bridges were built with staged construction alongside the existing bridges without significant traffic stoppage. The intersection of U.S. 521 and SC 377 was also improved as part of this project. The geometric design included removal of Spur U.S. 521 and other geometric modifications. The 2006 average daily traffic passing over the bridges on SC 377 was 3,000 with 6 percent commercial truck traffic. Because the existing bridges, built in 1955, were structurally deficient, they were posted with weight limits and truck traffic was diverted 14 mi before the start of the project.

SCDOT determined that the main bridge had a sufficiency rating of only 10.8 percent (in which 100 is an entirely sufficient bridge and 0 is an entirely deficicient bridge) and the adjacent three bridges were in poor condition as well. SCDOT approached the highway corridor as a whole using route management concepts to support the decision to reconstruct the four bridges at the same time. This was done to limit construction impact to one event rather than three. Traditionally, multiple contracts would have been let at different times to reconstruct all the bridges. The main river bridge would have been replaced first. Two years later, the adjacent bridges would have been replaced and the safety enhancements at the intersection would have been included under one of the bridge reconstruction contracts.

This project presented an opportunity to integrate several innovations that decreased the project delivery time and increased the overall project value. The following is a summary of the project's innovative features.

Innovative A+B+C Contracting

Since time was of the essence in restoring truck traffic, a project-specific A+B+C bidding provision was developed to encourage the contractor to strive for the most efficient method to achieve the shortest possible construction time. This type of bidding provision has the following components:

- A is the total dollar amount for all of the work.
- B is calendar days bid for total contract time multiplied by the associated daily cost.
- C is the road closure time for trucks multiplied by the daily associated cost.

No-Excuse Incentives

A special contract provision specified a no-excuse incentive completion date, defined by the contractor's time bid from the winning A+B+C bid. The provision was developed for this project because truck traffic was detoured 14 mi due to the structural inadequacy of the existing bridges and it was imperative to eliminate the detour as soon as possible. The no-excuse incentive date could not be adjusted for any reason except a catastrophic event. The project was substantially finished by the no-excuse incentive completion date as defined in the contract, which entitled the contractor to the full incentive pay.

Performance-Based Contracting

SCDOT developed a new ride quality specification based on the IRI target value of 65 inches per mile for each 0.1 mi section of pavement. The IRI is measured according to SCDOT specification SC-T-125. Payment is based on the original contract unit price per ton of final asphalt surface tested plus a bonus according to a graduated scale for IRI values below 65 inches per mile and a penalty for values exceeding 65 inches per mile.

Self-Consolidating Concrete

Self-consolidating concrete (SCC) has excellent deformability and resistance to segregation, so it can be used in heavily reinforced formwork without difficulty and can result in high-quality smooth surfaces. SCDOT developed SCC mixes and special provisions with the University of South Carolina (USC) and a fabricator in order to use SCC in several bridge beams on this project.

HfL Performance Goals

Safety, construction congestion, quality, and user satisfaction data were collected before, during, and after construction to demonstrate that innovations can be deployed while simultaneously meeting the HfL performance goals in these areas:

- **Safety**
  - Work zone safety during construction—This project was successful in holding work zone-related crashes to only two during the construction period, which is below the preconstruction crash rate of 19 crashes per year over the past 6 years. SCDOT reported one vehicle crash in the work zone that resulted in a fatality. The crash was not related to construction and did not damage SCDOT property. The other work zone crash involved three cars, but no SCDOT property damage.
  - Worker safety during construction—During construction, no worker injuries were reported.
  - Facility safety after construction—Postconstruction safety will be documented to determine if a 20 percent reduction in fatalities and injuries in 3-year average crash rates is realized.

- **Construction Congestion**
  - Faster construction—By combining the three different contracts that would have been needed to reconstruct all of the bridges and the intersection under traditional contracting methods, SCDOT reduced the duration that highway users were impacted by more than 50 percent. Because of the way this contract was structured, the contractor worked on all bridges and the intersection at the same time, reducing the overall time spent on construction on SC 377. This is an example of using the route management concept to minimize the impact of work zones on the motoring public.
  - Trip time—SCDOT reported no noticeable passenger vehicle congestion during construction. This was largely because of the use of staged construction, which allowed traffic to flow freely on the original two-lane route configuration during nearly the entire project.
  - Queue length during construction—Queue length was not an issue because traffic flowed freely though the work zone.

- **Quality**
  - Smoothness and noise—The tire-pavement sound intensity (SI) values measured for the pavement surfaces showed that the new construction exceeded the goals set for the HfL program, although the average SI measured across the bridge decks was slightly higher than the HfL target value. However, the smoothness measurements for both the four bridges and pavement sections failed to meet the HfL goal and, in fact, the IRI values were more than double the HfL target value. While it is difficult to achieve a smooth bridge deck on relatively short spans, the pavement sections were noticeably rougher than expected and generated a few comments on the user satisfaction survey.
  - User satisfaction—Overall, highway users responded with positive feedback to both survey questions on their satisfaction with the methods used to minimize disruption during construction and with the end product. SCDOT obtained 51 responses to the user survey, and the results indicated no less than an equivalent 6.0 score on a 7.0 Likert scale, well above the HfL performance goal of a 4.0 score. Even though the overall opinion was one of satisfaction, some respondents commented that the finished highway was rough in localized sections, which is confirmed in the measured roughness values.

ECONOMIC ANALYSIS

The benefits and costs of this innovative project approach were compared with those of a project of similar size and scope with a more traditional delivery approach. The economic analysis indicates that SCDOT's innovative approach generated a cost savings of about $6.9 million or 40 percent of the total project cost over conventional construction practices. Construction efficiencies from combining the projects and reduced construction time had a significant impact on the cost savings.

LESSONS LEARNED

Throughout this project, SCDOT gained valuable insights on the innovative processes deployed, both those that were successful and those that need improvement on future projects.

Benefits of the contracting and construction innovations used on this project include the following:

- The A+B+C bidding process enabled the contractor to determine the time necessary to complete the project according to the contractor's own capabilities. Thus, the project was bid with a shortened construction timeframe, which allowed for a more competitive bid price.
- The A+B+C bidding process allowed the contractor to accelerate the construction schedule to complete phase I ahead of schedule. This was accomplished by rotating work crews and working up to 7 days a week. The incentive payment awarded to the contractor offset some of the overtime labor costs.
- SCC used in the bridge beams expedited casting and reduced the time and cost spent on patching honeycombing, which commonly occurs with standard concrete.
- The contractor noticed little difference in handling the finished beams.

Areas needing improvement include the following:

- A drawback of this accelerated schedule was that materials and deliveries were not always available, plus construction crews and SCDOT inspectors had to work on weekends. In addition, SCDOT engineers use a 5-day calendar when making approvals and decisions, not a 7-day calendar, which was needed to keep up with the contractor.
- Demands on labor sometimes overlapped and slowed production.
- Most utility companies operate on normal work schedules, which caused scheduling conflicts with the contractor's accelerated project schedule.
- Curing time for cast-in-place bridge members sometimes slowed progress and conflicted with the accelerated construction schedule.

CONCLUSIONS

This project achieved a high level of quality and was brought to completion quickly and with relative safety as a direct result of innovative contracting and construction methods. Lessons learned about A+B+C contracting will be beneficial on future SCDOT bridge projects.

PROJECT DETAILS

BACKGROUND

This project is located about 4 mi south of Kingstree in Williamsburg County, SC. The project consisted of replacing four reinforced concrete bridges and realigning and improving the intersection of U.S. 521 and SC 377. The four bridges include the main bridge over the Black River and three overflow bridges over adjacent swamps. The bridges, about 52 years old, were found to be structurally deficient. Figure 1 is a map showing the general location of the project. Figure 2 is a schematic of the project.

