Ultra-High Performance Concrete for Prefabricated Bridge Element Connections
Webinar 2 – Why UHPC for Prefabricated Bridge Element Connections?
Transcript from Webinar

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Welcome everyone to the Why Ultra High Performance Concrete for Prefabricated Bridge Elements conference call. At this time all participants in a listen only mode. If you should require assistance during the call please press star, then zero. This conference is being recorded. I would now like to turn the conference to your host, Mr. Jag Mallela. Please go ahead, sir.

Thank you very much, operator, and welcome to the FHWA webinar series on ultra-high performance concrete. This is our second webinar. UHPC for pre-fabricated bridge element connections is an Every Day Counts focus innovation. I'm am Jag Mallela, with WPS Parsons Brinkerhoff your moderator today, and with me in the background is Mr. Tim Luttrell, my co-host, with Leidos.

Today's webinar is the second in the series of UHPC webinars that we will be conducting between now and August 2017. The focus of these webinars is to provide interested agencies and other parties with information on UHPC uses, benefits, and lessons learned.

Before I kick off our today's exciting webinar, I would like to mention and an administrative item here. Those of you who have tuned in, thank you for tuning in, and if you wish to obtain a certificate for professional development hours, we will have an opportunity for you to provide your information at the end of today's webinar. It is a little change up from the last one for those that attended. You will be given a PDF registration pod entry form at the very end of the webinar after it is formally closed by providing your names and email address. Once you do that we will issue the certificate all of you by email.

The first-order business today so you know little bit who tuned in today and help us learn a little bit more about the demographics, so I will bring up the first poll for the day. If you would all take a few minutes or minute or so to kind of complete this poll, we would very much appreciate that.

[Participants being polled] [Pause]

Okay. Just a few more seconds or so.

Great. Thank you for your participation. I'm going to end the poll now and go back to the presentation.

Today's webinar is titled "Why UHPC for PBE Connections" and it is focused on answering the questions on why, as well as how UHPC is used for completing prefabricated bridge element connections. The contents of this webinar will be presented through the experiences of two leading State DOT practitioners as well as FHWA. The State DOT practitioners today are from Iowa DOT and New York State DOT. The webinar is planned to last 90 minutes and our first 60 minutes or so are allocated to speakers who will present technical information. The last 30 minutes are for Q&A

and other minor administrative items at the end. If during the presentation you think of a question, there is an area to the lower left for most of you that is called the "chat pod" that you can type your question into at any time. We will keep track of those questions and answer them at the end.

All the answers to today's questions will be provided verbally during the Q&A time, so please as these questions pop up, be sure to type them in.

The presentation will also be available online within a few weeks of today – of today's completion date, along with the recording and a transcript. We will notify all the attendees when this information is available online through email that you have provided during the registration process.

Today's presentation team will be kicked off just like the presentation will be kicked off by Mr. Mark Leonard, followed by Ahmad Abu-Hawash and Mathew Royce. Our first speaker Mr. Leonard is on the FHWA technical services team. He provides technical services training and reviews services for highway structure design and preservation. He began in 2012 and has 28 years as of experience as a structural engineer and at the D.O.T., including 12 years as a state bridge engineer. He is a registered professional engineer in the state of Colorado and is a graduate of the University of Notre Dame with a bachelor of science in civil engineering. Mark is also the FHWA UHPC innovation deployment team lead and is the contact person for this particular innovation under EDC.

Ahmad Abu-Hawash is our second presenter, and he is the Chief Structural Engineer for Iowa DOT and serves on the AASHTO subcommittee on bridges and structures, technical committee T-4 for construction, and T-19 for technology and software. He is involved with several other TRB committees related to bridges, bridge research, and other Iowa DOT and national bridge forums. He has a BS from the University of Iowa and MS from Iowa State University in civil engineering and structures.

Mathew Royce is our third speaker. He is the director of Structures Design Quality Bureau, Office of Structures at the New York State Department of Transportation. This Bureau is responsible for the development of the department's policy on structures, general oversight of design quality, as well as introduction of innovative technologies, such as UHPC and other innovations. Mathew has been working for the office of structures at New York State DOT since 1988. Prior to his current assignment, he was assistant director of the Structures Design Quality Bureau. He is a licensed professional engineer in New York.

We have an exciting lineup and I hope you'll take advantage of the speakers at we have today and enjoy the presentation and have good questions for them. Now I'm going to turn it over to Mark Leonard to begin the presentation.

Thank you, Jag. Before we get to the main presentations, we want to take a few minutes just to say a few words about Every Day Counts. Today's webinar is made possible by FHWA's Every Day Counts initiative. Since 2011, there have been four rounds of Every Day Counts. In the first two rounds, prefabricated bridge elements and systems were promoted as a means to help us build bridges better and smarter, and then rounds three and four of Every Day Counts high-performance concrete is being promoted as a way to help us connect prefabricated bridge elements together and make them more durable and simpler, which leads us to the purpose of the Every Day Counts deployment of ultra-high-performance concrete, and that is to promote the use of ultra-high-

performance concrete to help us make prefabricated bridge element connections simpler, stronger, and more durable.

The goal of the Every Day Counts deployment of ultra-high-performance concrete is for bridge design, construction, and the material personnel to have an understanding of what ultra-performance concrete is, to know the benefits to using it for connecting prefabricated bridge elements, and to know where they can get additional information on how to use ultra-high-performance concrete for connecting prefabricated bridge elements.

At the beginning of Every Day Counts there were about 20…21 highway agencies that had used ultra-high-performance concrete. Let me say that again. There were 12 agencies at the beginning of everyday counts that had used ultra-high-performance concrete for bridges. And now we have over 20 agencies have used ultra-high-performance concrete to connect prefabricated bridge elements together, and we have over 80 highway projects in the US where ultra-high-performance concrete has been used to connect prefabricated bridge elements.

