**The following are questions and comments that were discussed during the pre-bid meeting and others submitted via e-mail with our responses:**

Q: The air content range specified for the steel fiber reinforced lightweight content is 6% to 7%. This range is very difficult to achieve. The range in the lightweight concrete specification has 5% to 9%. Can the steel fiber reinforced concrete air content range be revised to a similar 5% to 9%?
A: The allowable air content range will be revised in the specifications to 5% to 8% for the SFRC. If placement is by conventional methods, going down to 5% is not going to cause any problems for the lower limit. At the higher limit, an increase in air content of 1% decreases composite compressive strength approximately by 350-400 psi. The intent of requiring tight control is to ensure the contractor realizes he is working with a specialized material for a very unique application and not a routine/average concrete material.

Q: The lightweight coarse aggregate specifications require a gradation of ½" to #4 or ¾" to #4. Only one supplier has this gradation in their terminal. In order to include other producers, could the specification be revised to 3/8" to #8 gradation, as this is one of four listed in ASTM C-330 for structural lightweight concrete?
A: The lightweight coarse aggregate gradation will be revised in the specifications to allow 3/8" to #8. Regardless of the gradation, the contractor will need to achieve the desired fresh and hardened composite performance. Aggregate gradation primarily affects workability and air content in the wet state and strength and durability in the hardened state.

Q: Only one fiber supplier in USA produces fiber within the range specified between 1.35" to 1.5". Can we revise the specification to widen the range?
A: The allowable fiber length range will be revised in the specification to 1.0" to 1.5" to open things up to additional US suppliers. Going much higher than 1.5" in length would make mixing/placing without balling more difficult unless the fibers are collated.

Q: The specifications mention a flexural strength of 800 psi for the SFRC, but no mention of what test to use? Also, do you want to qualify the residual strength ($Re^3$) that is required?
A: Flexural strength is evaluated at maximum loads in a typical flexural toughness test for SFRC (much like a MOR test for plain concrete – flexural test using third-point loading, i.e. four-point bending). It is NOT the residual flexural strength (for FRC this is evaluated between prescribed deflection limits). The residual flexural strength is more a measure of post-peak toughness of the composite (and is not representative of the composite's flexural strength). Specification of residual strength requirement would be academic and not useful in practice for service performance (strength remaining after significant cracking). I5 toughness is already specified and would not gain very much additionally by specifying a residual strength.

Q: The contractor is being told by the steel fiber companies that the specification for the type and amount of required steel fibers needs clarification. Furthermore, the 1.5% steel fiber volume fraction would indicate roughly 196-198 lbs. of steel fibers per yard. This would add over 7.0 lbs. per cubic foot and is not practical to batch in a standard concrete truck mixer, place and finish without problems.
A: The volume fraction (1.5%) and fiber length specified here (1.0"-1.5" per above comment) should pose no problems, even with addition of silica fume, with special attention paid to mixing and placement. This dosage was mixed and placed successfully as part of test specimens produced by Dr. Gopal for this project. This is also doable in commercial practice, and the pre-placement trial should be helpful in this regard. Lower dosage rates typically seen (<0.5%) do very little in enhancing the mechanical performance (fracture toughness, impact and fatigue resistance) of the hardened concrete, but rather play a role in control of plastic shrinkage, drying shrinkage, thermal expansion and freeze thaw durability. For this specialized application we are talking about, this dosage rate is necessary and is practically possible to mix, place and finish. It will require more effort than the "superficial" dosage rate. It is our experience that the fiber specification (1.5% Vf of ~1.5" long fibers) is practical and commercially doable.