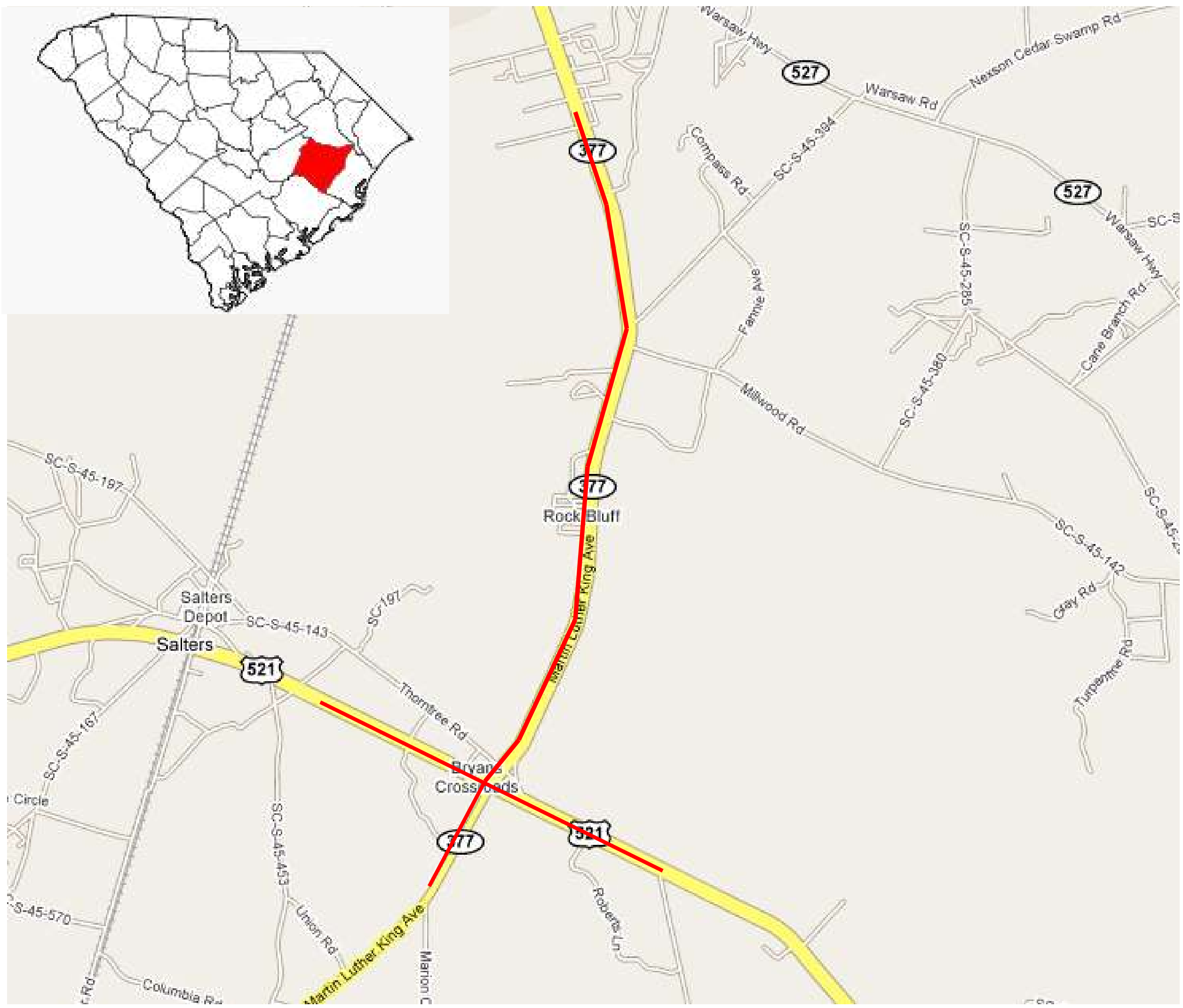


Figure 1. South Carolina HfL project location.

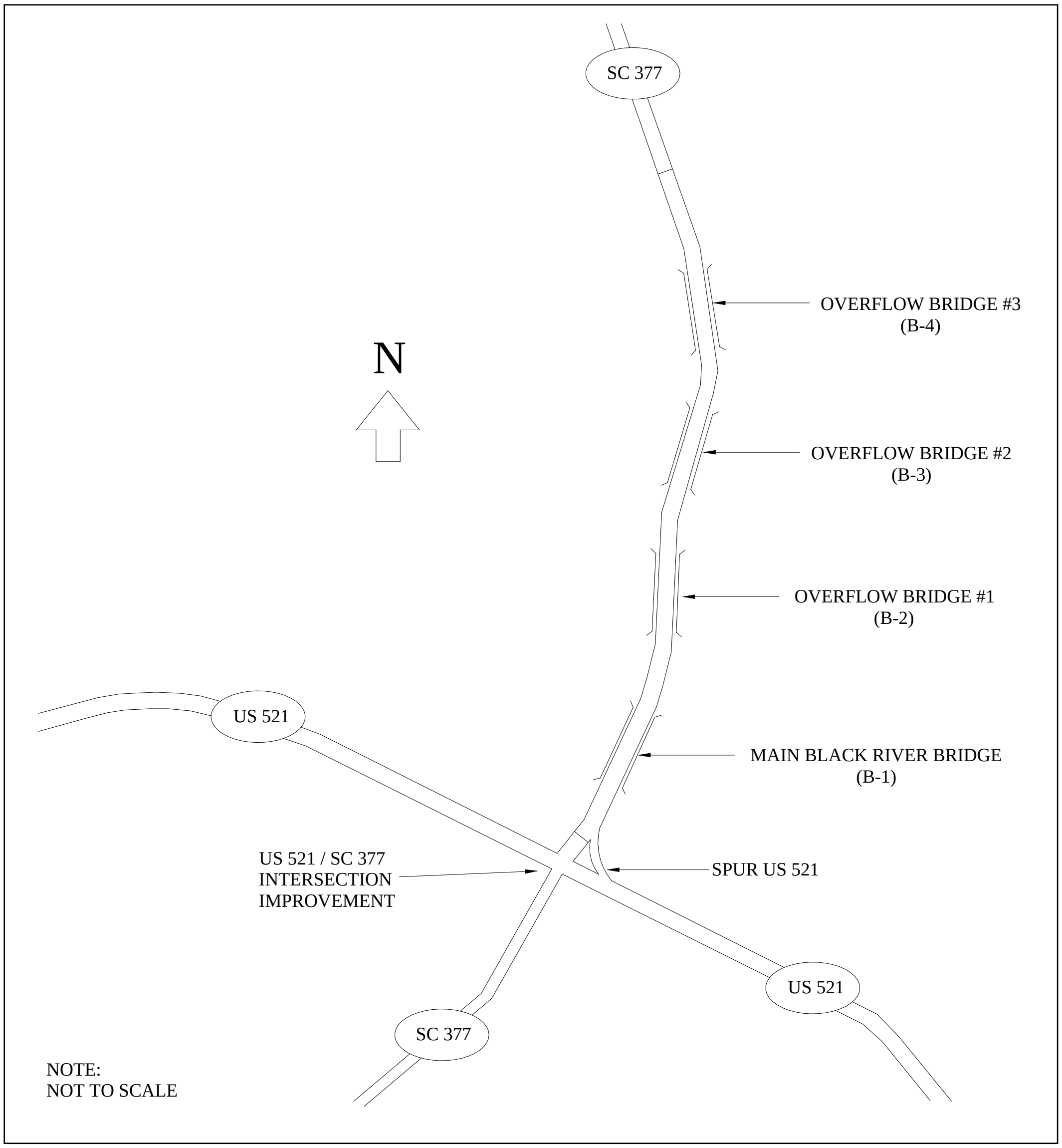


Figure 2. Schematic of project layout.

The 2006 annual average daily traffic (AADT) for the four highway sections in the project area was as follows:

- 2,100 on U.S. 521 west of SC 377
- 3,000 on U.S. 521 east of SC 377
- 800 on SC 377 south of U.S. 521
- 3,000 on SC 377 north of U.S. 521

Commercial vehicles comprised 6 percent of the AADT. Table 1 lists details of the four replacement bridges and table 2 lists details of the highway and intersection improvement work.

Table 1. Bridge details.

Bridge No.	Description	Length (ft)	No. of Spans	Type
B-1	Main Black River Bridge	360	6	Prestressed concrete and reinforced concrete
B-2	Overflow Bridge 1	420	14	Reinforced concrete
B-3	Overflow Bridge 2	420	14	Reinforced concrete
B-4	Overflow Bridge 3	420	14	Reinforced concrete

Table 2. Road and bridge details.

	SC 377 (mi)	U.S. 521 (mi)	Miscellaneous Roads (mi)	Total (mi)
Net length of roadway	1.200	0.450	0.071	1.721
Net length of bridges	0.307	--	--	0.307
Net length of project	1.507	0.450	0.071	2.028

PROJECT DESCRIPTION

The Black River bridges carry SC 377, a two-lane rural highway, over the Black River and adjacent wetlands near the town of Kingstree in Williamsburg County, SC. The bridges were built in 1955 with reinforced concrete and a substructure consisting predominantly of steel piles. Over the years, significant deterioration and corrosion of the steel piles was noticed. SCDOT survey results indicated the main bridge over the river was structurally deficient (with a sufficiency rating of 10.8 percent out of 100 percent). In September 2003, this bridge was posted for a load restriction for trucks of 3 tons per axle or 5 tons gross weight.

The surrounding community is rural and a majority of the truck traffic using this route carries agricultural goods and timber. After the bridge was posted for load restrictions, truck traffic was switched to a detour (figure 3) of about 14 mi. Passenger vehicles also were detoured for 5 days to allow the contractor use of the full roadway. Figures 4 and 5 show the original Black River Bridge.

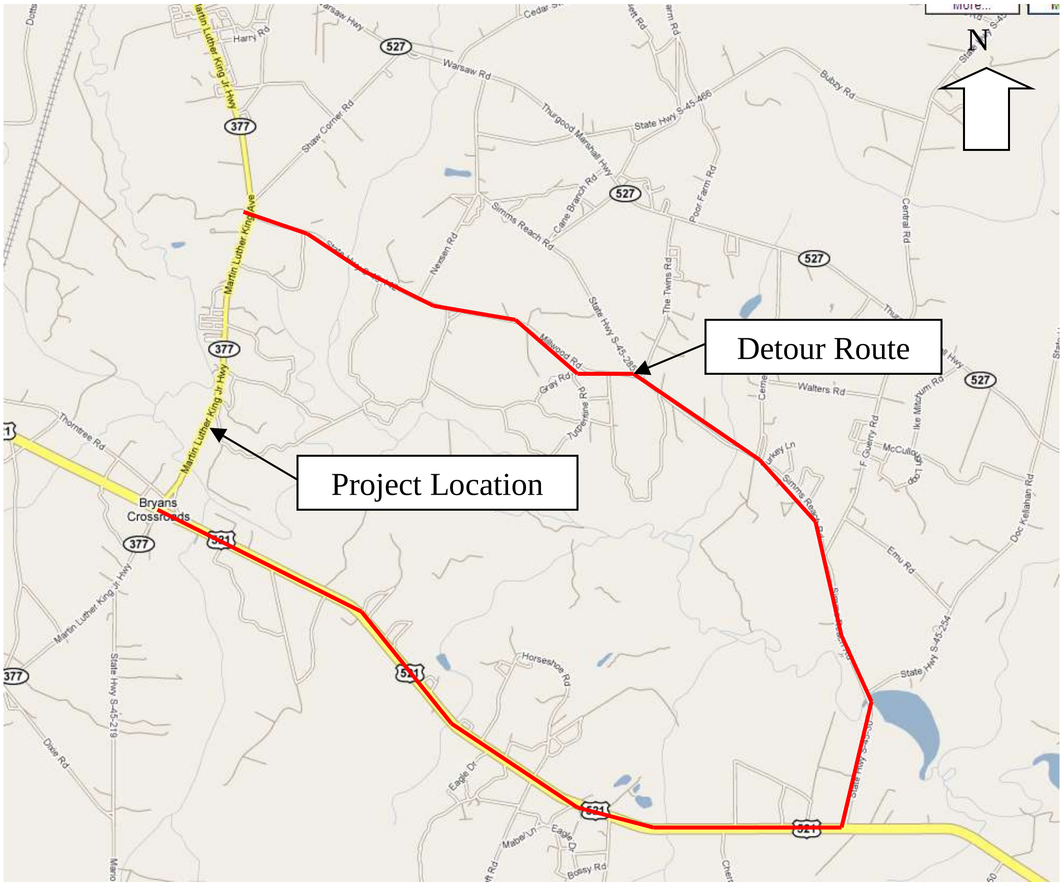


Figure 3. Detour route.

