Applying ABC Concepts to Long-Span / Complex Bridges June 2013 Webinar Questions	Response
General	
Define what you mean by long span and how complex can the bridge be and still be built by ABC methods.	A span length of 500 ft has often been used to distinguish between long span and conventional bridges, but this is not a meaningful distinction. It may be better to distinguish long span bridges by typologies i.e. cable supported bridges, rather than span length alone. It is my view that there are no inherent limitations to ABC for long span / complex bridges. It is rather that ABC techniques with reduce field labor and construction time are often desirable and cost-competitive.
Discuss if you have any concerns with potential risks of applying ABC to long span and complex bridges.	There are three primary sources of risks for ABC in their application to long span bridges: 1: the technique does not achieve adequate geometry control, which can be crucial to the overall success of a long span bridge, 2: the technique compromises serviceability of a major load carrying component of the structural system, and 3:the technique tends to localize risk to the ABC construction stages which, if not properly managed, can result in severe schedule delays damage to the partially constructed structural system.
What is the % of cost/schedule reduction that can be expected?	It is difficult to assess, given the range of potential long span bridge types and potential ABC techniques. In my past work, there are circumstances of at least 25% schedule savings, and 10%-50% construction cost savings.
Explain the relationship between design/build and ABC.	For long span bridges, the use of design build as a delivery system tends to promote opportunities for application of ABC. While the majority of my past projects were delivered in the more conventional design bid build environment, it is clear that for many long span bridge typologies, it is necessary that the engineer at least develop a conceptual way to erect the bridge. Given design build, where the designer can fully engage in both design and construction of a long span bridge, I feel that there are even more opportunities to integrate ABC into the project.
Design	
Has there been a case where ABC Construction has created a constraint for the project design and, if so, how did you work around this?	Yes, I would say once you start with an ABC philosophy, many constraints are added to the design process. Probably the best example is the Mary Avenue Cable stayed bridge, which required only night time lane closures for bridge erection. This more or less dictated every aspect of design, the size of elements, where falsework bents were placed, how much could be erected in a given night, what should the erection strategy be, even what should the interim geometry of the bridge be to help in cable installation. The outcome is a bridge that needs very little time for erection, a logic that makes perfect sense over a busy interstate.
How were the curves accomplished in the first bridge if all the sections were the same?	It’s a good question, the most important strategy is to use a circular curve which does not change curvature (as for example a parabola does). The next is a decision to use a polygonal shape, i.e. each segment is straight, and not curved, and third (probably most importantly) that every field section be exactly the same length. This introduced more field sections than would be typical of a cable stayed bridge, but the advantages of repetition more than outweighed the additional segments.

Can you comment on the use of kinked girders versus curved girders as an ABC technique?	I have used kinked girders on a number of occasions and feel that in many circumstances, particularly for long radii curves, it's the way to go. One has to be a bit careful with diaphragm and splice locations, together with flange lateral bending, but with some careful thought and engineering, it results in a system that is both much easier to fabricate and erect.
What are some rapid deck replacement options for long-span (8000' long) bridges?	This is an important question that can scarcely be answered in a few sentences, but I would offer that heavy prefabrication in terms of steel orthotropic, overfilled steel grid, and full depth precast concrete deck systems are all viable alternatives in most cases. For long span bridges, where weight can be a major driver, particularly for suspension bridges with corrosion damage to the main cable, lighter weight systems like orthotropic or grid deck systems are often necessary. In addition, elimination of stress relief joints on long span bridges is an important goal. We have been working on floating deck systems for long span bridges whereby we eliminate stress relief joints, that are particularly promising systems.
What are your thoughts on precast segmental arch bridge construction as an ABC method?	Precast segmental arches offer some major advantages, particularly for shorter spans whereby falsework can be readily deployed. Cast in place closures are often necessary, although we have been working on some strategies for three hinged arches where no such closure is required. There are practical span length limitations to this sort of construction, this is a primary drawback.
Can you comment on skew versus straight abutments?	Well, for long span bridges, it almost always makes sense to square the abutments, given the incremental change to an already long span represents an additional cost that is almost always less than the complexity and cost associated with skewed abutments. However, arch bridges and truss bridges are relatively straightforward to skew, and I can imagine circumstances, where for highly skewed bridges a skewed system would be more cost-effective.
Does your mesh 'railing' on the pedestrian bridge comply with AASHTO requirements for railings?	Yes, and in some cases more stringent state requirements in terms of aperture size. It should be noted that there are tensioned systems, which require pretensioning in order to minimize displacements.
Costs	
What is the design and construction costs of ABC relative to more conventional methods?	It is my hope that we have demonstrated in circumstances where a good degree of repetition is achieved, that costs can be less, in some cases, significantly less than conventional constuction
Can you comment on Life Cycle Costing of ABC versus conventional construction for long-span / complex bridges?	Life cycle costs should only be negatively impacted by ABC if the service life of PBES joints are compromised. This remains an area of focus, particularly for deck and superstructure elements, such that we obtain systems that are indistinguishable from conventional bridge construction in terms of service life.
How did the fabrication cost compare for the top and bottom chords of the truss to traditional truss chords with gusset plates?	It was quite clear from our competitive bid, that we were more cost-effective fabrication, as we had approximately 25% additional steel but approximately the same overall price. In terms of schedule, and erection and field installation, there were additional advantages, both in terms of cost and schedule.