You can review these projects. This map that is shown on this slide is available on FHWA's website. This map is interactive and by clicking on the dots that you see there on the map, this interactive map will give you more information on each of the bridges that have been completed in the US using ultra-high-performance concrete. Examples of the information are the location of the bridge, the owner, how much high-performance concrete was used, and when the construction was completed. The way you can get to this map is just go in and do an Internet search for "FHWA ultra-high-performance concrete interactive map" and it should come up.

To support this growing familiarity with ultra-high-performance concrete through Every Day Counts, FHWA is providing technical assistance, workshops, webinars, peer exchanges and presentations, and of course today's webinar is an example of one of those activities.

With regard to workshops, we have 18 agencies now that have sponsored ultra-high-performance workshops, and so if your agency would be interested in sponsoring UHPC workshop, contact me, and my contact information will be provided towards the end of this webinar.

With that we have our introduction to the Every Day Counts deployment of UHPC, and I would like to turn it over to Ahmad so we can start our main presentations. Think you.

Thank you, Mark. Good afternoon, everyone. I will be talking about Iowa's experience with UHPC by presenting a few case studies discussing the evolution, connection details, lessons learned, and the future of UHPC in Iowa.

In Iowa we have used UHPC in I-girders and decks as in waffle panels, in superstructures using optimized pi-shaped girders, and in deck overlay and connections between deck panels, modular units, and in negative moment connections. We have also used it for foundation piling for integral abutments, but for this presentation I will focus on connections only.

I will briefly talk about four projects where we used UHPC in connections. These projects demonstrate the use of UHPC in joints on different superstructure systems, starting with waffle deck panels on restressed concrete beams in Wapello County, and then on two projects in

Pottawattamie County with modular superstructure units made up of concrete deck on rolled steel beams, and finally in Buchanan County with pi girders.

The first project is a Wapello County waffle deck system. The purpose of this project was to develop a waffle deck panels system. It included panel design, fabrication, testing, and a demonstration bridge. Also, in a follow-up phase, a design guide was developed.

The intent of this waffle panel design concept was to develop a lighter and more durable precast deck with simple connection details.

The demonstration bridge was a 30-foot wide by 60-foot long single-span bridge with a waffle deck system supported on five Iowa D-beams spaced at 7 foot 4 inches. The 14 waffle deck panels were joined at the centerline using UHPC and stainless steel rebar. This slide shows the placement of the waffle deck system.

On each of the four projects, a different method of forming the joints was used. On this project, the contractor used sandbags to secure the top forms to the deck. As you can see in the top photo to the right. And as you would expect, the use of chimney to maintain pressure head was a common practice, as shown here. UHPC is added through a chimney to make sure the joint is completely full and the process is repeated until all joints are completely filled. On a typically bridge size you probably cannot fill all the bridge joints in one day, so you have to come up with a system where you could divide the joints. Mainly because mixing UHPC is a slow process, especially if you're using small mixer. This slide shows a view of the completed deck from below.

Some of the lessons learned on this project were that it pays to have simple joint details. Also the coordination between the contractor and the UHPC supplier is a must. In this case the contractor, it was his first experience with UHPC, but he was willing to listen to the supplier, and now it really contributed most to the success of this project.

In general, UHPC allows you to simplify joint detail in terms of widths and reinforcing development. It gives you more durable joints. It limits or prevents water penetration so you would not have problem with corrosion down the road.

The second project I want to talk about is the US-6 over Keg Creek, which is located just east of Council Bluffs, Iowa. This project featured a precast modular grid system, precast pier columns and caps, abutment footings and wings, and UHPC joints between modular superstructure units. It was the first bridge in the US using full moment-resisting UHPC joints over the piers.

This slide shows the layout of the superstructure system. It consisted of six modular units. Each unit is a precast concrete deck on two steel rolled beams. Exterior units included the barrier rail.

As I mentioned earlier, different joint-forming methods were used on each of the four projects. On this project, the contractor used Tapcon screws instead of sandbags to secure the forms to the deck. Almost 10,000 screws were used. As a bridge owner, having that many holes in a brand-new deck is not really desirable, so one of the lessons learned here is that if you don't want to have any screws drilled to your new deck, you probably will want to have something specified in the plan to restrict that.

The photo on the left side, you see the plywood forms secured to the bottom of the deck and the abutment back wall. The photo in the middle shows the construction crew wetting the joint services ahead of the placement of the UHPC, which is very critical. On the left – or on the right you can see the joint at the completion. It is covered with the top forms.

As you can see from this slide, seam congestion in the joint was an issue. The joint width at the top was 6 inches with U-shaped hair pins projecting from each side, plus four rebar, one at each corner. I would say definitely this was overkill for a UHPC joint. With UHPC, you don't really need to have that much steel.

So, lessons learned here: you need to think about the constructability of the joint. To be fair about it, this project was the first application of UHPC joint between modular units, and it was substantially approved test improved on the next modular project in Iowa.

Surface preparation is another parameter that is very important to the performance of UHPC connections. It is very crucial to have the proper superstructure in the joints, which can be achieved by either applying a retarder to the forms before casting and following-up with pressure wash after form removal to expose the aggregate, or you could have aggressive sandblasting, or you could use a textured form liner. Unfortunately on this project we had to rely on bonding agent only because the casting method that was used by the contractor did not allow for early removal of the form to use the exposed aggregate method, and we could not do any sandblasting because we were using an epoxy-coated Rebar and we did not want to damage the epoxy coating.

This photo shows typical placement operation of UHPC, the use of motorized buggies and troughs is very common practice on these projects.