Figure 4. Original Black River Bridge.

The original bridge deck structure consisted of about 10 inches of reinforced concrete and was supported by steel beams. The steel beams rested on concrete pier caps supported by steel piers.

Figure 5. Black River Bridge pile detail.

About 0.5 mi from the main bridge is the intersection of U.S. 521 and SC 377. Reconstruction of this intersection included safety enhancements and geometric modification, such as additional widening and turn lanes to ensure smoother and safer traffic flow. Figure 6 shows the original intersection of U.S. 521 and SC 377, looking east on U.S. 521. Traffic at this intersection was controlled by stop signs and warning signals on SC 377.

Figure 6. Intersection of U.S. 521 and SC 377 before reconstruction.

Since this route is used frequently by local residents, a full closure of SC 377 to facilitate bridge replacement work would have included a long detour for all vehicles. An option would have been to build the new bridges next to the existing bridges. However, this option would have significantly impacted sensitive wetlands areas and increased the amount of roadwork involved in the project. Therefore, SCDOT decided to adopt a two-phase construction approach, which minimized the environmental footprint of the new bridges and kept lane closures to a minimum.

The HfL innovations adopted during the reconstruction of this project include the following:

- A+B+C contract bidding
- No-excuse incentives
- Performance-based contracting
- SCC in the bridge deck beams

Details of these innovations are discussed further in this document.

A+B+C Bidding

Given that time was of the essence in restoring truck traffic, SCDOT developed a project-specific A+B+C bidding provision to encourage the contractor to strive for efficient production methods and achieve the shortest possible construction time. The provision had the following components:

- A: Total dollar amount for all work
- B: Number of days—cost per day of $1,800—not to exceed 790 days
- C: Number of days until phase 1 is complete—cost per day of $9,000—not to exceed 365 days

Table 3 shows the results of the bidding process.

Table 3. A+B+C project bids.

A+B+C Bid	Winning Bid	Second
A portion	$14,251,451	$12,750,642
B portion	430 days x $1,800 = $774,000	700 days x $1,800 = $1,260,000
C portion	210 days x $9,000 = $1,890,000	335 days x $9,000 = $3,015,000
Overall Bid Total	$16,915,451	$17,025,642

Although the winning bid was $1.5 million more than the second bid, 270 days were saved on the final product. Of the total, 125 days were saved on phase 1 of the project. This project was awarded to the winning bidder, United Construction Inc. The total project cost, discussed in the "Economic Analysis" section of this report, takes into account the cost of the B and C portions of the contract plus incentives awarded to the contractor for early completion.

This type of a bidding process enabled the contractor to determine the time necessary to complete the project according to the contractor's capabilities. The project was bid with a shortened timeframe, which allowed for a more competitive bid price. With an accelerated timeframe to complete the project, contractor crews worked 7 days per week instead of 5. This was made possible by the availability of multiple crews and crew rotation. The incentive portion of the bid helped offset some of the costs of overtime pay. A drawback of this accelerated schedule was that materials and deliveries were not always available on weekends, plus construction crews and SCDOT inspectors had to work on weekends. In addition, SCDOT engineers use a 5-day calendar when making approvals and decisions.

No-Excuse Bonus

This special provision was included in the bid to attract bids with the shortest possible construction timeframe. According to this provision, the bonus or incentive was paid to the contractor only if the project was substantially completed before the deadline. This could not be adjusted for any reason except a catastrophic event. The no-excuse bonus was $9,000 for each day the contractor finished interim construction ahead of schedule. The bonus was restricted to 30 days ($270,000). By offering this bonus, the contractor was encouraged to complete the project ahead of schedule, reducing the duration of the truck detour.

Performance-Based Contracting

SCDOT developed a new ride quality specification with incentives. On this project, the maximum acceptable IRI for each nominal 0.1-mi segment of vehicle lane, when tested in accordance with SC-T-125, is 65 inches per mile. When initial measurements are 65 inches per mile or less, payment is based on the original contract unit price per ton of final hot-mix asphalt (HMA) surface tested, shown in table 4. The pay adjustments summarized in table 4 apply only to the surface course of HMA. The surface course was not as smooth as SCDOT required, and the contractor has milled and replaced several areas at its own expense.

Table 4. Adjusted pay schedule based on IRI.

Segment IRI (inches/mile)	Price adjustment—HMA final riding course
Less than 46	105%
46–50	103%
51–55	101%
56–65	100%
66–70	95%
71–75	90%
76–80	80%

Self-Consolidating Concrete

SCC is an innovative concrete product that has excellent deformability and resistance to segregation. It can be placed in heavily reinforced formwork without difficulty and can result in high-quality smooth surfaces. This project included the use of SCC in bridge beams for the first time in South Carolina. SCDOT, with the help of the fabricator and USC, developed an SCC mix and special provisions for its use in casting the bridge beams.

Since SCC is significantly more fluid than normal concrete and is more resistant to segregation, the concrete can flow more easily in a heavily reinforced structural cross-section. This fluidity reduces the potential for honeycombing in concrete. SCC proponents claim that the main advantage is a substantial reduction in labor hours and total production costs by using fewer workers to pour, vibrate, and finish the structural elements. Martin[1] determined the increase in material costs for SCC is about 17 percent, which can easily be offset by improvements in pouring productivity (about 47 percent) and reduction in vibrator and equipment maintenance costs. SCC also has a safety advantage because workers are not on top of the casting forms carrying vibrators and power cords, which are a tripping hazard during fabrication. The result is high-quality beams that should last longer than conventional cast beams and are fabricated with fewer workers.

Staged Construction—Phase 1

The prime contractor for this project was United Construction Inc. Several subcontractors were retained, including Goodson Construction and C&R Asphalt for the roadwork portion of the project. Phase 1 of the project consisted of constructing two-thirds of the width of the new bridges next to the existing bridges. The existing bridges were 26 ft wide, whereas the new bridges were 44 ft wide (two 12-ft-wide traffic lanes and 10-ft shoulders). Figure 7 shows a schematic of phase 1 construction of the main bridge. Figure 8 shows the profile and elevation of the main bridge.

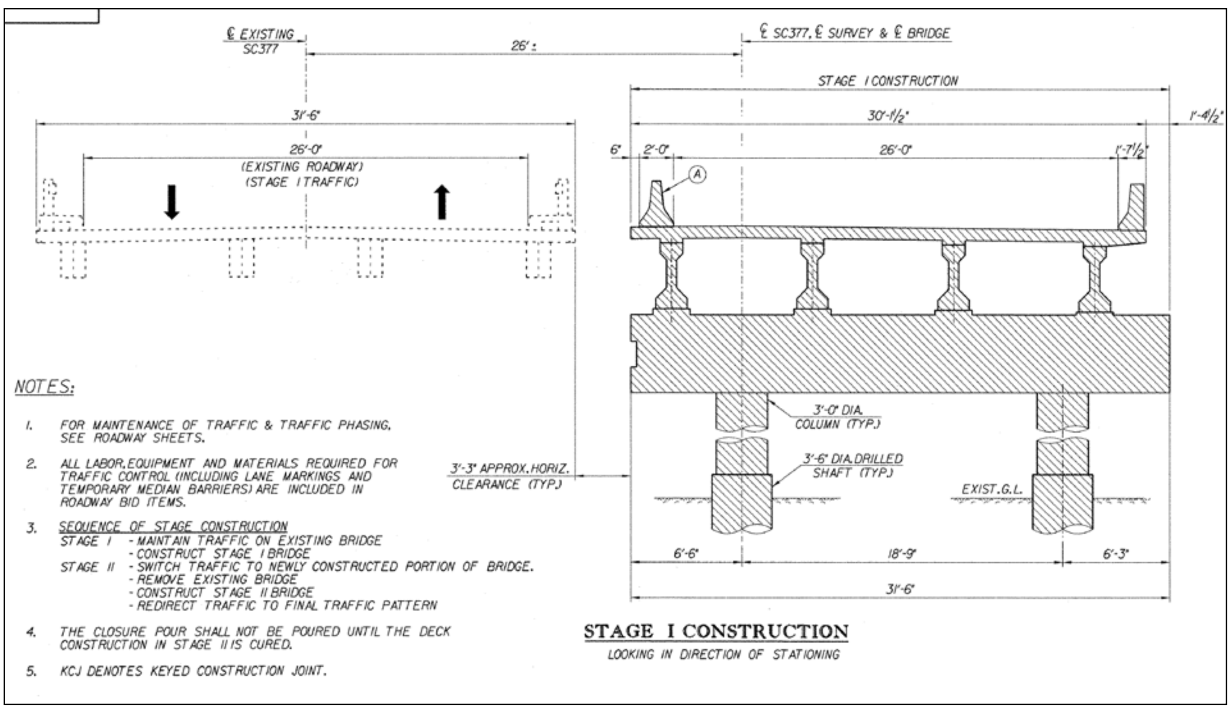
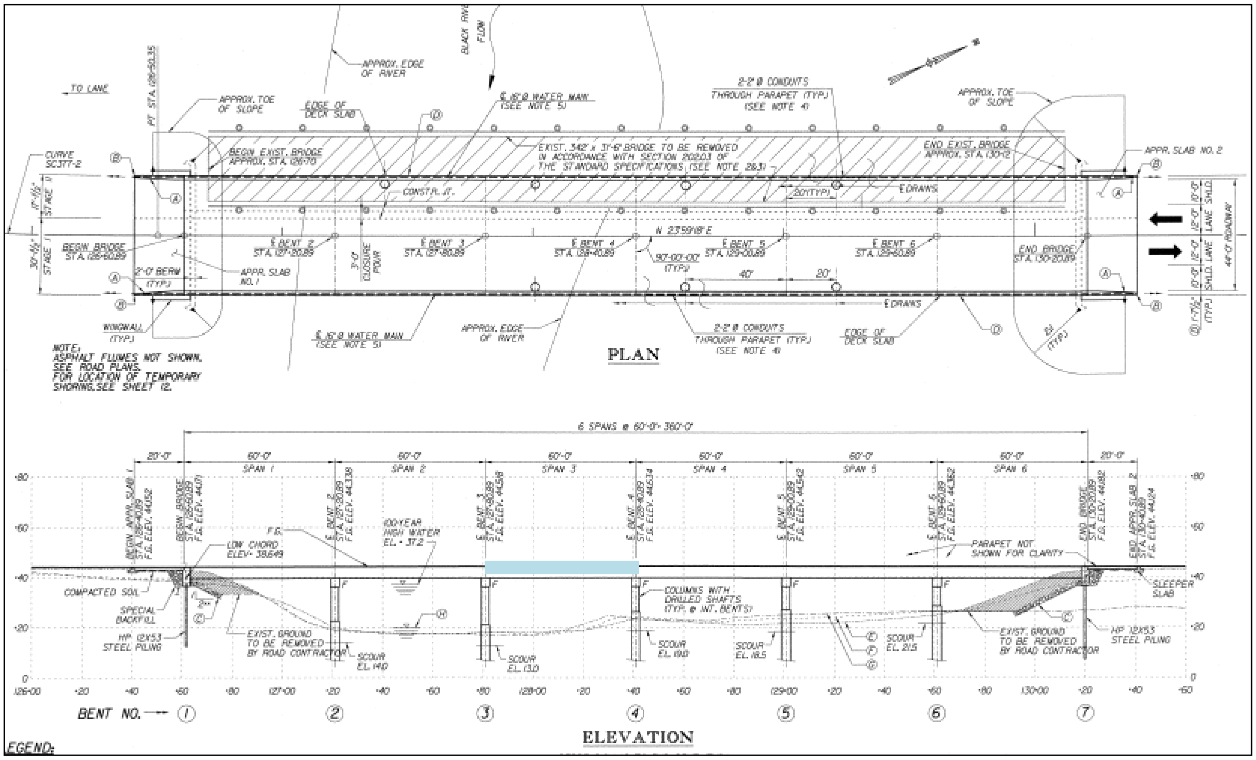


