

August 23, 2012

TO: Paula Hammond
Secretary of Transportation

FROM: Julie Meredith, SR 520 Program Director

RE: Pontoon Peer Review Panel Recommendations and WSDOT Actions

Attached are the findings and recommendations provided to WSDOT by the Expert Review Panel, which was convened in June to evaluate the concrete cracking and spalling which occurred in the first six (of 33) SR 520 pontoons being constructed in Aberdeen. The Panel has:

- visited the site;
- reviewed the design and contract documents;
- reviewed the repair procedure developed by the WSDOT Bridge and Structures office and implemented by Kiewit-General (Contractor);
- reviewed cracking in the longitudinal and cross-pontoons and;
- summarized their findings and recommendations, which are the result of their review of conditions in Cycle 1. The recommendations are applicable to Cycle 2 and beyond.

After the repairs were made to Cycle 1, including repairs of the post-tensioning related spalling and cracking, concrete shrinkage and other “structural”¹ cracks (according to WSDOT standard procedures), the six pontoons were successfully floated out of the Aberdeen casting basin on July 30, and temporarily docked at the Port of Grays Harbor. The pontoons then were inspected by the contractor as part of their quality assurance responsibilities and by WSDOT as part of their quality verification responsibilities. Towing of the first pontoons to Lake Washington began on August 8 and the first pontoon traveled through the Ballard Locks on August 11.

Staff from the SR 520 Program, Aberdeen construction site office, WSDOT Bridge & Structures Office and WSDOT Construction Division have reviewed the panel findings and recommendations and are addressing all the recommendations. The following summarizes the recommendations and the steps being taken by WSDOT to address them. The urgent nature of the work is driven by the need to define changes that can be implemented in time for construction of the Cycle 2 pontoons.

WSDOT and the Contractor have been working to address the issues encountered, minimize any impact to the overall project schedule and budget, and deliver pontoons that will meet the needs of the people of Washington for decades. WSDOT and the Contractor will begin discussions soon to explore opportunities for schedule recovery, as well as an exchange of information related to any entitlement that may be due under the terms of the contract. Both parties will be taking due diligence to assess responsibility for schedule and cost.

¹ The contract specifies all cracks which are 0.006” wide and greater as “structural”. Cracks smaller than this are generally caused by concrete shrinkage due to thermal effects or concrete curing.

Specifics of findings, recommendations and actions being taken:

Cycle 1 pontoons, per Expert Panel observations and recommendations:

1. **Panel Observation:** Repairs have been made to all of the areas affected by spalling and cracking observed after post tensioning. Based on site visits, review of repair details and other available data, the Panel concurs with the WSDOT Bridge and Structures Office that repairs made to the bolt-beam/slab spalling and pulled-out post-tensioning ducts are adequate for structural capacity. pontoons T, U and V were successfully re-tensioned longitudinally after this repair.
2. **Panel Observation:** All other cracks have been repaired “per Contract procedures” similar to the procedures successfully used on the other WSDOT floating bridges.

WSDOT Response/Action (to Observations #1 and #2): The Cycle 1 pontoons have been inspected by the contractor (per their quality assurance responsibility) and WSDOT (per our quality verification responsibility) to determine conformance with contract requirements following float out. Final correction items will be completed in Aberdeen or on Lake Washington as needed. These items, when completed, will result in completed pontoons that will fulfill the intended requirements for bridge support and design service life.

3. **Panel Observation/Recommendation:** The Panel stated “the repair areas should be inspected throughout the construction, towing and assembly on the lake. Special consideration and attention should be given to these areas according to normal WSDOT maintenance and operations procedures”.

WSDOT Response/Action: In response the Peer Review Panel’s recommendation, additional inspections will be scheduled to verify pontoon performance during transport, bridge construction and service use. These inspections will be conducted in accordance with WSDOT normal procedures to verify safety and early detection of potential problems so that they can be corrected.

Cycle 2 and subsequent Cycles per Expert Panel recommendations:

1. **Panel Observation/Recommendation:** Verify that contract requirements are adhered to. The Panel reiterated that the Contractor’s QC and QA staff, with oversight from WSDOT QV site staff, must verify that contract requirements are followed – and specifically that the concrete thermal control plan; concrete curing requirements; concrete mixing, batching procedures and moisture control are performed as required by the contract and that the necessary construction documentation procedures are performed.

