

PCEF Meeting  
Delaware DOT  
Dover, DE  
August 28<sup>th</sup>, 2007

### Meeting Minutes

Meeting convened at 9:00 am with attendees in person and by video (web) conferencing.

Introductions

Call to accept the previous meeting minutes. Motion by Bob Horwhat, second by Claude Napier. Approved.

1. Central Atlantic Bridge Associates Update from Hank Bonstedt, PCAP

#### Overview

- Members include Bayshore, Schuylkill Products, and two others. Not all producers are members but can still provide input.
- Committee mission is to communicate, to unify, and to transfer technology, research and development.
- There will be a bridge design seminar in Carlisle, PA 01/14/08. Fee is \$80.
- Their manual is current through AASHTO LRFD 2004.

#### Issues

- Bulb Tee PCEF Standards – no specific issues stated
- High Performance Concrete – we need to develop a standard definition. Currently every state has their own definition and mix designs and it's difficult for the precasters. Also, source approval reciprocity was discussed as a need.
- Self Consolidating Concrete – states have different admixture, vibration and spread requirements. There is a need for consistency.
- Steam Curing – stated that requirements are slowing productivity. They would like to see a 12-hour requirement and/or to stop curing at the release strength.
- Bughole Rubbing – is this really necessary for elements that will be below grade? Stated that it was a waste of time. Costs and time could be saved by eliminating this requirement if it isn't necessary.

**Action Item #1 – The Materials & Construction QC/QA Subcommittee is requested to convene before the next full PCEF meeting to discuss and resolve the issues raised above by the CABA group.**

2. “Lessons Learned on VDOT Spliced Girders & Bulb Tees” by Rodney Davis, VA Transportation Research Council (VTRC)
- Discussed the Route 33 over Mattaponi and Pamunkey Rivers and Route 123 over the Occoquan River bridge projects.
  - Concluded that it is a cost effective option for intermediate spans.
  - Two main topics, splices and spans made continuous for live load.

#### Conclusions Discussed

- Splices cast one at a time are better than all lines of beams at once.
- Continuity diaphragm details need extra attention in design
- Do not embed the ends of the girder. Pass through bars and embedment cause problems. Can embed the ends at integral backwalls.
- More steel is needed for shear reinforcement in the beam ends. Beam ends need to be designed.
- Lightweight concrete worked well. There weren't additional cracking problems. Design methods are the same, just the modulus of elasticity is different.
- Problems arise when the deck is in the critical path. Issues arise with curing and replaceability when prestressing is in the deck.
- Decks should be post tensioned.
- There are many issues with longitudinal cracking.
- Polyethylene and polypropylene post-tensioning ducts have problems. Couplers leak and cause damage. Steel ducts perform better. Ducts should be pressure tested. Thermal gradient during cool down causes map cracking at ducts.
- There is insufficient reinforcement at splices and diaphragms. There was major cracking at beam ends. Need better design for the cast-in-place concrete at the pier.
- There are concentrated stresses at the shear keys in the beam ends.
- There was movement of falsework that caused major cracking.
- 180 degree bend bars for moment connections should be provided top and bottom.
- Tendon Layout Anchorage Blocks. Need to spread to reduce cracking, stress and reinforcement but don't anchor them short in the deck. That causes more problems with debris and moisture. Four or more tendons are recommended.
- Issue with form oil and related cracking. Not elaborated on.

#### Discussion from Questions

- Steam curing, massive concrete, temperature gradients are issues related to map cracking.
- Discussion on gaining continuity for live load with bars vs. strands.
  - PCI recommends 180 degree bent bars in bottom flange. They are stiffer and perform better in the long term.
  - There are issues with movement of the strands over time with respect to the concrete. This softens the joint.

- The bars provide a known positive moment capacity. They can be designed to be weak enough not to pull the beam ends off.
- Design of the positive moment at two weeks results in too much steel. The time between beam and diaphragm casting stated at 90 days is too long for the precasters. Causes issues.
  - Virginia Tech designs for 1.2 x Cracking Moment instead. They have designed the positive moment at the pier of a 69" bulb tee with 4 - #6 bars and 2 strands using this method.
- Question about chloride ion inhibitors in lightweight concrete. Answer was yes they have 2. They are useful to reduce the permeability.
- Question about standards being developed for tendons and ducts. Answer was that they recommend to check periodically in construction for leakage and voids and to seal the ends with a steel plate.

3. Design Parameters and Standardization Subcommittee Report by John Martin of VDOT and Claude Napier of FHWA

- They have developed a CD and information is available on the web for the final PCEF shapes. There are 162 girder shapes with 3 flange widths, 3 web widths, and 2 bottom flange depths, all using 1 set of forms.
- Preliminary design tables were also developed
- The intent was to match the PCEF shapes with those already available, including the New England bulb-T shapes. Intent is for the States to allow one for one substitution, as needed by contractors or precasters.
- Discussion of a new agenda item for standard details, parameters, and splice girders.