Figure 7. Phase 1 construction details.

Construction preparation began in late October 2007. The initial construction period for phase I was planned at 210 days. Light vehicle traffic was maintained on the existing bridges while construction was started. All truck traffic was maintained on the detour route during phase I.

[1] Martin, D., *Economic Impact of SCC in Precast Applications*, First North American Conference on the Design and Use of Self-Consolidating Concrete, Center for Advanced Cement-Based Materials, Northwestern University, Evanston, IL, 2002.



Note: Span 3 (shaded) has SCC beams.

Figure 8. Profile and elevation of Black River Bridge.

Bridge Beams Manufactured with Self-Consolidating Concrete

As mentioned earlier, this project included the first use of SCC bridge beams in South Carolina. SCDOT had a research contract with USC to develop SCC mixes and full-scale testing. The main objectives of this research were as follows:

- Increase research on full-scale bridge members.
- Evaluate the feasibility of using SCC in highway bridge structures.
- Evaluate fatigue endurance of prestressed concrete bridge beams.
- Address regional variation in concrete constituents.

USC performed full-scale testing on similar SCC and high-early-strength concrete beams in May 2006. Researchers found that comparable crack patterns and failure modes were obtained in both types of concrete beams under load testing. They concluded that SCC beams were a viable alternative to conventionally poured heavily reinforced concrete girders. A demonstration bridge project was planned to evaluate the feasibility of SCC beams in bridge construction.

The SC 377 project was chosen as the demonstration project for the use of SCC beams. The beams, prestressed AASHTO Type III bridge beams, were fabricated by Standard Concrete

Products Inc. of Savannah, GA, in March and April 2008. Figures 9 and 10 show the fabrication process.

Figure 9. Fabrication of SCC beams.

Figure 10. SCC beam pretension tendon detail.

Six SCC beams were fabricated for this project. As part of the research effort, four SCC beams were instrumented with strain gauges. USC has a contract to monitor the performance of SCC and conventional beams used in the project. Researchers installed the strain gauges and lead wires before SCC was poured into the forms (figure 11). On each instrumented SCC beam, two vibrating wire gauges were placed at the top and bottom of the beam at mid length. Temperature gauges were also installed.

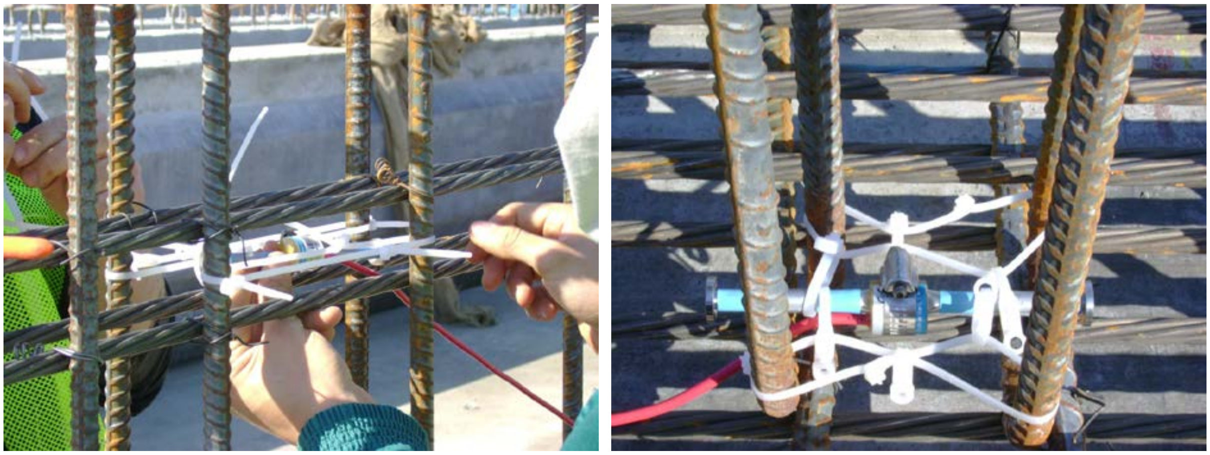


Figure 11. Strain gauge installation in SCC beams.

During fabrication, researchers measured the properties of fresh SCC. These tests included the SCC spread test, U-box test, L-box test, and air content (pressure method) test. The researchers cast several compressive strength test cylinders for further laboratory tests.

Construction of the Black River Bridge

After fabrication in Savannah, GA, the SCC and conventional beams were transported to the construction site by trucks. Construction of the Black River Bridge substructure began in April 2008. After the beams were set (figure 12), the contractor placed the formwork and plates for the bridge deck. The bridge deck concrete was poured on May 14. Figure 13 shows the completed phase I of the bridge.

Figure 12. Construction of Black River Bridge (Phase I).

Figure 13. Black River Bridge after phase I of construction.

The contractor completed construction of phase 1 30 days before the deadline and collected the full bonus ($9,000 x 30 days = $270,000). Construction on adjoining earthwork and roadwork between the four bridges was also in progress during this time.

For only 5 days, the road was closed through the work zone and all traffic was diverted to the detour route. This closure was necessary to tie in the adjacent roadwork to the new bridges. On June 12, 2008, the new phase I portion of the bridges and connecting highway pavement was reopened to all traffic, including trucks, and phase II of construction began.

Staged Construction—Phase II

Major construction activities during phase II include the following:

- Demolition of old bridges
- Construction of the remaining half of each bridge
- Removal of old asphalt pavement and repaving
- Intersection improvement at U.S. 521 and SC 377

Figure 14 shows the construction details in phase II. As seen in the figure, the shaded portion represents phase II construction of the new bridge (one-third width). The old bridge was demolished before construction commenced on phase II.

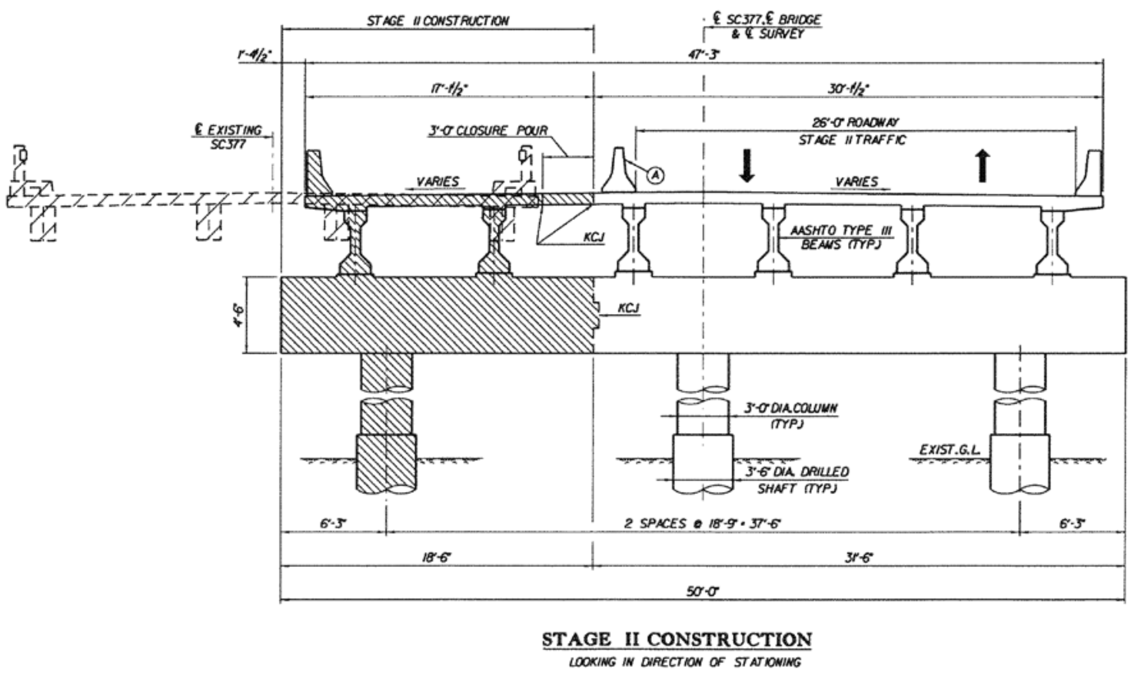


Figure 14. Phase II construction details.