The purpose of this slide is to highlight the importance of having tie forms when you use UHPC, and also highlight the drawbacks of using hidden joints.

On this project everything was going great until we ran into this so-called bottomless joint. The contractor lost a significant amount of very expensive UHPC before discovering that a hidden form on the bottom of the back wall probably got knocked loose during backfilling.

In any case there is no need to use UHPC in joints below deck surfaces. So lessons learned here: make sure that you have super tight forms on when using UHPC and avoid hidden joints.

On this bridge, UHPC was used in a vertical joint between barrier rail sections. It is probably not a good use of UHPC unless you really need it for structural performance. This project was completed in late October/early November, so installation blankets were needed to protect the joints from cold weather as you can see in the top photo. The bottom photo shows what the joints would look like right before grinding.

And this slide shows the grinding and the surface texturing operation to achieve the smooth profile. With UHPC you have very short window for grinding – prior to getting a minimum compressive strength of 10-12 ksi. As UHPC starts to increase in strength above 12 ksi, it gets tougher to grind but it is not impossible.

The third project I want to talk about is located on Iowa 92 over Little Silver Creek just east of Council Bluffs. We call this project the second-generation Keg Creek, because we took what we learned from Keg Creek, which was the first project with modular units, and we applied it to this project.

The UHPC longitudinal joint details described here on this slide are a major improvement from the previous project in terms of shape and width, as we specified 10-inch wide joints with diamond-shaped key. In terms of surface treatment, we specified this surface texture options, and in terms of reinforcing steel, we simplify the detail and used stainless steel.

For the transfer joints, we probably could have used UHPC, but we opted for traditional concrete in consideration of cost and also the ease of use of traditional concrete and the contractor's comfort and experience. Also traditional concrete is going to give you faster strength gain and cure, and concerns about—that's in terms of design—concerns about transferring the flexural stress over the piers.

This slide shows joint layout and typical details with the UHPC longitudinal joint. And this time we said no to the 10,000+ screws drilled in our new deck. The contractor used a joint system to secure both top and bottom forms, as you can see in these photos. On the upper right, this is a shot of the inside of the joint, you can see the coil side inserts in the stainless steel Rebar, and the bottom photos show you the top and bottom forms secured to the deck. This project was completed in late fall, so typical cold weather protection was also needed, and they had to apply heat.

The last project I want to talk about is in Buchanan County. It is a 52 x 32 full extension UHPC pi girder bridge. It was a demonstration project using a South Korean UHPC mix. It was collaboration between Buchanan County, KICT, University of Iowa, and Iowa State University. UHPC was used in the pi girders and the joints. This slide shows the bridge layout and different cross-sections of the bridge and the pi girder and the connection details.

The UHPC longitudinal joint made use of simple detail, was L-shaped, bar connected to the girder using a coupler.

This photo shows the current UHPC primary ingredients: the bag binders, the steel fibers, liquid admixtures. All these ingredients were donated by KICT and shipped directly from South Korea. What is interesting about this Korean mix is that it allowed the use of local ingredients like fine sand and locally produced cement. The Korean UHPC mix was mixed in a typical concrete ready mix truck by Buchanan County construction crews at the local shop in Independence.

This slide shows the construction of the UHPC joint and then on the right side you see the completed bridge before grinding.

Throughout my presentation I talked about lessons learned on each project, starting with proper surface preparation between precast units that is critical. It can be achieved by applying retarders to the forms, followed with high-pressure wash to produce an exposed aggregate finish, though it can be done by sandblasting or the use of textured form liners. Also you need to take advantage of UHPC properties and use shorter steel bar extensions in the joint and reduce congestion. You could use stainless steel bars across the joint interface which will give you some flexibility in terms of what

surface texture you could specify, and also it is going to give you backup protection in case of leakage.

Also ensure that all forms are tightly sealed. Avoid the use and vertical surfaces unless you really need it for structural performance. And for deck applications, consider limiting the use of UHPC to exposed deck surfaces only. Really there is no need for UHPC for hidden joints. The use of UHPC in the negative moment, especially if you are relying on it for continuity, is not really proven yet. The use of deck screws to secure forms is not really desirable, and there are other options. Finally, instead of specifying single brand of UHPC, you can specify performance specifications and let the contractor choose the type of mix they want to use.

Is still has to be UHPC, obviously.

So what is next? In Iowa, we developed a set of bridge standards using concrete box girders with UHPC joints for low-volume roads, for spans of 30 to 70 feet—and these standards are available for 24 and 30 foot roadway sections—and we are getting ready to implement on a fleet of bridges. We just applied for eight grants. Hopefully if we are successful we will probably let a single contract for 10 to 12 bridges on the county system. That single contracts will be responsible for supplying the concrete boxes for all the bridges, and also be responsible for constructing the UHPC joint. We thought this was an efficient way of at least introducing a brand-new set of bridge standards, and to give our local industry – to let them know we are serious about the standards.

We are planning on doing another ultra-high performance concrete overlay in Iowa. We plan to use ultra-high performance concrete for overlay on a primary road next year. As I said, last year we tried it on the county system and we were successful. Finally, Iowa DOT is the lead state on a pooled fund study to develop guide specifications for UHPC in collaboration with FHWA. If your state DOT is interested in joining the full fund study, it is listed under solicitation number 1434.

I believe that is everything I have today. Back to you, Jag.

Great. Thank you. Thanks for a very nice presentation. At this point I think we will go to our poll question that will help us learn about the experience of our audience here in regard to UHPC. I'm going to bring this up here and leave it on for a minute or so you can please respond to the questions. As you do that, I do want to give a couple quick reminders. The first one is to type your questions in the chat pod as they occur to you. We will answer them at the end after Mathew was done with his presentation. Please continue to type those good questions there. I see some nice ones pop up. The second reminder is about the PDH certificate. We will have an opportunity for those who wish to get one to put in their information at the very end of the webinar.