Are the costs related to barge delivery of materials and erection greater than conventional construction methods?	It depends, to a large degree, on the cost associated with temporary falsework for in-water work. In circumstances where foundations and environmental commitments allow for cost-effectvie falswork and trestles, this is the preferred strategy.
Materials	
Do you see lightweight concrete as being a useful tool for ABC for long-span bridges?	Yes, we have used lightweight concrete on numerous projects, and particularly for superstructure systems where weight is a major cost-driver. Movable bridges are a clear circumstance where lightweight concrete is the only logical choice, whether with full depth precast or overfilled grid deck.
What materials work best for long-span / complex bridges constructed using ABC techniques?	Prefabricated steel and concrete elements are ideal for ABC, and we have extensive experience with both systems on long span bridge projects. Better still are prefabricated systems that are designed to support erection equipment and represent additional advantages for ABC methods.
Construction	
Do you have any examples of applying ABC methods to phased construction, specifically for bridge widenings?	Bridge widenings are often very challenging projects, particularly at deck level where it longitudinal joints are to be avoided, necessitating some type of cast-in-place closure. We have used girder pairs with the deck installed for short span widenings successfully, although geometry control between existing and widened is always a challenge.
What is the largest prefabricated component that can be done relative to crane size, transport by land or sea, etc.?	Practical limits for float-in operations are limited by barge availability, with ocean barges typically in the 1500 ton to 3000 ton range. The use of multiple barges can extend this limit (but there are geometry restrictions that need to be accommodated, i.e. for lake champlain bridge, delta frames allowed positioning the load directly under the strand jacks). For overland transport from a remote fabrication site, a width limit of 14 to 16 ft and a length limit of 200 ft is somewhat typical but can be highly route dependent.
Can you comment on the strengthening process for structural elements when required?	In general, steel is much more readily strengthened than reinforced / prestressed concrete although there has been significant development in concrete strengthening techniques in the last two decades. Strengthening connections for either structural system remains a practical challenge, and some foresight on the designer's side could be particularly helpful. I believe there are many circumstances where a bridge that can be easily strengthened would have significantly more utility to an owner than a conventional bridge and this is something that I am doing a bit of research on.
How do you ensure that the fabricated PBES supplied to the site meets tolerance and profile specs during fabrication?	A short answer is good specifications and quality control, a longer answer is to consider handling and erection directly in the design of the PBES.
Have you ever found any fabricated section rejected as a result of dimensional tolerance faults?	Yup. The ability to reject an element prior to erection is a significant advantage of PBES. Also, I have had the experience where PBES are effectively repaired / modified prior to erection.
Durability	
How does the durability and long-term performance of these ABC structures compare with its traditionally constructed counterparts?	It is our goal to achive similar levels of serviceability from ABC and conventional construction. As has been mentioned above, deck joints between PBES is an area of continuous focus and is worthy of further investment and development

How do you maintain / assure quality when performing ABC (I've seen many instances where speed was of greater importance than QA)?	The quality / speed of construction trade-off can be problematic. Good specifications and QA/QC of prefabricated elements is a start. Well thought-out and readily constructable connections / joints, are an important component as well. But the best strategy is to ensure the critical path of the project does not go through some difficult to inspect and to construct component that invites poor execution.
Are there, in general, any foreseen associated problems with using long-span elements for ABC construction?	One concern can be the use of highly repetitive construction where you have a systematic problem. In these circumstances, it is always helpful to construct a mock-up prior to field execution. We have learned more from mock-ups than I could say, and I would recommend mockups in most if not all highly repetitive operations.
What are your comments on joints and shrinkage relative to long-span / complex ABC bridges?	Shrinkage, particularly of closure concrete between PBES elements remains an important issue. We have had some success on the materials side with shrinkage compensating admixtures / expansive concrete, with the use of post-tensioning and with reinforcement design and detailing to minimize crack widths. In these highly restrained regions, some measure of all three techniques can be necessary.
Miscellaneous	
Are there environmental issues that can be better addressed in long-span / complex bridge projects that are constructed using ABC techniques?	Yes, there are a number of ABC construction techniques that can reduce the environmental impacts of a project, particularly with in-water work. A strategy that is becoming more prevalent is the use of PBES systems hung from pre-installed piles / drilled shafts to eliminate conventional cofferdam construction, minimizing disturbances to important benthic habitat.
What ABC methods are being used on the new New York bridge project?	There are a number of ABC techniques that are contemplated for the new New York Bridge including PBES systems for deck, and pier foundation elements for the approaches and main span as well as the potential use of incremental launching for a few of the approach spans. Design is currently underway and it will be interesting to see how much ABC techniques are utilized on this $3+ Billion project.
What was the name of the rail viaduct in Brooklyn, which the presenter mentioned?	Atlantic Avenue Viaduct
Bravo! Ted. Outstanding presentation. Your work validates that long-span bridges have more opportunity to innovate and you guys have excelled. Keep up the great work.	That's super kind, thanks.
I like those prefabricated details that you guys came up with. Very effective use of prefabrication techniques and details. Looks aesthetically pleasing.	Again, thanks.