Figure 15 shows the demolition of the main bridge. After all of the old bridges were demolished, construction was started on phase II. The initial project completion date was February 2009 with conventional construction methods, but the accelerated schedule accepted by SCDOT and the contractor called for a December 2008 completion date. As noted earlier, construction on this accelerated schedule was made possible by employing extra crews and working 7 days a week.

Figure 15. Demolition of the old Black River Bridge.

The bridges were ready for deck concrete placement in late September 2008. Bridge deck concrete was placed within the span of 1 week on all four bridges. Figure 16 shows phase II of construction. Figure 17 shows a typical completed section of the bridge.

Figure 16. Phase II of construction.

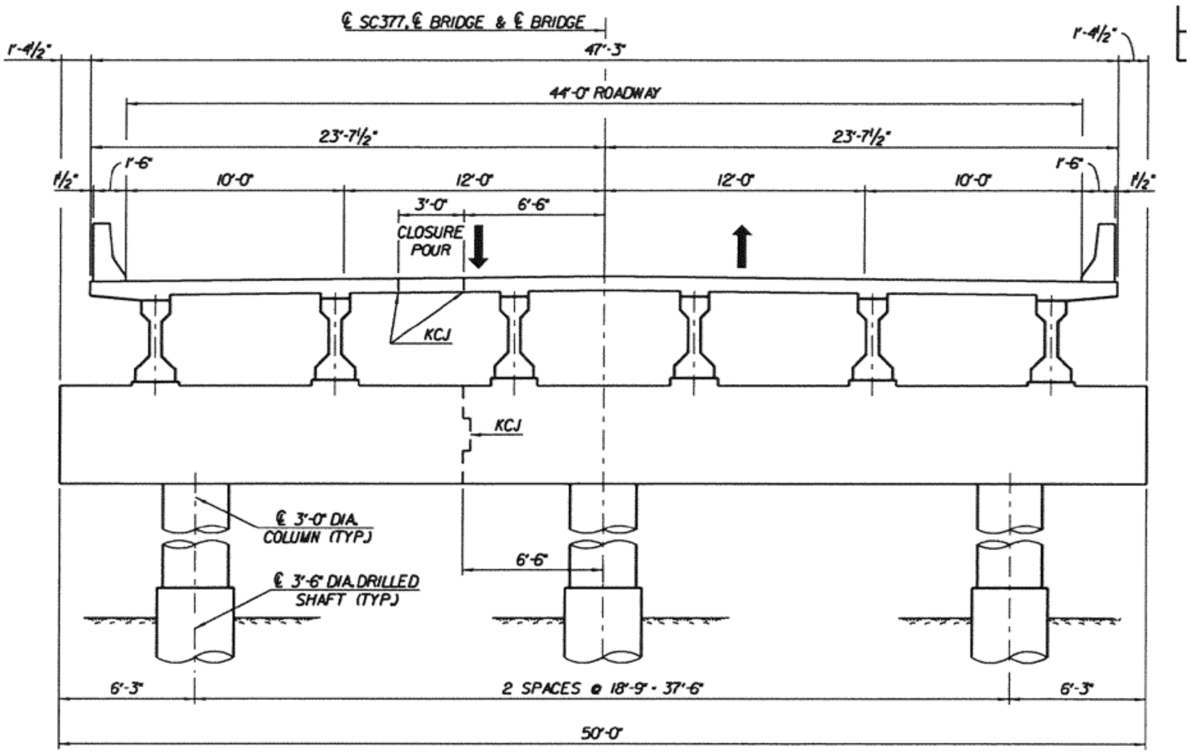


Figure 17. Completed typical section of the main Black River Bridge.

The asphalt surface course was placed late November 2008. However, because of problems stemming from paving late in the season, the final surface was too rough to be accepted under the performance criteria in the contract. Traffic operated on the highway throughout the winter, and the surface was milled and repaved in spring 2009. SCDOT accepted the final surface course.

DATA ACQUISITION AND ANALYSIS

Data on safety, traffic flow, quality, and user satisfaction before, during, and after construction were collected to determine if this project met the HfL performance goals.

The primary objective of acquiring these types of data was to quantify the 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.

This section discusses how well the SCDOT project met the specific HfL performance goals in these areas.

SAFETY

The performance goal for this project was to achieve work zone and worker safety during construction and reduce future crash injuries and fatalities by 20 percent (based on a preconstruction 3-year baseline). The project was successful in holding work zone-related crashes below the preconstruction crash rate of an average of 19 crashes per year over the past 6 years. SCDOT reported one vehicle crash in the work zone that resulted in a fatality. The crash was not related to construction. One other work zone crash occurred involving three passenger vehicles. Therefore, the performance goal of holding crashes below 19 crashes per year was achieved. Historical data between 2001 and 2006 is presented in table 5.

Table 5. Crash summary.

Year	Type of crash			Total	Persons Killed	Persons Injured
	Fatal	Injury	Property Damage Only			
2001	0	8	6	14	0	16
2002	1	9	17	27	1	27
2003	0	6	9	15	0	9
2004	0	7	14	21	0	13
2005	0	5	9	14	0	5
2006	1	12	10	23	1	22
Total	2	47	65	114	2	92

Road Safety Audit

Transportation experts from the SCDOT conducted a road safety audit (RSA) prior to construction to ensure that all aspects of safe operation of this roadway were noted and recorded to enable appropriate decisions on resource allocation. The RSA team noted that U.S. 521 is a designated evacuation route. While the team believed that the project would not have any major impact on the functionality of U.S. 521, the possibility of such an event should be considered. Since the staged work on U.S. 521 was vital to the staging of the rest of the project, an active hurricane season could possibly hamper the staging, thus delaying the project. Conversely, the team noted that if an evacuation was ordered, the project's possible impact on traffic flow should be considered. In addition to traffic flow concerns, the RSA team made the following safety recommended:

- Prior to construction the existing pavement markings should be inspected to ensure adequate visibility.
- Review of the bridge and pavement plans to ensure safe and efficient transitions during construction.
- Verify the vertical curves along entire project to ensure adequate sight distance.
- Check the guardrail placement to avoid creating blind spots at driveways.
- Review of the staging plans to minimize potential conflicts during the construction of the new bridges and demolition of the existing bridges.
- A possible alternative to flattening out the proposed 2:1 embankment slopes may be to install a bituminous curb with frequent downspouts behind the guardrail.
- The speed limit should be decreased from the existing 55 miles per hour throughout all stages of construction.

IMPACT ON TRAFFIC

Traditionally, this single project would have encompassed three or more contracts at different times. SCDOT used the concept of route management to combine the separate contracts into one and reduced the time highway users were impacted by more than 50 percent. Under this contract, the contractor worked on all bridges and the intersection at the same time, reducing the total construction time spent on the project. A key feature of route management was to minimize the duration of work zone slowdowns.

SCDOT reported no noticeable congestion during construction, largely because the use of staged construction allowed nearly continual use of the original two-lane route configuration. Queue length was not an issue because traffic flowed freely though the work zone.

QUALITY

Sound intensity (SI) and roughness testing were conducted by personnel from the National Center for Asphalt Technology in Auburn, AL.

To get baseline measurements of the existing roadway, two areas were considered for this project. The first area, on SC 377, included the four bridges on SC 377 and five pavement sections among the bridges. The second area was along U.S. 521. Thus, this project had five pavement sections on SC 377 (S-1 through S-5), four bridge sections (B-1 through B-4), and one pavement section on U.S. 521, shown in figures 18 and 19.