**Action Item #2 – The Design Parameters/Standardization Subcommittee is requested to convene before the next full PCEF meeting to discuss and resolve the issues covered under Items # 2 and #3 above.**

4. Update on FHWA HPC Technology Delivery Team by Lou Triandafilou of FHWA

- Team consists of FHWA, State DOT, university and industry representatives
- Intent is to help the states further utilize HPC.
- They also provide assistance with prestressed beam design & construction issues, provide seminars to the states, issue surveys and provide results for the states' use.
- They are looking at the deck cracking issues.
- They maintain a website for discussion topics & reference materials  
<http://knowledge.fhwa.dot.gov/hpc>
- They are looking at research for slip forming of SCC.
- Texas developed software for temperature control and mass concrete placement guidance.

- There is a 5-year pooled fund study headed by KS DOT that is looking at developing a low cracking concrete bridge deck specification.
- Other issues they are looking at include fire resistance and ASR.

#### 5. 2006 Survey on State DOT HPC Implementation by Claude Napier of FHWA

- Looked at corrosion resistant steel reinforcement
- Objective was for long term durability
- Stated that some states use HPC but don't refer to it by name, they just have low permeability requirements.
- Results from the survey will be compiled on a CD that will be available for distribution; and will be posted on the Team's HPC website.
- Slides presented show that many states are not using HPC as routinely as was expected.
- Issue about testing permeability at 28 days or 56 days. Concrete containing fly ash actually has lower initial permeability but it drops off. 56 days would capture the reduction.
- Using HPC is in line with the federal initiative, Highways for Life because the intent is to Get in, Get out, and Stay out. Maintaining durability and prolonging bridge service life helps us minimize the number and duration of construction work zones.
- Very low usage was noted for SCC. SCC benefits include better consistency for heavily reinforced members and using for repairs instead of shotcrete.
- Lightweight concrete benefits include reduced crane capacity and reduced loads to the substructure.
- Additional cost for upgrading to stainless steel reinforcement could be offset by not needing to waterproof or seal the cracked concrete.
- VA has a policy to galvanize exposed bars (i.e. bars projecting out of prestressed members) because of the 60-day UV exposure limitation in ASTM specifications for epoxy-coated bars.

#### Discussion from Questions

- Question about whether there were any thoughts to going back to black bars when using HPC because of the reduced permeability. Answer was no, HPC still cracks.
- Discussion on epoxy pros and cons and issues with bonding.
- Discussion on MMFX
  - Use with low grade stainless and stainless clad for proprietary requirements.
  - No issues with handling (damage)
  - Higher strengths can be utilized
  - No issues with bonding
  - Question about whether it is domestic and complies with Buy America.

- Discussion about mixing galvanized with black bars and prestressing strand. Are there problems with the galvanic reaction? See attached article.
- Question about the life expectancy of HPC. Answer was 75 years. HPC has a chloride diffusion rate of about 50-60 years for 2". Regular concrete is 12-20 years.
- Discussion about the use of fibers to minimize cracking. Stated that polypropylene be used for control of shrinkage cracks only.

6. Precast Concrete Plant Certification by Richard Krolewski of the National Precast Concrete Association by web-conferencing)

- There are 1100 members, 315 plants certified of which 89 also produce prestressed concrete.
- 24 state DOT's require certification of prestressed concrete plants (pending in WV).
- They provide certifications that are process related, not project specific.
- The stated benefits were: an increase in QA/QC; competitive edge for certified producers, especially for smaller facilities; and that one program covers multiple products.

Discussion from Questions

- Question about whether there was a working agreement between NPCA and PCI. Answer was that there was not, but that it was good to have alternative programs from which precasters could choose. That would strengthen QA/QC.
- Question about the fee scale. Answer was that fees are based on sales and include a random unannounced inspection. \$1,200 dues for plants with sales less than \$3 million; \$1,850 for sales between \$3M and \$10M; \$2,700 for sales greater than \$10M. Initial plant certification cost \$3,450.

