ABC Innovative Projects

US 6 Bridge over Keg Creek						
Location	on US 6 over Keg Creek 6 miles east of the city of Council Bluffs in Pottawattamie County					
State	Iowa					
Owner	State					
Year ABC Built	2011					
State ID #	7814.2S006					
Federal ID #	043231					
Coordinates	***Latitude:*** 41.28975247			***Longitude:*** -95.66201998		
Contact Person	Ahmad Abu-Hawash, P.E. Chief Structural Engineer, Office of Bridges and Structures Iowa Department of Transportation Phone: 515-239-1393 Email: ahmad.abu-hawash@dot.iowa.gov					
Mobility Impact Time	***ABC:*** 2 weeks of traffic disruption			***Conventional:*** 4-6 months		
Impact Category	*Tier 1*	*Tier 2*	***Tier 3***	*Tier 4*	*Tier 5*	
			X			
Benefits	reduced traffic impacts, improved material quality and product durability, improved work-zone safety					
Description	• 204.5-ft-long and 47.2-ft wide three-span bridge (67.25 ft - 70 ft – 67.25 ft) • Rural location • Average Daily Traffic count: 3,890 (2009); 5,380 (2029) • Traffic management alternative, if constructed conventionally: extended use of 22 (13 out-of-distance)-mile detour ***Existing Bridge:*** Built in 1953, the existing three-span 180-ft by 34.7-ft two-lane continuous concrete girder bridge was structurally deficient and required replacement. ***Replacement Bridge:*** The replacement bridge has two traffic lanes, one in each direction, and two 8-ft-wide shoulders. It consists of precast semi-integral abutments, precast columns and pier caps connected with high-strength grouted couplers, and modular beams with composite slab superstructure. Each superstructure span consists of six modular full-span beam segments. The segments are 7.3-ft wide with two W30x99 steel rolled I-beams and 8.5-inch-thick composite concrete deck. Six-inch-wide longitudinal closure joints filled with ultra-high-performance concrete (UHPC) connect the segments. ***Construction Methods:*** The bridge was constructed as a three-span continuous bridge by combining field-cast UHPC joints with simple-span modular segments erected with conventional cranes. UHPC joints were used for both the longitudinal joints between adjacent modular beam segments and, for the first time in the US, the moment-resisting transverse superstructure joints at each pier. Prior to construction, structural testing was done to evaluate the moment-resisting					

	transverse connection over the piers. The bond broke between the UHPC joints and deck panels, and cracking was observed in the panels. As a result, the beam ends across the piers were retrofit with longitudinal rods post-tensioned to 70 ksi in the field. The contractor fabricated the precast elements on site, and concrete drilled shafts were constructed outside the bridge footprint at the two interior support locations. The bridge was then closed and demolished. The 4-ft square precast columns were installed on the drilled shafts, connected with grouted splice couplers in the columns. The 85-ton pier caps were lowered onto the columns, connected with grouted splice couplers in the caps. Abutment steel H-piles were driven, and precast abutment stem and wingwalls were assembled. Self-consolidating high-performance concrete (HPC) was cast in the abutment cap pockets. The 60-ton modular steel beam and composite concrete deck segments were installed, complete with traffic railing on the outside segments and suspended abutment backwalls. Longitudinal and transverse closure joints in the deck were cast with UHPC. The precast approach slabs were assembled. Self-consolidating HPC was cast in the deck lifting loop pockets and in the precast approach pavement joints. The deck and approach slabs were diamond ground to final profile. Fully-contained flooded backfill was used to minimize approach settlement and avoid the bump at the end of the bridge. A structural health monitoring system was installed to assess the overall bridge performance during and after construction. The contract included incentives / disincentives of $22,000 for road closure with detour in effect per day less than / greater than the 14-day maximum closure. ***Stakeholder Feedback:*** Extra attention is needed for field tolerances. Approximately ¼ inch of bridge width was added for each of the six modules as they were erected. This additional width added up to 1.5 inches, making it difficult to install the last segment. The contractor made a last-minute substitution of self-consolidating HPC instead of UHPC in the deck lifting loop pockets and in the precast approach pavement joints to avoid running out of UHPC due to form slippage in one location that resulted in UHPC loss.
High Performance Materials	• High-performance concrete (HPC) for all precast elements • Ultra-high-performance concrete (UHPC) deck closure joints • Self-consolidating HPC in substructure pockets, deck lifting loop pockets, and precast approach pavement joints
Photos Additional photos	  

