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**WHITLOCK DALRYMPLE POSTON & ASSOCIATES, INC.**  
CONSULTING ENGINEERS

October 8, 2003

Potomac Crossing Consultants  
6711A Oxon Hill Road  
Oxon Hill, Maryland 20745

Attention: Mr. Michael D. Bonin, P.E.  
Bridge Area Engineer

Reference: Water Infiltration  
Woodrow Wilson Bridge Project  
WDP Project No. 01-03517

Dear Mr. Bonin:

This letter summarizes the review Whitlock Dalrymple Poston & Associates, Inc. (WDP) has performed regarding the Avanti Grout product proposed for use at the Woodrow Wilson Bridge footings. As requested by Potomac Crossing Consultants (PCC), WDP has reviewed the proposed material for potential adverse effects on the concrete, post-tensioning grout, post-tensioning strands, galvanized pipe, fiberglass reducer and polyethylene duct components of the structure. WDP has also given consideration to the material selection based on our experience with concrete construction and repair.

WDP was provided with the following documents for review:

- "BR-3A Construction Water and Post-Tensioning Ducts," dated August 15, 2003
- Avanti Grout, "AV-100 Chemical Grout Technical Manual"
- Avanti Grout, Material Safety Data Sheets (MSDS), "AV-100 Chemical Grout (Liquid)"
- Various pedestal sketches, including "Bascule Pier Pedestal Post-Tensioning Ducts Elevation 1."

WDP understands that water is infiltrating the post-tensioning loop tendon ducts presumably between the 10"-diameter steel duct and the fiberglass reducer. The proposed material is intended for pressure injection, by means of an expandable bladder apparatus positioned at the duct breach location. The desired performance from the grout material is to permeate and extend throughout the plane of the fissure at the level of the duct breach, wherein the grout material will set, effectively sealing the fissure and duct from continued water infiltration.

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REFERENCE FILE *Duct Repair (www)*  
CONTRACT # *PC 3455173*

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From a structural longevity perspective for this application, two characteristics are critical in the material selection: 1.) corrosion protection and 2.) durability. As the material may be in contact with post-tensioning steel reinforcement and post-tensioning components (e.g., grout, ducts) it is critical that the repair grout not promote or accelerate corrosion in the post-tensioning reinforcement. Moreover, the material, once in place, should function to effectively seal the system from continued water infiltration, which in itself is a mechanism for accelerating corrosion.

### **CORROSION PROTECTION**

ACI Documents 222R, "Protection of Metals in Concrete Against Corrosion," and 222.2R, "Corrosion of Prestressing Steels," indicate that infiltration of chloride ions and hydrogen sulfide to the concrete system is a primary impetus for corrosion. Nitrates, frequently used as concrete set-accelerating admixtures, behave similarly in initiating and promulgating corrosion activity. The presence of these ions can contribute to an atmosphere conducive for post-tensioning steel failure due to corrosion pitting, stress-corrosion cracking, and/or hydrogen embrittlement.

Reinforcing steel, when properly encapsulated by concrete materials, resists corrosion activity at its surface by means of a thin passive layer. The passive layer is an effective barrier against rapid access to, and rapid corrosion of, the reinforcing steel. High pH levels found in typical concrete and grouted tendons maintain the layer and the corrosion resistance. Protection against the combination of infiltration of ions associated with corrosion and the reduction of the system pH level is an effective way of mitigating against corrosion damage; any materials selected for incorporation at or near the level of the reinforcing steel should be selected accordingly.

Avanti AV-100 Chemical Grout is one part of a 3-component grouting system. The other two parts "AV-101 Catalyst+" and "AV-102 Catalyst AP" are incorporated as catalysts for forming the final gel product. Review of the technical documents available describing these materials indicates that they do not contain chloride, sulfide, and/or nitrate components that are otherwise shown to initiate and accelerate corrosion. These grout products reportedly contain proprietary chemical blends for the purpose of product performance. WDP consulted with Frank Aguilar and Luke Keenan, technical staff at Avanti International, to confirm that the proprietary components of the grouting system do not contain the previously discussed ions. The Avanti representatives reported that the chemicals are not present in the grouting components.

Technical information from Avanti International, in the form of product data sheets as well as correspondence with technical staff, indicates that the pH level of the AV-100



Chemical Grout once fully set will range from 7 to 11, depending on site application conditions. For reference, the pH level in normal concrete is generally around 11.