I am seeing that the participation is good and slowing down, so I at this point will close the polls, and we will go to the presentation and this time we will have Mathew do his presentation.

Thank you, Jag. This is Mathew Royce from New York State DOT. I'm happy to share some of our experience with the UHPC, especially in the use of connections.

What I have is a slide that explains different connection details that we have been using. And as we go through the presentation, I will show what these are. Some of you are not familiar with this type of superstructure type that I am showing here.

First of all, let me explain why we use UHPC. New York State has been using precast prefabricated components for a long time, and we were searching for a solution for the connections because what we have encountered was the precast product itself is really durable and strong, but the connections usually are more complicated and not durable. In 2008-2009, we started working with the Federal Highway Administration to double up some of these contact the connection details. We finally got some specimens shipped over to the Feds' lab and worked with Ben and his people there, and they did some testing for us. Everything turned out to be really good, and we started using the UHPC since then.

The main attraction for us is to strength and durability of these connections, ease of fabrication in construction, especially with the shorter projection of rebar into the joints, acceleration in the field operations, and also the feasibility of using an emulative design that allows us to use cast in place versus precast option in our construction.

The next slide I have is a section through a longitudinal joint. That joint is over a steel girder top flange. We generally prefer to have longitudinal joints over top flanges mainly because of ease of performing, and you'll also notice the shims at the flanges; that is primarily how we support the panels. One of the attractions for that is actually during the construction sometimes we have done weekend closures for replacing decks and we have done quite a few of them, and speed is very important.

So adjusting the panels after the placement is not an easy thing to do from a time perspective, so they can actually do this array and necessary calculations for the type of shims elevation and once you set it there, great, once you put the panels down, everything comes out to the right elevations. That is generally what the contractors would like to do.

The next one is a transverse joint, which is very similar to the longitudinal joint, except that is near the former, which is not shown here. Also we will have a top former also to contain the UHPC. It's very formable material, if you have a cross slope it is not going to stay there if you place the material from the top is going to follow out of the bottom, so you need a top form to contain that, and there is some double up that is happening now which may help us to avoid that, but right now based on the technology there, we are using a top form, and also we keep an extra thickness or overflow to the UHPC because it tends to settle down, and we don't want to have an area that is lower than the surface in the UHPC. That is generally when we put our quarter inch or so of extra overfill, and our general practice is to have decks diamond ground, no overlays.

So, we generally provide about half an inch of extra thickness for the diamond grinding operation, which is actually shown here, it is almost like the diamond grind surface is shown here.

The next slide I have is a slide of a layout of a three-span structure over I-81 that we double up this deck replacement. What we actually do is we provide the contractor with a cast in place design, and we understand that they will use precast. So we don't tell them the layout, it is up the contractor to direct that. This particular drawing is a drawing prepared by the contractor and the fabricator submitted it for our approval, and the benefit of that is we are allowing them the freedom to slice and dice the deck the way they want it so it is easier for them to fabricate, transport, and placed the panel, and we find it really attractive for them to use this to make their life easier by doing that work for their convenience.

We are not concerned about the location of these joints, especially because our joints are stronger than the panel itself, so it is definitely stronger than the precast solution, the cast in place solution that we had designed for, and also it enables them to make a judgment on which is more economic, easier to fabricate and transport, or more joints. The joints are expensive, so that is another reason why we let them do it.

This also gives us an opportunity to use this system for cast in place versus precast option. We have done multiple projects like that. Some of them went cast in place and many of them went precast. We give them the cast in place design and tell them you make it the way you want and tell us what you want to do, and that way that marketplace decides whether the system is economically viable, and this allows us to do that.

The next one is a slide of the joint and you can see the exposed aggregate finish. The first few deck replacements we did, we did not use that, and they tended to have some leakage issues, and then we started moving into the exposed aggregate finish that Ahmad was talking about. That is the only one we use these days—that in addition to the exposed aggregate finish. After diamond grinding we generally use methacrylate to seal any leakage. The way we do it is we give the contractor the option to demonstrate to us by testing that the joint is leak resistant or they can apply the methacrylate. And that seems to be working very well.

This is the deck to girder connections, and the first one on the left side is the conventional deck with a cast in place deck. The second one is a precast with openings coming out of the top of the precast slab through which they can install struts for the shear connection, and in those situations, we have to use UHPC only for that connection to the flanges, because the durability of the deck itself is a concern. The right one is another option where the hidden pocket – that one has two ways of dealing with it. Either use UHPC to fill that space, or you can use conventional grout. If you're using UHPC, the next slide will explain a little bit more. If you are using UHPC, that is the second picture from the top, you can have shorter struts. The benefit of having shorter struts is it is not going to interfere with the transfer of reinforcement that is going through the opening for the pocket. So that makes it faster for installation. The negative about that is UHPC is more expensive. So we generally provide the contractor the option of using either one of them, and they can pick and choose based on which is more beneficial. Do they want to make it faster, less complicated in the field? Or do they want to save money on the grout by choosing a non-sheer grout? With UHPC, based on the test that is done by Federal highways, you don't really need to have the struts penetrate into the deck.

This is a view of that hidden pocket that was prepared for the testing for UHPC. One is for steel girder connection, the other one is for concrete girder connection. Both of them performed very well, and we continue to use that. Right now, one thing about that is that hidden pocket tend to provide a thinner slab around the pocket, and if the contractor is not very careful in handling these nails, that could tend to crack more, especially at those locations. And we have had a few incidents of that. We don't really want to see that, so we are now working with the Federal Highways to come up with a new detail where that problem is also solved, and hopefully we can get some -- I am expecting some positive feedback from them and maybe adopt that in the near future.