7. FHWA Technical Working Group for HPC Research Program by Lou Triandafilou of FHWA.

- Research and Development segment headed by Ben Graybeal of the FHWA Turner Fairbank Highway Research Center (TFHRC). His studies center on:
  - HPC deck cracking – new test facility to be developed at TFHRC to study structural and environmental loadings
  - NDE methods for detecting voids and corrosion in post tensioning ducts – funds have been committed to pooled fund study 1134, "Inspection Methods & Techniques to Determine Non-visible Corrosion of P/S Strands in Concrete Bridge Components"
  - Uniform extension of LRFD shear provisions
  - Lightweight concrete
    - Inspection methods and materials

- Report completed on industry and code shortcomings
  - Research plan completed for transfer and development length
  - 27 full scaled girders to be fabricated to run 54 tests in shear and flexure
  - 6-10 ksi LWTHPC with equilibrium densities 125-130 pcf to be studied
  - Deployment
    - Integral Abutments – RFP to be written to develop guidance manual
    - Manual on HPC practice.- RFP to update current manual
    - Integrating Bridge Project Development through Automation – handled under HPS program
    - Deck Design and Construction Manual/rating examples – in RFP stage
    - Evaluating/extending service life of P/T bridges
    - Design guide for corrosion-free HPC Box Beam bridges
  - Technology Transfer
    - Conferences – 2009 Concrete Bridge Conference
    - International HPC Symposium – planned for May 29-June 1, 2010 in DC
    - HPC Bridge Views/Aspire Magazine – continuing issues
    - State Hosted seminars – MS and ND this year
    - Deck design/construction training course – continuation of above manual development
8. Materials and Construction QC/QA Subcommittee by Bob Horwhat of PADOT and Paul Finnerty of MDSHA.
- Called for a vote to look at precast-only structures issues and not solely prestressed members, with respect to quality. Non-interest in a PCEF-backed effort continues.
  - PennDOT has a pilot program for SCC implementation – they are one of the lead states working with industry to implement SCC. There has been a learning curve but they have come to a final proposed addition to their Document 201.
    - Wanted to put to ballot the previously developed . Discussion as to whether that has been done previously. Lou will investigate.
  - Discussion on the PCI concrete repair document. Used for repair of new precast p/s members, not on existing structures.
  - Subcommittee will look at reciprocity of QC functions, prefabricated bridge element standards, and mix designs.
  - Main committee added that they should look at steam curing and bughole rubbing requirements (**See action item #1 above**).
9. Serviceability-based Design for Vertical Beam End Reinforcement by Dr. Rodney Davis of VTRC
- Lightweight showed extensive damage.
    - Standard Specification design requirements are lacking
    - With proper design and details we can minimize cracks.

- Two zones were identified.
  - The general zone
    - One beam depth away from the end.
    - Non traditional analysis needs to be performed in this zone
    - Outside of this zone, plain sections remain plain, stress equals MC/I
  - Also a web panel
    - This is a square with sides equal to web depth
- Problems. Heavy reinforcement to h/4 from end. Cracks beyond that region due to eccentricity of strand and how stress is transferred to beam
  - Cracks happen when strands are cut or during lifting.
- Parametric Study
  - Shorter section were okay. Deeper were inadequate.
  - Need more reinforcement and/or higher transfer stresses. 0.8 f'c was recommended.
  - Need to look at where the lifting devices are.
  - For cracks, no repairs were needed at 0.005"; 0.008" was questionable; 0.012" was poor and corrective action was necessary.
  - Need another study to look at the region between h/4 and 3h/4 and specifically look at lifting device area.

#### Discussion from Questions

- Question about how to fit in all the extra reinforcement. Answer was that they bundled the bars.
- Discussion about what to do if beams don't meet the criteria. Answer was if 1 beam is bad, repair it. If all the beams are bad it indicates a design or curing problem.
- Discussion about compressive tests vs. splitting tensile and maturity tests.

#### 10. State DOT Update on HPC/SCC Implementation since August 2006

- DE
  - HPC used for all decks.
  - Specify less than 1500 coulombs.
  - Using PCEF bulb tee's.
  - Not currently accepting SCC in structural components.
- MD
  - Have done 2 latex concrete overlays. Problems with it setting up too fast, poor workability, and shrinkage cracks.
  - HPC will be used on 65 decks in ICC project.
  - SCC on a case by case basis with precasting plants.
  - Using PCEF bulb tee's on all new concrete superstructures, including the Hampstead By-pass design/build project. Use 8" webs since they can usually deflect 3 rows of strands. Prefer draped over debonded strands.