## **DURABILITY**

The AV-100 Chemical Grout achieves its strength in repair applications by forming a matrix with soil typically present at pipe coupling interfaces. The material spreads throughout voids by means of pressure injection and sets to form a gel. Set times vary based on ratios of the three mixing components and site conditions, such as temperature. The material is non-expansive; all voids to be sealed must be fully filled by the grout in order to eliminate infiltration. The reported durability of the product functioning as sealant is reported by Avanti to be on the order of several decades. WDP's dealings with this and similar products have indicated effective sealant performance on the order of a decade; as of this writing, the materials are currently still effectively functioning. WDP is not aware of the strength of materials properties such as tensile strength and/or shear resistance of the proposed grout.

The exact nature of the fissures in the river footings is not known at this point, though a typical thickness is expected to be relatively small. WDP understands that the intent for this material is to fill a void and subsequently seal off the ducts by means of completely filling the fissure. The effectiveness of the repair depends on the ability of the grout material to permeate the fissure and set properly. This is to be achieved using the bladder injection system, specially designed for the 4" diameter to 10" diameter transition at the suspected reducer breach. WDP consulted with Avanti International regarding the application of this material for the sealing of a fissure as well as the application of an expansive sealant. [Two expansive Avanti products are AV-333 and AV-310. These are polyurethane resin foams.] While the expansive sealant offers increased performance in terms of sealing the area immediately around the breach, there also appears to be a strength benefit in terms of having a "structural" material filling voids of uncertain sizes. There is, however, a drawback with regard to working time during application. The expansive materials activate immediately upon contact with water. In this case, the delayed/controlled set time of the AV-100 Chemical Grout appears to be an advantage with regard to applying the material and withdrawing the apparatus.

WDP has some question, from both a strength of materials and an application standpoint, as to the integrity of the AV-100 material in the case of larger voids under constant head pressure from the infiltrating water. Without the benefit of a matrix, the AV-100 material must depend on close contact with the faces of the fissure for strength in application. If the fissures are relatively thin, this should not be a problem. If, however, larger pockets are present, the material will likely have to



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resist the head pressure from the infiltrating water without the benefit of a matrix for strength. However, consideration of the reported problem would seem to indicate that the most likely location for the most substantial voids would be immediately adjacent the duct breach which benefits the repair procedure since that is closest to the point of application for the repair material. Ultimately, WDP believes that the repair material lacks some of the strength of materials performance attributed to the expansive grouting materials but offers increased application time as well as documented sealant performance in particular applications.

### SUMMARY

WDP has reviewed the proposed material for repairs to be made to river footings on the Woodrow Wilson Bridge. Based on our review of product technical documents and correspondence with the manufacturer's technical staff, WDP believes that the proposed material, Avanti AV-100 Chemical Grout does not appear to contain ions, including chlorides, sulfides, and nitrates, associated with initiating and promoting corrosion of post-tensioned reinforcing steel. The pH level of the final set product is at or slightly below the pH level typically associated with concrete with favorable resistance to corrosion activity and hydrogen embrittlement. This range is thus not viewed as a particular detriment to the overall repair, nor is it viewed as an overall enhancement. Thus, it is not anticipated that this product would otherwise contribute to the deterioration of any of the discussed post-tensioning system components or the initiation and acceleration of corrosion activity.

The anticipated durability of the proposed material is difficult to assess. The gel nature of the proposed product does not provide the sealing benefit of similar expansive materials, such as polyurethane resin foam. However, with the proposed technique for repair—completely sealing the infiltration fissure—expansive materials do not allow enough working time to effectively permeate and seal the entire void. With proper application, given the extended working time of the proposed material, successful installation may be achieved. Given the relatively unique application for this repair, WDP cannot confidently assess the anticipated longevity of the repair material. In more typical applications, however, WDP recognizes the successful long-term performance of the proposed material and similar products.

Given the scale of the project and the relatively unique application for the repair materials, it seems reasonable to prepare and test a mock-up of a footing. Other than the quality of the seal immediately around the duct, the evaluation should consider the overall penetration of the proposed repair material into the fissure as well as performance of the repair material when subjected to water infiltration during installation.

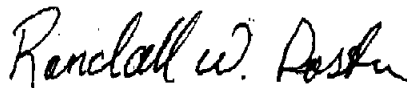


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Please do not hesitate to contact us should you need any further information or clarification.

Sincerely,

**Whitlock Dalrymple Poston & Associates, Inc.**



Randall W. Poston, Ph.D., P.E.  
Principal