This is the longitudinal joint I showed you. In this particular case, you can see the struts are below the rebar, and this is a very easy way to form and pour the longitudinal joints above the top flange of

the steel girder. You can see a tie down in the middle that is used to hold down the fascia panel, which is having the concrete pad attached to it so it is a little bit tippy, so we hold it down by using some tie downs there.

And this is the view of the hidden pocket. You can see a little bit of solid and to that pocket. That is generally used to support the panel on top of the girder. It is beneficial to do that.

This is the view of the finished steel system. You can see some of the shorter -- the first interior girder has shorter struts. It has that joint on top of it—the longitudinal joint—the other ones are longer. You can also see the shim blocks on which the panels will rest and carry load to the girders. That is an easy way to set up and install these panels. I would prefer not to use the longer struts because it is faster, but once the quantity of the UHPC comes down, maybe the contractors will opt for that more and more. I have seen a few of them opting for that in some projects.

This is the panel placement, which if everything is done right, it usually goes pretty fast and then we took more time removing the deck than placing the deck back on. This is another -- this is a cross-section of the panel with the concrete barrier. This is really useful for excavating construction because UHPC joint goes all way to the top of the barrier, which Ahmad showed that too, and in this case it worked out really well for us.

This is the installation of the panel with that precast barrier as part of the panel. It is a tight space, but they worked it out. The contractors are smart. They know how to handle these kinds of things. These are weekend closures, and they managed to remove the deck, put all the panels down, put the joints down, and were able to open it back up on Monday morning. That is quite a bit of an achievement.

This is the hidden pocket from the underside; you can see the exposed aggregate. They used non-sheer grout for this. Back when we were using these for these projects, we wanted to limit the quantity of the UHPC to begin with because we had some issues with the fiber content, steel fibers coming from abroad, so the quantity of fiber for project could be limited because of that, the foreign source, so Buy America stopped us from using more quantity of UHPC so these hidden pockets were predominantly using ground rather than UHPC. Now it is open. The materials are here and there is no such restraint.

But the quantity that – it is attractive to use grout from a cost perspective. UHPC placement, as I showed you before, you have the top forms to hold the material down…it takes quite a bit of time to mix and place this material, but nowadays when we have large quantity of placement every day, they have used multiple mixing units, and they have quite a bit of quantity to make that placement. We have major projects going on right now. We have a project in New York City and that is going on at least year and a half, and, while defined as a cast in place deck, the contractor proposed as a value engineering using precast, and they cut about a year and a half out of the whole project out of a five-year project, so we allowed that.

And the other one is the deck bulb tee. This is the first application of the UHPC where we use our own deck bulb tee longitudinal connection. This is the view of the first application. It was done in 2009, longitudinal joints with the UHPC. It is a full moment connection and we doubled up our distribution factors based on the decline, and we also instrumented those bridges to make sure the

assumptions and the distribution factors are correct, and that actually came out to be a conservative approach after the instrumentation and the study associated with that.

This is the view from underneath. You can see the UHPC joints are a darker color. It is still performing very well. In this particular case we had an overlay—an asphalt overlay —on top of this first application.

This is another similar application. That is a type D next beam, very similar to deck bulb tee in its performance it has a full top deck on it, with UHPC joints between them. In addition to the joints, I think they also use this material—this is a super structure replacement project—they also used it to fill under the bearings—the UHPC was used. So in the case of pedestals that you pour, you fill under the bearings usually with regular concrete, but this one was UHPC to make it faster and easier to do, so that is another application of the UHPC that we have used the material wisely, I believe. This is a modular deck beam similar in nature, longitudinal joints, we are seeing quite a bit of use with this to speed up the construction. Generally speaking, next beam that we used, type D, in the range of about 40, 45 to 60 to 70 feet spans, the modular deck beams, probably one from about 60 to 110 and deck bulb tees usually go from 80 to probably about 130, 135. One-hundred thirty-five is the longest we have used for deck bulb tees.

A good application, it speeds up the construction; it's a very efficient system, and we like it. Whenever we have an opportunity to use it, we have no concern about that. We have used it on the interstate and in major projects, so we are confident about the durability of this. This is another application of a connection between the precast approach slab, also the connection between the deck and the approach slab. We generally use a jointless system whenever we can for the connection between the deck and the approach slab. This is what we are seeing here. There is a bond breaker on top of the back wall that allows the moment of the bridge due to temperature. And also we generally grout underneath the approach slab to get a complete, full seating of the approach slab.

Another application we have used it for is semi-integral abutment backwalls. This was proposed by the contractor. We had a UHPC for connections between the units, but they found it difficult to ship a unit with the back wall that is hanging below that. So usually that is the type of hanging backwall use on the abutment. They came up with a system that is shown here where the backwall is cut into pieces and the UHPC is used to connect them. It turned out to be a very useful, easy construction solution and this is the fabrication of that module. The back wall is ready to be poured as part of that, and you will see it is sitting on the yard for the contractors to pick up, and this is the bridge seat, where you can see the bottom pieces are there, the top piece is exposed aggregate finish, and when everything is said and done you place the UHPC to complete the whole bridge system.

Another exciting use we have is the UHPC link slab. We used that early in 2012 for the first time. We have been using link slab or cast in place also, but the UHPC gives us particular attraction because of its ability to accommodate rotation, and this one is ideal for that. When you use pre-task decks or when you are simply removing and replacing joints on existing decks, we tend to use UHPC link slab. A sample design procedure is available for you to download if you would like to see that, and I think more and more states are interested. I have received calls about that in the recent past.