Q: The Steel Fiber specification G.2.3.1 calls for a steel fiber length of 35-38mm, 2,000 fibers per pound with an aspect ratio between 40 and 60. Type I steel fibers are cold drawn wire fibers with a high tensile strength

(>160,000 psi) and perform better and at a lower dosage rate than Type II steel fibers with much lower tensile strengths (50,000 psi).
A: The specifications do not preclude Type I fibers. No mention of the fiber type is made intentionally so to provide more flexibility in the bids. Reference is only made to ASTM A820 which requires a minimum tensile strength of 50,000 psi. Fiber strength is not an issue (beyond this minimum tensile strength specified in ASTM A820) at the length specified (1.0" to 1.5") because composite failure is by fiber pull-out, even with end deformed, continuously deformed or crimped fibers. In fact fiber strength is really a nonissue, because "fiber pull-out" implies very large displacements/crack-widths – a condition not desired even under extreme service conditions. Fiber type (Type I – Type V per ASTM A820) plays very little influence compared to the more important reinforcing parameters such as fiber length, fiber volume fraction and fiber aspect ratio on the mechanical performance of the composite.

Q: ASTM A820 calls for 10% tolerance for length which is larger than the range specified (35mm to 38mm)?
A: The range for lengths given in inches was 1.35" to 1.5" which meets the 10% tolerance per A820. As noted above the range for fiber length will be revised to 1.0" to 1.5" which does as well. The metric versions of 35mm to 38mm given in parenthesis do not. The JSP will be revised to eliminate the metric lengths to avoid confusions on this.

Q: Section G. 2.4.1 states the mix design shall contain a steel fiber volume fraction of 1.5% (this equals approx. 198 lb of steel fiber per cubic yard of concrete). How was this determined? Does this make sense structurally?
A: The fiber volume fraction of 1.5% was established primarily to achieve desired composite properties in the hardened state and is based on experience with the mechanical performance of SFRC over many decades. This volume fraction also takes into account fiber length, wearing surface thickness, ease of mixing without balling/segregation, and ease of placement using conventional methods or by pumping.

Q: No mention is made of utilizing dispensing equipment for fibers at this dosage rate to help eliminate balling of fibers.
A: Section 3.4.4 allows for any fiber dispensing method as long as it is approved by the Engineer after ensuring that mixing, pumping, placing and finishing techniques ensure uniform fiber distribution throughout the mixture without fiber balling or segregation. After approval, the placement plan shall not be changed unless approved in writing by the Engineer. The flexibility in the dispensing method allows for use of straight, end deformed, crimped, continuously deformed, single or collated steel fibers. The specified placement plan and subsequent trial placements should show whether or not balling of fibers will be an issue.

Q: It was not clear whether the splitting tensile strength (such as AASHTO T 198-09; ASTM C496-04) is to be part of the submittal package for mix approval or whether it will be included for field acceptance during the job. The splitting tensile strength of 425 psi (28 days) specified for the steel fiber reinforced lightweight concrete may be difficult to achieve, consider reducing requirement?
A: The split tension data is recommended for mix approval and is not typically used for field quality control/acceptance. For SFRC, the relation between split tensile strength and compressive strength is not the same as for plain concrete (split tensile strength for SFRC is closer to 8-12% of compressive strength). There are several references for 8-12% range cited for SFRC, so the 425 psi figure is well in this range and should pose no problems. Additionally, the requirement for tensile strength is $0.17*f'c^{0.5}$ (f'c = 6 ksi) per AASHTO code for lightweight concrete (w/o fiber) which equates to around 425 psi.

Q: The time frame to blast clean, metalize, shoot studs and pave the deck is quite narrow. What production rates are being assumed to be able to complete this work within the time frame given?
A: The base rates for these operations were taken from actual production rates used on the IDOT McNaughton Bridge in Pekin Illinois. These rates were than scaled up by assuming 2-10 hour shifts, with 3-4 crews per operation and with the contractor performing multiple operations at the same time (in concert). It was also assumed that once the operations have been performed on the outside lanes, the rates will increase due to experience and efficiency of methods. It is understandably an aggressive time schedule.