Project Planning	***Decision-Making Tools***	*Site Procurement*	***Project Delivery***	***Contracting***
	• TPF-5(221)	•	• Design-bid-build	• Full lane closure • Incentive / disincentive clauses
Geotechnical	*Foundations & Walls*		***Rapid Embankment***	

<table>
<tr><td>Solutions</td><td colspan="3">•</td><td colspan="2">• Fully-contained flooded backfill</td></tr>
<tr><td rowspan="2">Structural Solutions</td><td colspan="3">Prefabricated Bridge Elements & Systems</td><td>Construction</td></tr>
<tr><td>Elements</td><td>Systems</td><td>Miscellaneous</td><td rowspan="2">•</td></tr>
<tr><td>• Modular beams with decks
• Precast caps and columns
• Precast backwalls
• Precast wingwalls</td><td>•</td><td>• CIP reinforced concrete closure joints
• Bars in splice couplers
• CIP pockets in precast abutments
• UHPC closure joints
• Precast approach slab
• Prefab parapets</td></tr>
<tr><td>Costs</td><td colspan="5">The engineer’s estimate for the project was $2.10 million. The low bid was $2.66 million ($564,000 = 27% higher than engineer’s estimate). There were 7 bidders. The cost per square foot of bridge was $231 compared to $124 for conventional construction in this region in 2011.</td></tr>
<tr><td rowspan="2">Funding</td><td>Federal only</td><td>State only</td><td colspan="2">Federal and State</td><td>Other</td></tr>
<tr><td></td><td></td><td colspan="2">X</td><td></td></tr>
<tr><td rowspan="2">Incentive Program ($)</td><td>Highways for LIFE</td><td>IBRD</td><td colspan="2">SHRP2</td><td>Other</td></tr>
<tr><td>$400,000</td><td></td><td colspan="2">$250,000</td><td></td></tr>
<tr><td>Contract Plans</td><td>Complete Set:</td><td colspan="2">Contract Plans (link to pdf)</td><td>ABC *:</td><td></td></tr>
<tr><td>Specifications</td><td>Complete Set:</td><td colspan="2">Iowa DOT Standard Specifications for all projects [http://www.iowadot.gov/specifications/index.htm]</td><td>ABC *:</td><td>SP090109-PrefabAppSlab (link to pdf)
SP090110-PrefabSub (link to pdf)
SP090111-PrefabSuper (link to pdf)
SP090112a-UHPC (link to pdf)
Addendum-A01 (link to pdf)
Addendum-A02 (link to pdf)
Addendum-A03 (link to pdf)</td></tr>
<tr><td>Bid Tabs</td><td colspan="5">Bid Tabs (link to pdf)</td></tr>
<tr><td>Schedule</td><td>Engineer’s:</td><td colspan="2"></td><td>Actual:</td><td>Contractor’s CPM (link to pdf)</td></tr>
<tr><td>Other Related Information</td><td colspan="5">Video: One Design – 10,000 Bridges [http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Pages/Video-One_Design-10,000_Bridges_536.aspx]

12-Question Survey Summary (link to xls)

ABC Center at FIU Presentation, February 2012 (link to pdf)

2011 Keg Creek Showcase Presentations [http://www.t2events.ce.ufl.edu/events/Iowa_Showcase_Presentations.asp]

Iowa DOT US 6 Bridge over Keg Creek Website [http://www.iowadot.gov/us6KegCreek/]

Time-Lapse Video of Keg Creek Bridge Replacement [http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Pages/Time-Lapse_Video_of_Keg_Creek_Bridge_Replacement_532.aspx]

SHRP2 Project Report [not yet published]</td></tr>
</table>

	"No Magic Necessary," May 2011 Iowa DOT *Inside Newsletter* (link to pdf) " ABC Modular Bridge Demonstration Project Design and Construction," 2011 PCI National Bridge Conference Proceedings (link to pdf) Iowa DOT Bridge Standards Website [http://www.iowadot.gov/bridge/v8ebrgstd.htm]
Photo Credits	Iowa Department of Transportation & HNTB

* Specific to the ABC used in the project.