WSDOT Response/Actions: The Headquarters Construction Office and the SR 520 Program Team (including the Aberdeen Project Office) are reviewing all contract requirements to verify that they have been followed. The Contactor will be directed to correct their procedures if there are areas where requirements were not followed. Project site and HQ construction staff are working with the Contractor to define changes to the technical requirements (e.g. adding reinforcing steel) to improve results. This may include contractual changes which could result in cost and schedule adjustments.

2. Panel Observation/Recommendation: “Many of the observed cracks are more extensive than anticipated” (compared to the extent of cracking in the ACME concrete pilot program). Accordingly, the panel has stated “the cracking needs to be understood and measures taken” to minimize or eliminate such cracking in future cycles.

The Panel recommended changes to the contract requirements to improve the concrete’s resistance to cracking, focusing on the allowable water/cement ratio requirements and the maximum length of wall and slab pours.

WSDOT Response/Action: The WSDOT Construction Division materials section regularly verifies cement properties, batch plant procedures and practices for construction projects. The cement in this application is different than the ACME demonstration project and this may be a contributing factor to cracking. The WSDOT Construction Division materials section has been asked to look into this with assistance from SR 520 program staff and oversight of the Expert Panel.

Additionally, concrete batching, moisture control, water/cement ratios and thermal control and concrete curing procedures have a significant effect on cracking. Adjustments to these elements are being considered by the SR 520 Program Team and will be reviewed by the Expert Panel in terms of actions and procedures which are beneficial for Cycle 2 and subsequent cycles.

3. Panel Observation/Recommendation: Bolt Beam. The bolt beam is the structure that holds the bolts which connect the pontoons to each other when they are in their final place on Lake Washington. It is a highly stressed area containing the end anchorages for the post-tensioning tendons and is the location of the major concrete spalling and cracking which occurred on May 11.

In order to more clearly understand and eliminate the post-tensioning cracking observed in the Cycle 1 pontoons, the Panel recommended additional analysis so that changes can be implemented for Cycle 2 and subsequently. Specifically they recommended a detailed finite element model analysis of the end wall/bolt beam area, and revisions to the design if indicated by that analysis.

Additional potential design/construction changes include modifying the as-constructed post tensioning profiles, changing some deck hatch configurations, changing construction sequencing and adding reinforcing steel in specific areas to minimize the potential for spalling and cracking in future pontoons.

WSDOT Response/Action: The Bridge & Structures Office is reviewing the design of the bolt beam using a finite element model developed by SC Solutions. They have modified the duct head locations and defined additional steel reinforcement to more securely restrain the post-tensioning tendons in position per the contract M-11 drawings. The Expert Panel will review the results of this analysis regarding the need and configuration of additional steel reinforcement. It will be verified that this analysis and design review is sufficient in terms of necessary changes for Cycle 2 and beyond.

Independently, WSDOT has engaged Parsons Brinckerhoff to analyze the as-designed M-11 bolt beam for structural adequacy and potential changes for Cycle 2 and beyond. The Expert Panel will also review the results of this analysis.

4. Panel Observation/Recommendation: Pontoon end walls. The post-tensioning also stresses the pontoon's end walls, which has resulted in significant and extensive cracking due to this post-tensioning, plus thermal and autogenous² concrete shrinkage and the resistance of the interior precast panel walls. The Panel recommended that the interior precast panel walls be decoupled from the end walls until after post-tensioning and that the steel reinforcement in the end walls be reviewed and modified if necessary.

WSDOT Response/Action: The Bridge & Structures Office is modeling the pontoons with the end walls decoupled from the interior precast panel walls to verify that this will resolve cracking from post-tensioning. Moreover, additional reinforcing steel will be included in the end walls.

5. Panel Observation/Recommendation: Quality Control (QC - Contractor), Quality Assurance (QA - Contractor) and Quality Verification (QV – WSDOT). The Panel suggested WSDOT assign additional quality verification personnel to the project, over what is normally provided for a design/build contract, because of the magnitude and uniqueness of this particular project and the complex, integrated design and construction requirements.

WSDOT Response/Action: The Contractor has been directed to review their QC/QA staff and procedures to see where improvements can be made. WSDOT will review our QV procedures including staffing levels and areas of focus to determine additional needs.

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Autogenous shrinkage is a volume change when there is no moisture transfer to the external environment. It is therefore different than drying shrinkage and most prevalent in high performance concrete where the water-cement ratio (w/c) is under approximately 0.32. The w/c ratio for the Aberdeen pontoons was as low as 0.28.