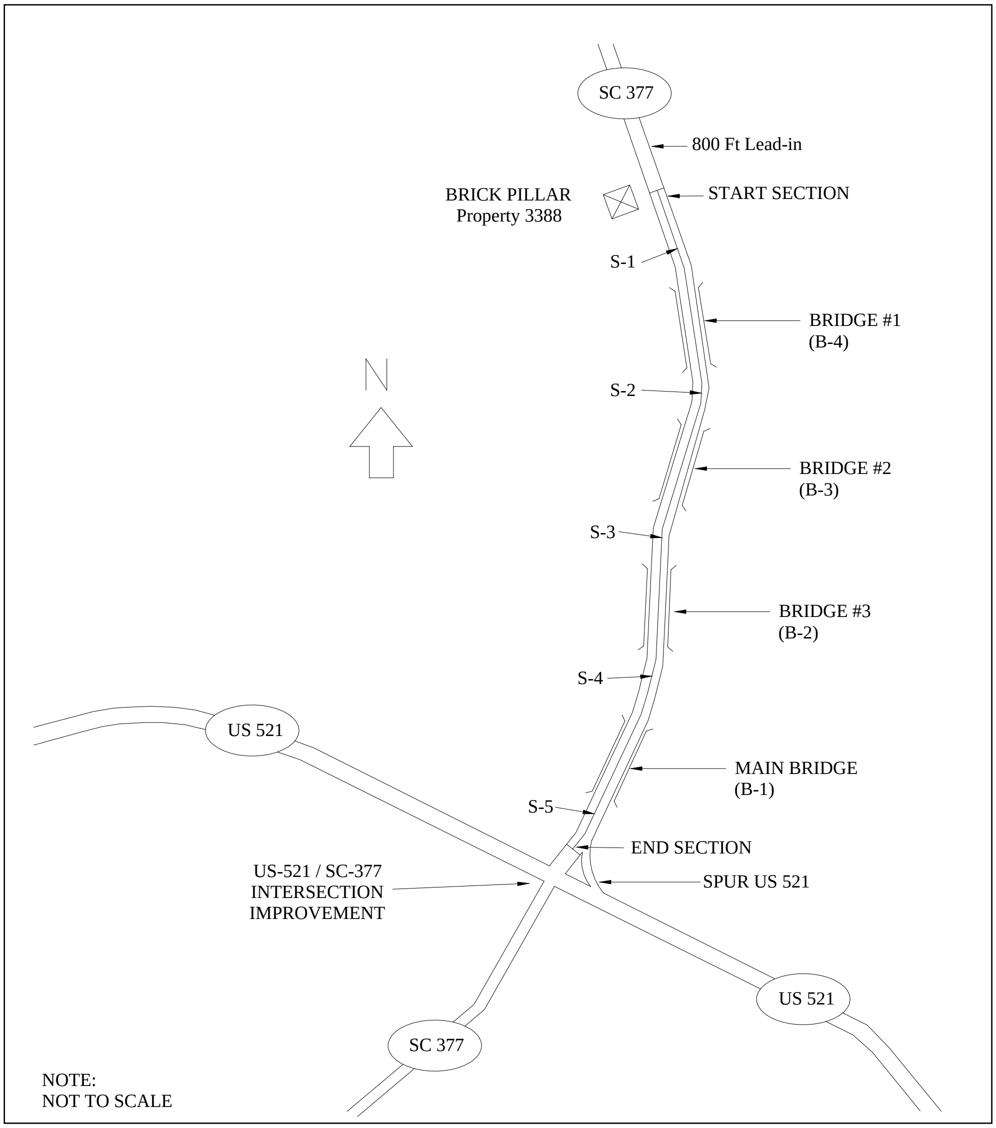


Figure 18. SC 377 pavement and bridge test sections.

The test section encompassing the intersection of U.S. 521 and SC 377 was 2,000 ft long, with 1,000 ft on either side of the intersection. Both the eastbound and westbound lanes had identical surfaces, so only the eastbound lane of U.S. 521 was tested for convenience. Three repeat runs were made for both roughness and OBSI measurements on all test sections to ensure data repeatability.

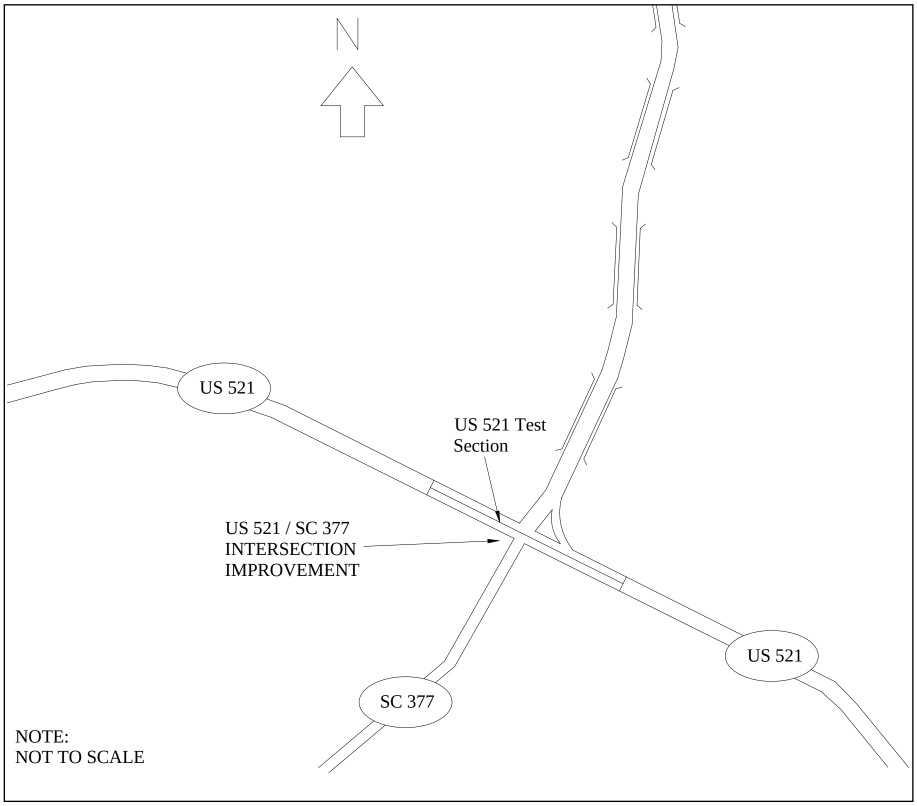


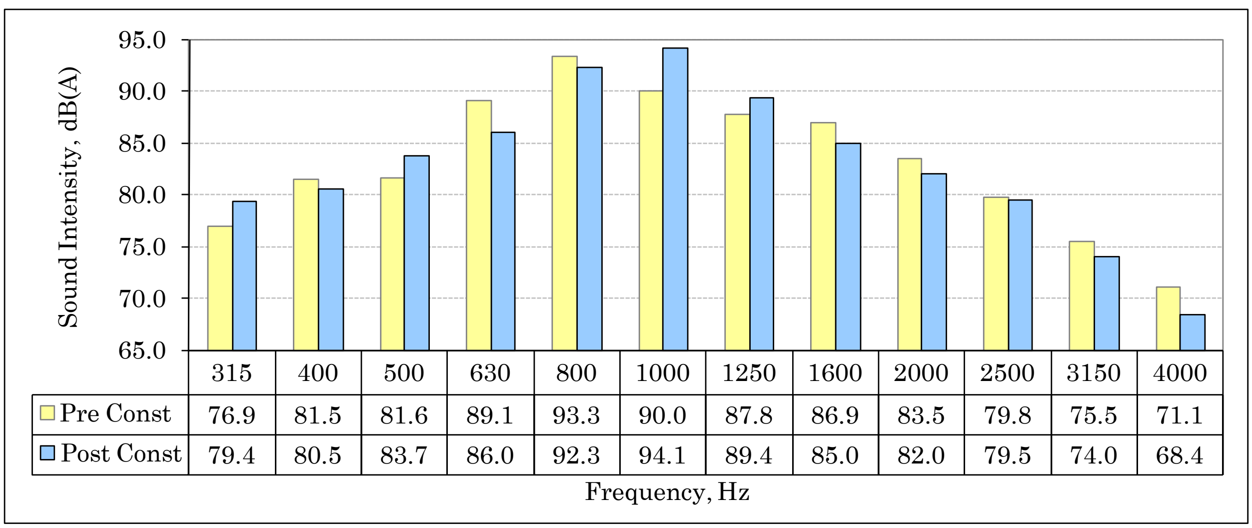
Figure 19. U.S. 521 pavement test section.

Sound Intensity Testing

SI measurements were made using the current accepted OBSI technique AASHTO TP 76-08, which includes dual vertical SI probes and an ASTM standard reference test tire (SRTT). SI testing was done before reconstruction and on the new bridges and pavement surface after project completion. SI measurements were obtained at a constant vehicle speed of 45 miles per hour (mi/h). A minimum of three runs were made in the right wheelpath with two phase-matched microphone probes simultaneously capturing noise data from the leading and trailing tire-pavement contact areas. Figure 20 shows the dual probe instrumentation and the tread pattern of the SRTT.

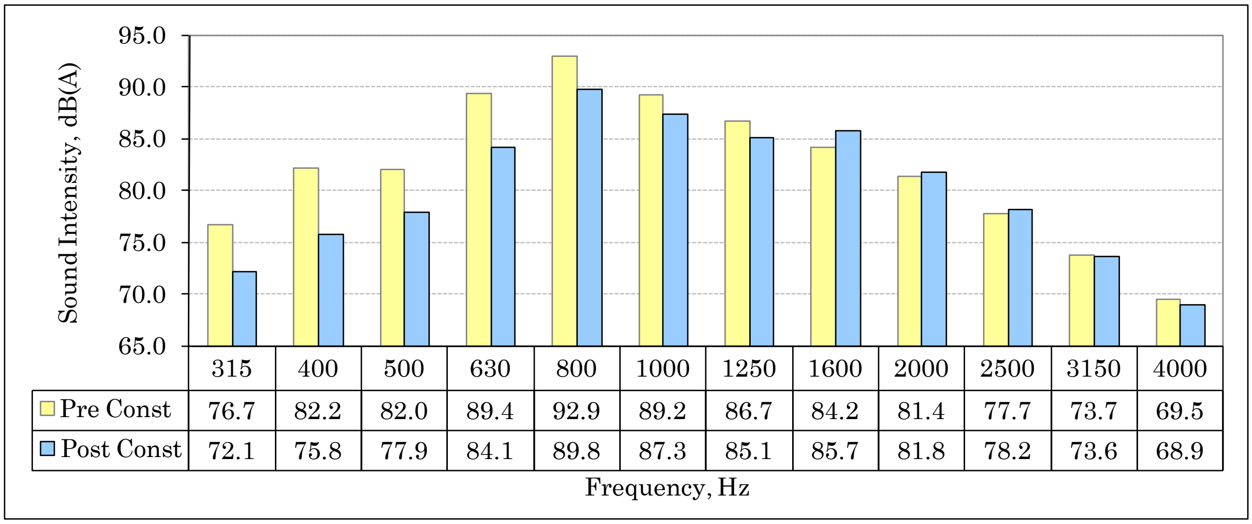
Figure 20. Onboard sound intensity probe and tire tread of the SRTT.

The average of the front and rear OBSI values was computed over the full length of the bridge decks and pavement to produce SI values. Raw noise data were normalized for the ambient air temperature and barometric pressure at the time of testing. The resulting pre- and postconstruction mean SI levels are A-weighted to produce the noise-frequency spectra in one-third octave bands, as shown in figure 21 for the bridges, figure 22 for the SC 377 pavement sections, and figure 23 for the U.S. 521 pavement section.