This is the first bridge we designed with the link slab. You can see the middle support, that's where we eliminated the joint. This is a precast deck system with UHPC joints. After diamond grinding it

looks great. You can't even see the joint in the middle. It is a really attractive solution and working very well.

And then going into specifications, we use a non-proprietary specification and we have a set of standardized qualification testing for the material, and once that is done that material can be used in any projects as UHPC. They only need to do the quality control test that is necessary during that actual installation of the joint material.

Lessons learned:

Based on our experience, one of the things we noticed straight from the get-go is proper material storage is very important. If this material is not stored correctly and has a chance to absorb moisture, you usually get silica bore in the mix, and we don't want that, so they have improved that practice quite a bit. I don't think we are seeing that too much anymore.

Pre-wetting the precast surface is very important. UHPC is a very low water penetration mix. You don't want to lose any more moisture to the existing concrete, so that's very important.

Consolidation settlement of UHPC is an issue. We generally use overfill to counter that.

Formwork, as Ahmad was saying earlier—it is very important to have a leak-proof form work. They do leak if you don't have the right form.

Mixing time seems to be better now because of bigger mixers, multiple mixtures, the contractors are getting used to handling this, and we have a lot of contractors experienced in UHPC now, so there's less of a problem there. For some of you who start for the first time, the contractor may have to go through this and learn by doing it and understanding it.

Strength gain issues: for actuated deck replacement, we used an actuated cure. We cured all the way up to 110, 105 degrees. We use the maturity method, so we get strength in about 12 hours, we get about 14 ksi, and we use the maturity method to make sure we get there. Some of the cylinder tests were done later on to make sure our maturity levels are still intact.

Specimen preparation is also a little bit of an issue. You need end grinding of the specimen core to get the correct strength results.

Going forward, we see UHPC as an attractive solution for us. It is kind of growing in the market now because design builders are using it quite a bit, and also when you give the option to contractors, they are going in that direction.

We have also used UHPC for a column to capping connection, which I am not showing you. It is a very good solution, but we have not fully developed that detail, which is why I'm not showing it to you, but we are committed to developing that, and in the near future we will have further detail for that. It is a very, very useful detail when you have replacement caps or when you use precast components to connect each other, it is a very easy simple solution, very easy to construct, faster strength gain, and all that nine yards. That is what we are really focusing on. We are also interested in UHPC overlays. We are looking for a few projects, and also we are participating in the cold

development with other states, so I see an exciting future for the use of UHPC in New York. That is all I have. Thank you.

Thank you, Mathew. Appreciate that very much. Very rich and varied experience with UHPC not only for superstructure connections but you did allude to that substructure to superstructure connection, and I'm sure others will be watching it in your progress.

I think now we are getting to the Q&A stage, but before I get there, there is one additional poll. I think this is related to the challenges, the obstacles for using performance-based UHPC connection specifications. I already see a question of the chat pod that was posed in this regard. I think this is an open answer type poll question; it's not an objective answer question, so I will leave it on here for a little bit so you can see it. The specific question we are asking you is, what are the obstacles you see for requiring a performance-based UHPC connection specification as opposed to one that, in the specification, is for using a proprietary product? Some people have had stated some concerns regarding the quality schedule issue, and other issues. If you don't mind taking a moment to answer in a short way what are some of the challenges, it will help us create more education products and guidance.

I'm going to leave this up here. The next phase is really the Q&A phase. We have a number of questions coming in, so please continue to feed those questions into us. As part of the Q&A phase, we will have all three speakers who presented today, Mark, Mathew, and Ahmad, answer some of the questions, but in addition we have two more experts join us for this part of the presentation. We have Ben Graybeal from the Federal Highway Administration and Andrew Foden from WSP Parsons Brinkerhoff joining is, and as a brief introduction, Ben is the team leader of bridge engineering research at FHWA, and he is perhaps one of the nation's most prolific UHPC researchers and research program managers. He has extensive experience in UHPC and has been working on this innovative product since he officially began this work in it in 2001. Andy is the senior bridge evaluation and technology manager at Parsons and has overseen the placement of over 1 million square feet of precast bridge deck with UHPC.

Both of them are experts and certainly your questions stated today will be answered by today's presenters but if there's something general our other experts are available as well. Thanks for responding to the short question here, but I think we can … I will keep this open for a little bit and then they can jump right into the Q&A there. I'm going to take the questions as they have come in the sequence as much as I can and have our panels answer them.

The first question is from Daniel. The question is, is it possible to use galvanized stainless forms —I guess in this case metal forms—I get the sense of the question is what is the compatibility with UHPC. I assume by extension you can use other types of forms like maybe fiber reinforced and other types, so is the issue with using these forms? I'm going to say I will direct the first to …

I can that this one. This is Mark Leonard. Like you said, the question is ultra-high performance concrete compatible with galvanized steel forms, and the answer is yes. It is Portland cement concrete, so yes, it would be compatible with them. For the connections of deck level precast panels, still stay in place forms wouldn't necessarily provide any advantages or would not even be applicable, but they would be compatible with ultra-high performance concrete.

Excellent. Thank you so much for taking this one. The next question is for Ahmad. The question is, did the project using Korean UHPC have Federal funding?

The answer to that is no, Buchanan County did not use Federal funds. They actually built the bridge themselves and they had the material donated by the Koreans, and the only State money used was more related to research and testing, but other than that, no.

Okay. Thank you, Ahmad.

The next question is from Adam, and the question is has anyone used a shrinkage reducing agent or even expansion agents to resist joint leakage. This is a very interesting question. Ben?