Q: Does MoDOT have any experience with previous removals of the polyester concrete test patches on the deck? What can be expected?
A: MoDOT has not previously removed any of the polyester concrete test patches. It was observed during the application that equipment used to pour the patches could only be cleaned with a torch if they weren't cleaned with Acetone prior to the polyester setting up on them. It is anticipated that a pre-heater and pavement heater will be necessary.

Q: Section 4.2 of Bridge JSP I indicates that silica sand and steel shot will not be allowed for the blast cleaning abrasive material, why not? Is steel grit OK?
A: The intent was that steel shot and silica sand would not be able to attain the specified angular surface profile of 2.5 to 5.0 mils per JSP I Section 5.2.6 like steel grit would. The JSP will be revised to allow any abrasive material, however if silica sand or steel shot are selected the Engineer will require a test panel to be used to adequately show that the contractor's method of blast cleaning will meet the specifications prior to blast cleaning the deck.

Q: Does the pressure washing of the deck have to be ultra-high 40,000 psi? How can we confine water during pressure washing?
A: Per Section 5.2.3 of Bridge JSP I indicates that high pressure or ultra-high pressure water jetting is acceptable. The contractor is responsible for confining water during the pressure jetting operation by means and methods.

Q: Does the deck under the north barrier curb need to be cleaned and metalized; the quantities, plans and Special Provisions don't account for this?
A: The intent is for the portion under the north barrier curb to be cleaned and metalized similarly to the rest of the deck. The plans sheets, quantities ("Surface Preparation for Overlay of Orthotropic Steel Deck Plate") and JSP will be revised accordingly.

Q: The staging in the roadway traffic control plans indicates that between Stages 1 and 2 there will be temporary barrier running across the end of the bridge deck on the Missouri side? Will the deck need to be paved in additional stages at this location?
A: No, the intent was for the bridge to be paved unabated from end to end. The roadway traffic control plans will be revised accordingly.

Q: Are the pavement smoothness requirements appropriate for the overlay, especially as it relates to the application of the methacrylate sealer?
A: The Roadway JSP Q for Pavement Smoothness will be removed from the specifications.

Q: What can be done during the application of the methacrylate sealer to prohibit pools of the sealant from puddling in the grooves in the overlay concrete?
A: The contractor is responsible for applying the sealant without it puddling up thru means and methods.

Q: On sheet 42 of 47 there is a detail for a Class 3 Gouge Repair – the repair plate appears to be fastened down to the existing steel deck through a bolted connection. Can you let me know if there would be another acceptable method of fastening this plate (such as welding) to the deck to allow all work to be done from the topside rather than having to access the underside of the bridge? Since we do not have a location on these repairs it is difficult to determine what kind of equipment we would need to access the work area if we have to tighten the bolts from the underside.
A: Alternative repair methods to the bolted plate repair shown on the plans, including welded repairs, threaded studs or blind bolts, will be evaluated on a case by case basis depending on the repair geometry as an acceptable change order proposal. The JSP was revised for this language. Also, the majority of this class of severe gouging was observed in the inside (south) lane of the WB bridge.

Q: Can you explain the need for access to substructure, are these to be temporary, permanent or can what you need be done with a barge and manlift, set up one time per substructure:

A: This refers to JSP S. Inadvertently, language related to providing facilities for inspection of substructure from the ground or water was included. These will be removed from the JSP. The intent is that the inspectors can access everything they need to see from the top of the bridge or thru the abutment houses.

Q: Can Micro Silica be used in lieu of latex modified which requires a mobile mixer?
A: No. For this application, the Micro Silica will provide inferior performance compared to the latex modified concrete.

Q: Why would there be half-soling with hydro-demolition, won't the hydro-demolition remove all the bad concrete?
A: The intent is that the hydro-demolition refers to the removal of the top 1.5" of concrete for the entire area of the abutment slabs in order to place the latex modified wearing surface. The half-soling is for areas where there is deteriorated concrete beyond this level, especially below the layer of reinforcing bars. After hydro-demolition the Engineer shall delineate the areas for half soling. Please refer to Sheet 7 notes of the bridge plans.