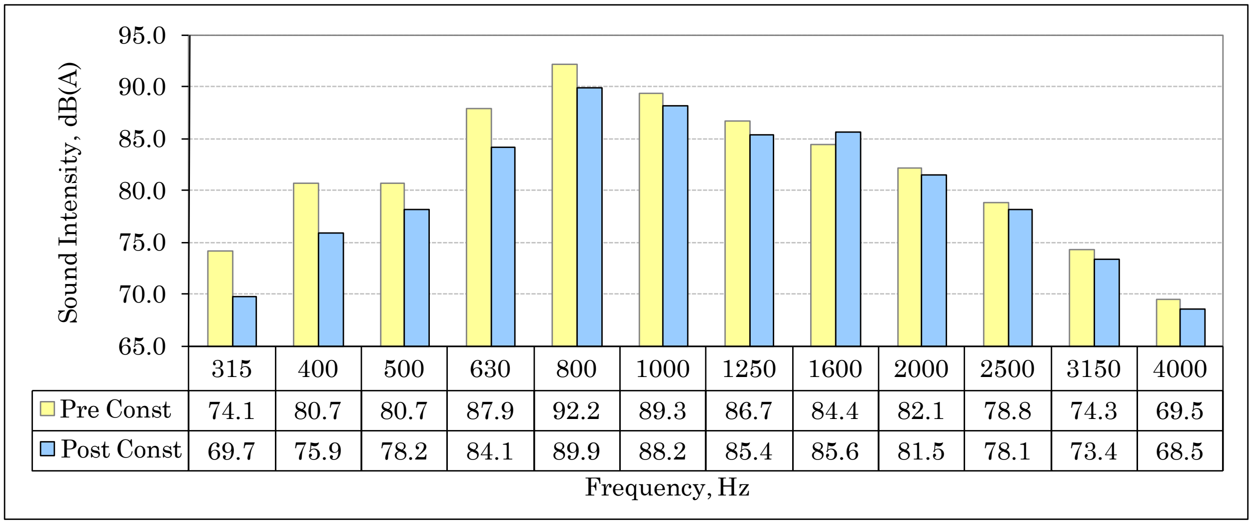
	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
Pre Const	76.9	81.5	81.6	89.1	93.3	90.0	87.8	86.9	83.5	79.8	75.5	71.1
Post Const	79.4	80.5	83.7	86.0	92.3	94.1	89.4	85.0	82.0	79.5	74.0	68.4

Figure 21. SC 377 bridge sections mean A-weighted sound intensity spectra.



	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
Pre Const	76.7	82.2	82.0	89.4	92.9	89.2	86.7	84.2	81.4	77.7	73.7	69.5
Post Const	72.1	75.8	77.9	84.1	89.8	87.3	85.1	85.7	81.8	78.2	73.6	68.9

Figure 22. SC 377 pavement sections mean A-weighted sound intensity spectra.



	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
Pre Const	74.1	80.7	80.7	87.9	92.2	89.3	86.7	84.4	82.1	78.8	74.3	69.5
Post Const	69.7	75.9	78.2	84.1	89.9	88.2	85.4	85.6	81.5	78.1	73.4	68.5

Figure 23. U.S. 521 pavement section mean A-weighted sound intensity spectra.

What these figures show is typical of HMA pavement. The peak frequency for this type of surface is normally in the middle range of the spectrum at 800 to 1,000 hertz (Hz), followed by a steady reduction in values as frequency increases. The pre- and postconstruction mean SI levels for the pavement and bridge sections are summarized in table 6.

The goal was to achieve a tire-pavement noise measurement of less than 96.0 dB(A). The SI for the newly constructed pavement surfaces was 94.5 dB(A) for SC 377 and 94.7 dB(A) for U.S. 521. The average value dropped 2.1 dB(A) and both pavements meet the performance goal. However, the overall SI for the bridges increased by 0.6 dB(A) with the mean value of all four bridges at 98.2 dB(A), which does not met the 96.0 dB(A) goal.

Table 6. Summary of mean SI levels.

Test Section	Preconstruction	Postconstruction
	SI, dB(A)	SI, dB(A)
SC 377 S-1	96.8	95.7
SC 377 S-2	96.9	94.0
SC 377 S-3	97.2	95.1
SC 377 S-4	97.3	94.0
SC 377 S-5	96.8	93.8
All SC 377 Road Sections	**97.0**	**94.5**
Bridge 1	97.8	97.9
Bridge 2	97.1	98.0
Bridge 3	98.0	98.1
Bridge 4	97.6	98.8
All Bridge Sections	**97.6**	**98.2**
U.S. 521	**96.4**	**94.7**

Roughness Measurement

Roughness measurements from the test sections were collected using Auburn University's ARAN test van (figure 24). The ARAN van is equipped with a high-speed inertial profiler that is used to make profile-based roughness measurements in each wheelpath of the pavement surface. Roughness in each wheelpath is reported in terms of inches per mile in accordance with the International Roughness Index (IRI) approach.

Figure 24. Auburn University ARAN test van.

Roughness measurements were collected at a constant speed of 45 mi/h. The raw roughness data were processed to determine the average IRI for both wheelpaths. Table 7 shows the IRI average values for the pavement and bridge sections.

Table 7. Summary of roughness measurements.

Test Section	Preconstruction	Postconstruction
	IRI, in/mi	IRI, in/mi
SC 377 S-1	94	117
SC 377 S-2	102	138
SC 377 S-3	91	162
SC 377 S-4	118	143
SC 377 S-5	104	111
All Road Sections	**102**	**134**
Bridge 1	149	120
Bridge 2	151	130
Bridge 3	141	131
Bridge 4	127	168
All Bridge Sections	**142**	**137**
U.S .521	**98**	**104**

The overall IRI values increased 32 percent for the SC 377 road sections, decreased 4 percent for the bridges, and increased 6 percent for the U.S. 521 pavement section. The increase in smoothness across the bridges is an improvement, but none of the newly constructed pavement surfaces meets the target IRI value of less than 48 inches per mile. The goal is extremely difficult to achieve on short-span bridges because the mean is influenced by the bump caused by expansion joints in the structures. The roadway sections, on the other hand, should have been smoother after the project was completed.

USER SATISFACTION

The HfL requirement for user satisfaction included a performance goal of 4-plus on a 7-point Likert scale for the following two questions:

- How satisfied are you with the new facility?
- How satisfied are you with the approach SCDOT used to construct the new facility in terms of minimizing disruption?

SCDOT conducted a user satisfaction survey in which nearby residents were solicited by mail. Instead of a 7-point scale, the agency used a 5-point scale to determine the level of project satisfaction. An equivalent 5-point scale response score of 2.9 was needed to achieve the HfL satisfaction goal. A total of 51 highway users responded to the survey. The results were satisfaction scores of 4.4 for the new highway and bridges and 4.3 for the approach used to minimize disruption. Both scores exceed the equivalent goal of 2.9. Some respondents commented that the finished highway was rough in localized sections, which is evident in the measured IRI values, but the consensus was that the finished project was an improvement. The Appendix contains the complete survey results.

TECHNOLOGY TRANSFER

The South Carolina project was included as part of an HfL demonstration project showcase highlighting prefabricated bridge elements and systems (PBES). The showcase, held July 22, 2008, in Frederick, MD, included projects and representatives from HfL projects in three States: Maryland, South Carolina, and Virginia. Officials from the Maryland State Highway Administration (MDSHA), SCDOT, Virginia Department of Transportation, and FHWA Divisions joined the HfL team in developing and implementing this technology transfer program focused on PBES.

About 75 participants from six States (Maryland, North Carolina, Pennsylvania, South Carolina, Virginia, and West Virginia) and the District of Columbia attended the showcase. After opening words from MDSHA and FHWA representatives, speakers presented information on each demonstration project, incorporating comments from both the agency's and the contractor's perspectives. The meeting agenda is in the Appendix.

MDSHA Deputy Administrator Doug Rose opened the workshop with a brief welcome statement, followed by FHWA Delmar Division Administrator Nelson Castellanos, who summarized the goals of the showcase and the overall HfL program. Vasant Mistry of FHWA gave a comprehensive presentation on the state of the industry on PBES. He focused on accelerated bridge construction practices and how these technologies have been used throughout the country. He discussed FHWA resources and initiatives available to promote PBES use (available at www.fhwa.dot.gov/bridge/prefab).

Jeff Robert, MDSHA project engineer and coordinator, and Butch Lundgren of Concrete General, Inc. delivered an overview of the Maryland projects. They provided a predesign summary of the projects, including site photos, traffic impact and maintenance of traffic alternative studies, and comparative projects of similar scope. They also presented a review and application of strategies to these projects within the HfL program goals, primarily public awareness and the use of PBES, from both the agency and contractor perspectives.

Bener Amado and Randy Cannon of SCDOT described the SC 377 project. Their presentation featured innovative contract bidding and incentive and disincentive clauses for schedule performance and the use of SCC in beam fabrication. The presentation also included comments from the contractor's perspective.

The project showcase agenda originally included a visit to a project site in Frederick so that participants could observe the placement of precast slabs. However, the Maryland project was behind schedule and the site visit was replaced by a slideshow presentation on the project.

ECONOMIC ANALYSIS

A key aspect of HfL demonstration projects is quantifying, as much as possible, the value of the innovations deployed. This entails comparing the benefits and costs associated with the innovative project delivery approach adopted on an HfL project with those from a more traditional delivery approach on a project of similar size and scope. The latter type of project is referred to as a baseline case and is an important component of the economic analysis.

The traditional SCDOT approach likely would have been to replace the main Black River bridge first, then 2 years later replace the three overflow bridges and address the highway intersection, resulting in the letting of three contracts at different times.

SCDOT supplied most of the cost figures for the as-built project in this economic analysis. The assumptions for the baseline costs were determined from discussions with SCDOT and national literature.

CONSTRUCTION TIME

The construction schedule for this type of project was estimated at 28 months, and SCDOT reported that construction was completed in 14 months. Therefore, the project was completed in half the time needed for traditional methods. The remarkable time savings were credited to the use of route management to group the multiple projects under one A+B+C contract, which incorporated no-excuse incentives. This allowed the contractor to recoup costs associated with extended work weeks to get the project open to traffic quicker than with traditional contracting. These incentives made it feasible for the contractor to complete the first phase of the project 30 days ahead of schedule and ended the 14-mi truck detour sooner than expected.