Sure, I will give it a try. I know that there are people who are working on at, but it is a little more difficult than it sounds. Whenever you're dealing with something like an SRA or an expansion agent you have to have the timing just right, so that when the materials inherently wants to be shrinking, you concurrently have a chemical reaction happening that is causing it to expand. It is not simple to make that timing happen just right. The better solution that people have been using to date is to try to make those UHPC shrink as little as possible, so using traditional concrete chemistry methods, have it shrank less, and if you have it shrank less than you can have good bond and then you don't have the joint leakage issue. So far that has been where people have been tending to go.

The next question I'm going to go is, if UHPC is used as an overlay, is top-forming needed? I know that Mathew just ended saying they are looking at some application projects on this, so I'm going to go to him first --

I can answer that. I think the materials that they have developed probably don't need that. Probably Ahmad is a better person to answer the question because they have done one already anyway.

The answer is no, you do not need to form it on the top. It's going to look like any other concrete for overlay. It is designed to be used as an overlay mix.

Okay.

If I can just add, there is a chemical that is added, so then your UHPC is not self-leveling like you have probably seen videos. We use UHPC in connections is self-consolidating almost to the point of being self-leveling. Using it an overlay situation obviously that would not work. You need to add some sort of an admixture that stiffens the mix.

Thank you for the answer.

Next question, and I'm going to let Andy take it, if he can. How difficult would it be to remove UHPC for future rehabilitation?

That is a great question. On the Pulaski Skyway where we had numerous connections, it had problems, it had to be taken out. You are talking about a material that the compressive strength of 25 ksi or more, and bonds very well to steel, so it would not be easy, but it's also not impossible. Typically on a precast deck panel bridge, your transverse joints are only overtop of the girders intermittently so it would only be small areas we have to really worry about that, plus the haunch

areas, but it can be done. It is a lot of work. You have to use a proper tool to make sure you are not damaging the steel, but it will not be easy.

Next question is for Ahmad. Is Iowa DOT using UHPC performance specification for procurement. We know the answer from New York State DOT, the answer is yes, right Mathew?

We are using a non- proprietary specification.

Okay. Ahmad?

On the four projects we presented, we did not use performance specifications. We actually did specify the material, but on future projects, we will not specify material. We will just use performance spec, and we already have that performance specification included in the standards for the concrete box girders. For the future from this point going forward, we don't have to specify a specific brand.

Great. Okay. I think the second one is does New York DOT contracts have time limitations for construction included in the specifications?

It is not in the specification for the UHPC. It is generally in the contract for the time limitation. They usually have incentive included in the contract, so the contractors know what the timeframe is they have to work with.

So it is the contract clause, not the test …

Yes. Not a spec clause, it's an overall contract clause for time limitation.

Just to elaborate on that, the next question is based on the contract clause and the contractor will be able to choose the method…

Yes. That is an important thing about the option that we talked about. If there is a duration specified, they know what they are going to get into, so they can decide whether they want to take a chance with one or the other and decide what their risks are. And that's how they do it, and in some cases they are willing to go with the cast in place option where they feel like they can actually make it on the material side of things, and some other situations they don't want to take that chance, and it is too risky for them and they would decide to go with the precast solution with the UHPC joints.

Great.

We have a couple more questions. Does New York DOT specified detail for forming the joint where UHPC is used?

We don't specifically a detail. In the past we had shown some detail in the plans as an example of how you can do it. What we require is a leak-proof joint that they have to provide us, and also a mechanism to overfill the joints. We don't specifically dictate the details of the performance system itself.

Okay. If that is the case, I think the next one is related to that, and I think both of you can answer this. Has New York DOT or Iowa experienced problems with leaks to the longitudinal construction joints over the top flanges? And maybe others can amplify?

On the very first project we had in Iowa, we did have some leakage. It was not directly over the top flange, but because the joint was not located over that beam, but that was the very first project. That's where we did not specify surface texture, and we used the bonding agent, so that was one of the lessons learned.

Okay.

We had some in initial cases where we encountered some leakage issues. They were able to handle it during construction. The most important thing if there are areas and that have potential for leakage and we cannot even see it, then the leakage will happen and leave behind a void within the joint without you even knowing it's there. That is the bigger problem of leakage.

Right. The next question is what was the span length of the Route 31 bridge?

I believe it was about 90 feet. The first one we built. After that, the maxim that we have done is about 135 or something like that. The first one, to answer the question, the first one we did was about 90 feet.

The next question is, can you provide a link for the example design of the UHPC joints that you mentioned? And this was for you, Mathew, maybe this is a good time for you, Mathew, to share some of the resources that that we have here. This is one of the resource documents that we have in that share file.

This is the link slab question. It says UHPC joint, but they didn't mention which one. Is there a resource that you can make available?

I think that is the Federal Highway publications are the best resources for that works but --

The design and construction report from the Federal Highway, HRT-0-84. It is in the download pod.

It is in the file share pod and I'm not seeing the file share pod on my screen. Is there something I need to do to get the file pod…

It is only accessible from the main screen.

Okay. There it is. It is the UHPC state of the art report.

No, I'm sorry, Jag, it's the second one in the list, it's the design and construction of the UHPC connections.

As a reminder to all the viewers, there is a host of resources here. I think the one Ben just mentioned is the design and construction of UHPC. That would have these details. There are a number of other resources that I would like to draw your attention to. One is the UHPC state-of-

the-art report that you can download through this file share pod, in New York DOT plan set for deck bulb tee project that Mathew described, the link slab design. There is a resource for that.