- WV
  - Using latex and silica fume overlays for 25 years with good results.
  - Use overlays as standard over new decks for rideability issues.
    - If there are no rideability requirements, use HPC decks with no overlays.
  - Have done 1 or 2 prestressed superstructures with HPC.
  - Have not used SCC in cast-in-place or prestressed. Have used it for Bebo arch and other precast.
  - Do not use PCEF shapes; instead, use Kentucky Modified or AASHTO shapes.
- PA
  - Have used an HPC special provision for 4 years. Have mix qualifications and approval of mix designs.
  - Have utilized HPC on 7-10 new decks this year
  - Use SCC on 80-90% of precast; made formal changes to specifications
    - Freeze/thaw testing
    - Durability testing
    - Permeability testing
    - Allow vibration as long as they demonstrate that there is no segregation
    - Do not use high fines ratio because of creep concern
  - Use PCEF shape on 1 project last year; 1 coming from a NY producer
- VA
  - HPC on most decks and 100% prestressed beams
  - SCC used for beams with normal and lightweight concrete. Not for decks.
  - Use PCEF shapes. 100% conversion since 2000
  - On federal-aid projects, must have low permeability specification for bridges on NHS or greater than 500 foot span.
  - Using Ultra HPC for one bulb tee project.
- NJ (by web conference)
  - HPC is standard for decks;
    - Still dealing with a lot of map cracking
  - SCC used on one drilled shaft project.
  - Use PCEF shape on Rt. 52 project; 8500 psi
- NY (by web conferencing)
  - Update from a precaster who has done a segmental column pier for NY utilizing SCC and HPC at 10 ksi.
    - Problems with heavy reinforcement and honeycombing. Vibration was required.

## 11. Discussion

- Need to standardize details for connections to prefabricated elements. Subcommittee needs to investigate.
- CABA website for preliminary design. Current to LRFD. Called Quick Beam
  - [www.caba-bridges.org](http://www.caba-bridges.org)

## 12. Corrosion of External Post Tensioning – Varina Enon Bridge; presentation by Claude Napier

- Failure of two post tensioning strands after 17 years in service
- Initiated inspections after Florida Sunshine Skyway problems
  - Inspection visual and with endoscope.
  - Identified ¾” holes used for grout verification and open vent holes that allow water and air penetration
    - If system isn’t sealed, it will have problems if grout has problems.
    - A sealed system can prevent problems even with poor grout
- 2003-2004 performed vacuum grouting rehabilitation of post tensioning ducts.
  - 3-4 times quantity bust on grout.
  - Grouted from high points, caused entrapped air
    - Current state of the practice is to grout from low points.
  - Large voids caused by excessive air from reactions from admixtures in grout and excessive bleed water from high water/cement ratios.
  - Pigeon Problems – very corrosive when droppings mix with water.
  - Water leaking from expansion joints due to poor maintenance.
  - Vertical post tensioning had large voids.
- Proposed Inspection Methods
  - Look for defects on ducts.
  - Use a stiff coat hanger to check penetration through vent tubes
  - Endoscope
  - Magnetic Flux Leakage
  - Half-Cell Potential
- There was high corrosion even w/o obvious water penetration.
- Water from the re-grouting contract may have recharged corrosion.
- Lessons Learned
  - Sealed system is very important
  - Use no-bleed grout; Dr. Andrea Schokker evaluating 3 types
  - Epoxy Injection and pressure grouting are not effective.
  - Vacuum Grouting is effective with good specifications.
  - Documentation is necessary for inspections and repairs.
  - Look at couplings for broken straps, bulges, cracked deviation blocks, and separation to indicate problems.
  - Active corrosion tests don’t show previous corrosion

## 13. Camber Growth after Strand Release by Dr. Rodney Davis

- Looked at bulb tees camber; normally equals 1.2 times creep coefficient; achieved 7” growth.
- 280-350 microstrain shrinkage after 1 year @70% relative humidity
- Had poor mix designs; 0.31 w/cm, 750 pcy cement
- High water causes creep; creep ceased after 2 months

- No steam curing in forms.
- Early strand cutting
- 40% slag replacement causes high creep at early age.
- High modulus because of the limestone used.
- Splitting tensile and elastic modulus are better indications of maturity.

14. PCI Georgia/Carolinas by Peter Finsen, Executive Director

- Looking to establish a committee similar to PCEF
- Looking at developing SCC specifications and doing university research.
- Very active in precast and prestressed industry. 21 certified plants, including 8 for prestressed concrete bridges.

15. Question about camber tolerance initiated by John Martin, VDOT

- VA
  - +/- 50% grounds for rejection; appears to be a recurring problem the past 2 years
  - Load test for worst girder passed for strength. Requested input from other states
- NY
  - 1" maximum tolerance given for time of release, nothing for growth.
  - If out of spec, load tested and has passed.
- PA
  - +/- 50%
  - Would evaluate out of spec with load test if necessary
  - Mostly steam cured
  - Never had any issues with out of spec
- MD
  - No issues
  - No tolerances given in plans
  - Differential tolerance given between beams
- WV
  - Tolerance given for fabricator including differential
  - Not checked in field
- DE
  - Tolerance in accordance with PCI
  - No issues

16. Discussion on next year's meeting at International Bridge Conference in Pittsburgh. No negative responses given. Group chose Wednesday afternoon, June 4, 2008, 4-8 pm.

Meeting adjourned at 4:00 p.m.