CONSTRUCTION COSTS

Table 8 presents differences in construction costs between the baseline and as-built alternatives. Baseline cost was determined in consultation with SCDOT engineering staff by (1) noting whether the itemized costs in the as-built cost table would have applied to the baseline case, (2) adjusting cost categories and costs as necessary, and (3) itemizing other costs associated with the as-built case that may not have been required for the baseline case. Therefore, the baseline cost estimate is inexact and the information presented is a most probable cost differential rather than a rigorous computation of a cost differential. Several other assumptions were made in selecting significant cost factors and determining some unit costs, as noted in table 8.

It can be estimated from table 8 that the adoption of the HfL innovations (as-built scenario) to reconstruct the four bridges, repave sections of the highway, and realign the SC 377 and U.S. 521 intersection resulted in a cost savings of $6,938,246 ($23,995,897 - $17,057,651) when compared with the baseline scenario.

Table 8. Capital cost calculation.

Cost Category	Baseline Case	As-Built (A+B+C)
Construction Costs		
Bridge Construction[1]	$ 18,456,086	$ 9,311,640
Roadway Improvements[2]	$ 4,939,811	$ 4,939,811
Traffic Control[3]	$ 420,030	$ 140,010
Total Construction[4]	$ 23,995,897	$ 14,251,451 (A portion of contract)
Construction Time	--	$ 774,000 (B portion of contract)
Bridge Closure Time	--	$ 1,890,000 (C portion of contract)
Contract Incentive[5]	--	$ 142,200
Total Cost	**$ 23,995,897**	**$ 17,057,651**

Notes:
[1] Baseline cost is taken from a slightly longer bridge project and prorated for the total length of all four bridge replacements.
[2] Roadway improvements are assumed to have similar costs.
[3] Traffic control is assumed to be three times the as-built cost to account for separate construction contracts.
[4] Design and engineering costs are assumed to be an integral component of the construction costs.
[5] Incentive was collected from early completion of the roadway portion of the project.

USER COSTS

Generally, three categories of user costs are used in an economic analysis: vehicle operating costs (VOC), delay costs, and safety-related costs. The cost differential between the baseline and as-built scenario in terms of VOC and delay costs was nonexistent because the free flow of passenger vehicular traffic would have been maintained via staged construction during either scenario. Heavy commercial vehicles were detoured before the project began and would have been detoured regardless of which construction approach was adopted, which negates any differential in the operating and delay cost of the commercial vehicles. Similarly, the differential in safety costs was considered negligible because of the short length of the work zone and the use of staged construction to maintain the free flow of traffic.

COST SUMMARY

The differential in VOC, delay costs, and safety costs was estimated to have no impact between the baseline and as-built alternatives. However, from a construction cost standpoint, traditional construction methods would have cost $6,938,246 more than the as-built case. As a result, the innovations used led to a 40 percent cost benefit over traditional methods on this $17.1 million project.

APPENDIX

South Carolina
Department of Transportation

August 21, 2009

To Whom It May Concern:

The Black River Bridges are complete!!! You submitted a comment during the public information phase of the project prior to construction. Since the project is now complete, the South Carolina Department of Transportation (SCDOT) is soliciting your input as to how the project progressed and your satisfaction with the procedure and project.

Enclosed you will find a survey that we would request that you complete and send back to me in attached pre-stamped envelope.

Again thank you for participating and helping us continue to find ways to better serve the citizens of South Carolina. If you have any questions, or comments, please include them in remark section of attached survey.

Sincerely,

for
Bener Amado, P.E.
Program Manager

BA:ars
Enclosure
File: PC/BA

Post Office Box 191
Columbia, South Carolina 29202-0191

Phone: (803) 737-2314
TTY: (803) 737-3870

AN EQUAL OPPORTUNITY
AFFIRMATIVE ACTION EMPLOYER

Figure 25. User satisfaction survey cover letter.

Table 9. User satisfaction survey results.

HIGHWAYS FOR LIFE

SC Route 377 Black River Bridge Replacments

	Question					
Response	A	B	C	D	Ave.	Remarks
1	5	5	5	5	5	Many Many Thanks
2	5	5	5	5	5	The planning, construction and timing on this project could not have gone better. You and your team should be very poud of this one. Another plus for Williamsburg Cty
3	4	4	4	5	4.25	The final paving was not done smoothly
4	4	4	5	4	4.25	I am impressed that the project was undertaken and completed as quickly as it was. Great job.
5	4	4	2	5	3.75	The job was great until they went back later and tore up a perfectly good road to redo it. It was fine before they reworked it. New it is rough and bumpy in thos spots.
6	4	4	3		3.67	Should have paved to side rails the same on both sides not half way, if you had to pull over to side.
7	5	5	5	5	5	You did a fine job on this project, and we are completely satisified with it.
8	5	5	5	5	5	Thank you so much for this beautiful bridge, it has made traveling back and forth to Kingstree, Lake City, Florence, etc. so convenient. I a a widow, so therefore I travel alone most of the time and I appreciate the safe feeling I have when I cross the bridge. Again Thanks - signed
9	5	5	5	5	5	We greatly appreciate you working with our community as of not to disrupt our lively hoods, and asses to health care.
10	5	5	5	5	5	You did a great job
11	5	5	5	5	5	When you're traveling on #521 from Andrews to Manning and turn right on #377 at the intersection going toward Kingstree, wht is the speed limit on #377 going over the bridges? There is no speed limit sign when you get on #377. Thanks
12	3	3	2	5	3.25	The redo of the areas of the bridges yielded results less satisfactory than what was done at the beginning. It was very smooth before those spost were tornup again and repaved. Should have left well-enough alone.
13	5	5	5	5	5	Very good
14	5	5	5	5	5	At imes when one lane wa sopen for trafffic the construction crew was efficient in the maintenance of traffic flow with minimal delay.
15	5	5	5	5	5	Good job
16	5	5	5	5	5	I would very much like to have a "put in" for kayaks and canoes at lower bridge where the parking area is located.
17	5	5	5	5	5	Thanks for the courtesy of listening to the residents effected by this work. Good Job - well done - signed
19	3	3	1	5	3	Of coures it inconvenietn to have to wait to move but this was handled as best as could be expected. BUT the road was beautifully smooth until they decided to "redo" vertain spots after the job had been completed. The redone spots are rough and bumpy. Wihs yo had left the original job alone.
20	5	5	5	5	5	Very, very good job I was very surprised.
21	4	4	4	4	4	Concerned about patch work
22	4	5	4	4	4.25	The Project was completed with respect to safety for local area residents and also weight limit restrictions

Table 10. User satisfaction survey results (continued).

HIGHWAYS FOR LIFE

SC Route 377 Black River Bridge Replacments

	Question					
Response	A	B	C	D	Ave.	Remarks
23	2	2	5	5	3.5	It was done in a professional way. I will tell everyone that it was done that way. Very good job.
24	4	4	4	4	4	Thank you.
25	5	5	5	5	5	The brides are a great improvement and we are enjoying using them.
26	5	5	3	5	4.5	Road not level in areas
27	2	4	5	4	3.75	The road and the bridges are very nice and wide. Thank you for a great job.
28			5		5	
29	5	5	5	5	5	
30	5	5	5	5	5	
31	2	2	4	5	3.25	
32	5	5	4	5	4.75	
33	4	4	5	4	4.25	
34	4	4	4	4	4	
35	5	5	5	4	4.75	
36	5	5	5	5	5	
37	5	4	5	4	4.5	
38	3	2	2	2	2.25	
39	4	4	4	4	4	
40	4	4	4	4	4	
41	3	4	4	3	3.5	
42	5	5	5	5	5	
43	4	4	4	4	4	
44	5	5	5	4	4.75	
45	4	4	5	4	4.25	
46			5	5	5	
47	4	4	3	3	3.5	
48	5	5	5	5	5	
49	5	5	5	4	4.75	
50	4	4	4	4	4	
51	4	4	4	4	4	
52	5	5	5	5	5	
Average	4.3	4.4	4.4	4.5	4.39	

Note: 51 responses - #18 was duplicate

Question A-	The approach used on this project minimized disruption to traffic.
Question B-	The approach used on this project minimized inconvenience to local area residents.
Question C-	I am satisified with the final highway and bridge project with respect to safety, riding comfor, and convenience.
Question D-	I will tell other people about my experiences with this road construction project.

July 22, 2008

MD/VA/SC HfL Showcase
Prefabricated Bridge Elements
AGENDA

8:30am - 9:00am	**Registration**	Room A
9:00am - 9:10am	**Welcome and Introductions** Doug Rose, Deputy Administrator - MDSHA	
9:10am - 9:30am	**Highways for LIFE Overview** Nelson Castellanos, Delmar Division Administrator - HfL	
9:30am - 10:00am	**National Perspective on Prefabricated Bridge Elements & Systems** Vasant Mistry - FHWA	
10:00am - 10:40am	**MDSHA/Contractors** Jeff Robert, Project Engineer - MDSHA John Narer, Project Engineer - MDSHA Contractor Representative (TBA)	
10:40am - 11:00am	**Break**	
11:00am - 11:40am	**VDOT/Contractors** Khossrow Babaei, Assistant District Bridge Engineer VDOT Robert Price, Resident Administrator VDOT	
11:40am - 1:00pm	**Lunch (Provided)**	Room B
1:00pm - 1:40pm	**SCDOT/Contractors** Randy Cannon, Bridge Project Engineer - TRC Bener Amado, Bridge Program Manager - SCDOT	Room A
1:40pm - 2:30pm	**Video Presentations** Jerry Burgess, Field Project Engineer - MDSHA	
2:30 - 3:30pm	**Open Panel Discussion** All Speakers	
3:30pm - 3:45pm	**Evaluations and Adjourn**	

HIGHWAYS FOR LIFE

Accelerating Innovation for the American Driving Experience.

Figure 26. Showcase agenda.