The entire slide set from today can also be downloaded in this file share. NYDOT has the precast drawings for the six span bridge on I-84. Those drawing sets are available for download and we'll have the cast in place options for the same bridge. In addition we also have a flyer which includes the link for webinar number three. That can also be downloaded from here. And Iowa DOT's reference document for the research and projects that they usually provide for ABC are available for download. There are a lot of resources in the pod share that you might want to reference.

Moving on, there is a question from the TXDOT bridge division. TXDOT recently intended to specify UHPC for closure pours in a full depth precast deck application, but the reaction from the contractors during a preliminary plan review was overwhelmingly negative. How do you overcome problems associated with cost and lack of availability in areas where UHPC has not been utilized?

Ben, can you lead that discussion first?

Sure. Certainly there are geographic areas where it hasn't been used yet, and when you are in one of those areas you have to choose to be a leader if you want to make it happen. It is unfortunate that Texas tried and was not successful, but I would hope they would try again. You know, contractors like to do the work that they like to do. They know how to make money and no one grudges that, but as an owner if you want to move forward with your new technology, you sometimes have to help make that happen.

There are a limited number of suppliers. There are a limited number of contractors who have pre-existing experience. It is new technology. None of that is surprising. As an owner it does come down to you deciding if you want to do it and if you do then you have to help make it happen.

Mathew could you speak down New York has helped make it happen now dozens of damages they?

Yes. Actually takes a little bit of effort to get this thing moving, and we definitely work with the Federal Highways and we just decided to move ahead with some trial applications, which the cost is going to be higher, we understand that, but we also understand that for accurate construction you need this tool, and probably even other tools too, to make it possible, and we have a high demand for it, so we started using it and once they get used to it the contractor builds up their own skill sets and they have confidence, then they see the value in it. It is hard to justify this. I'm being honest with you. And there are special applications, like the link slab or some kind of superstructure, or substructure connection between cap beam to column; there are exceptions. But for a wide-scale precast deck application, you need to have the need for accelerated construction, and then it makes sense, economic sense, to do that. As I said, design builders are asking for it because they will do anything at that is attractive for that because for them the first course is the main thing, and from the time limitation that they have to work with, they find it attractive to do that.

It takes effort and there has to be a need for it also works but I think that is a good summation is basically the market chooses to use the technology, and has got to be a win-win for all, but appears from your discussion that it is something that the market is finding attractive depending on the application and the need on the project.

I'm going to go to go rapid fire on this last question, it seems like we have to wind up after this, but I'll let everybody who has an answer for this go. The question is a little open ended. The question is, what is the fastest time you've ever realized from completing placement of UHPC to reopening the traffic? I'm sure it depends on the application. Do you want to go first Mathew?

Yes. You are talking about the whole project, right? I assume that is the case. We have done multiple deck replacements using UHPC connections for the precast deck panels during the weekend. We close the bridge Friday evening, and then remove the deck, repair the steel for receiving the panels, and by Monday morning we were able to open it back to traffic, and one think I want to mention there is even though you open that, we did not do full diamond grading at that time. You grind the joints down so the traffic can go over it without a problem. Is not going to be 100% smooth, but it is reasonably good enough to take the interstate traffic. Then you come back later and diamond grind it lane by lane without any major impact on traffic, sometime during the low traffic time we take lanes out and diamond grind that. That is the approach we have taken. We have done weekend closures for superstructure replacement also. That can be done. That is basically what we have.

Very good. Anyone else?

I guess the biggest factor is what strengths you need to get out of the UHPC before you open traffic, and that is kind of dependent on the temperature. If you have colder temperatures, it is going to take longer for the UHPC to care and gain the strength you want, so it depends on what you want to acquire in terms of strength, and what temperature, and what do you have to do to get this strength? Typically is that you should be able to implement a couple days from our experience.

Right. Thanks. That's all we have time for today. Thank you for the great questions. I'm going to administer one more poll. I have pointed to the resources that we have in the file share. Please take advantage of those. I see Mark Leonard posted the New York DOT specs that were requested. The final poll we have coming up here is on the webinar expectations, so if you would not mind filling this new poll on whether your expectations were met today, and that will be our final poll, but I do want to thank everybody for participating and all our speakers. There are a couple more concluding items that I would like to go over before we close. I'm going to give just a few more seconds to give some feedback on the webinar itself, and then I'm going to end well call shortly after that.

Mark as a question about UHPC: Mathew, can you provide the link for example using the design of the UHPC joint you mentioned?

I can provide that detail, but I don't have that right away, so at some point in time I can provide it.

Yes. That is great. Thank you.

Those resources were made available to you. The state of art report, Mark mentioned the UHPC website. It's very easy to find, in Google type the words "FHWA UHPC," go to this website and it has a wealth of resources related to UHPC, as well as our own webinar series and the announcements related to that.
In closing, we did the polling. We do have an upcoming webinar; the next one is on structural design detailing and designing UHPC. We have some really good speakers lined up for you to talk about the technical aspects of designing and detailing UHPC and going a little in depth, both from an agency and research perspective. Please be sure to dial into that. I'm going to leave you the contact

information to FHWA key personnel involved with the Every Day Counts UHPC innovation, Mark Leonard, who was today's speaker. That is his phone number email, as well as Ben Graybeal our panelist and FHWA UHPC technical expert. His contact information is available here, as well.

So, I would like to say thanks to all the participants. A recording to this webinar will be available at their UHPC site that he mentioned earlier, and we really thank you for participating in today's webinar. For those of you who don't need a PDH registration, you can log off at this time. The formal portion is concluded, but those who wish to have PDH certificate to get mailed to them, I just brought over a PDH registration pod. If you would need a PDH certificate mailed to you, please type your email address. We will leave this pod open for several minutes, 15 to 20 minutes, after the conclusion of this webinar so you can type in your information there. Thank you, again, to everybody.

[Event Concluded]