Q: Since the quantity and exact method of the polymer removal under the surface prep is not known, would you consider making this a time and materials item?
A: No. Assuming this refers to the removal of the 6500 sf of polyester concrete test patches, which is under Removal of Concrete Wearing Surface, the area of the test patches was referenced from MoDOT bridge maintenance records, so it should be fairly accurate. Please refer to the above comment and response for possible removal methods. If this refers to the removal of the residual polymer under Surface Prep, the method of removal shall be via blast cleaning as described in the JSP.

Q: Since it is not known if solvent cleaning is required under surface prep and how many times it might be required, would you consider making this a time and material?
A: No. On the McNaughton Bridge they tested for chlorides and sulfides after water jetting and grit blasting. Most of the time, they were way under the limits. In places with high chlorides, the contractor simply sprayed Chlor-Rid on with a weed sprayer, rinsed off and then re-blasted. There is not a large amount of solvent cleaning anticipated after the water jetting.

Q: It was said that the designers of the project talked to contractors that had performed this work and were comfortable with the time frames that they allowed for completion of the work. Can you please tell us the name of the contractor they talked with and what IDOT project they said was similar to this one?
A: The IDOT project was the McNaughton Bridge in Pekin, Ill. All information was obtained from IDOT bridge construction and maintenance personnel. Production rates were used from this project and up-scaled as described above.

Q: What was the purpose of the optional mechanical couplers shown in Detail A Stage 1&2 overlay, Sheet 40?
A: The north lane 4 is closed for the entire duration of the WB to NB ramp closure (~ 8 months). Once Lane 3 is closed in Stage 2 in coordination with the closure of the WB to SB ramp, the days are counted (2 lanes closed on bridge). This gives the contractor the option of placing reinforcement in Lane 4 during Stage 1 when they have more time and coupling them to Lane 3 in Stage 2 or to just wait until Stage 2 and place the reinforcement across both lanes.

Q: JSP I. Preparation of Steel Deck Plate Section 5.2.3 - Specifies Jetin Systems. I am unable to find any information on Jetin Systems and their products. What are the technical requirements, so we can find an equivalent?
A: No specific requirements were intended for the actual pressure jetting equipment. The JSP was revised to delete this requirement.

Q: JSP I. Preparation of Steel Deck Plate Section 5.2.3 - Talks about Chloride testing, high levels, solvents, and re-cleaning. How are we as the contractor able to quantify how much this might be? We have not been provided any test data and this type of project is rare so we don't have experience to draw upon.

A:  On the McNaughton Bridge they tested for chlorides and sulfides after water jetting and grit blasting.  Most of the time, they were way under the limits.  In places with high chlorides, the contractor simply sprayed Chlor-Rid on with a weed sprayer, rinsed off and the re-blasted.  Note that all of the residual polymer on the deck will need to be removed prior to testing and cleaning because chlorides can be trapped under it. There is not a large amount of solvent cleaning anticipated after the water jetting.

Q:  JSP I. Preparation of Steel Deck Plate Section 5.3.1 -  To be consistent with the rest of the repairs, and given that metalizing must be twice as thick in pitted areas, there should be a pay item for "Localized Pitting Repairs."  We have no ability to quantify this item.
A:  No, we don't anticipate a large quantity of this thicker metalizing.  The contractors will not be compensated for material overrun on the metalizing.

Q.  The specifications for the Poplar Street deck mix are requiring 6000 psi (800 flex) in 28 days.  Can you let me know at what compressive strength and flexural strength we could re-open the new lanes to traffic?
A: Traffic will not be allowed on the lanes until the 6000 psi compressive strength is attained per Std. Specs. 703.3.6.1.6.  However, the JSP will be revised to allow traffic on the lanes prior to the required 10 days provided the 6000 psi compressive strength is achieved.