pti Technical Notes
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PROPER DOCUMENTATION OF COMPONENTS IN AN UNBONDED SINGLE STRAND TENDON MATERIAL SUBMITTAL PACKAGE

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1.0 Introduction

Questions occasionally arise from engineers and contractors as to what documentation should be required in a submittal package from a supplier of unbonded single strand tendons. This issue of Technical Notes discusses these requirements as they are outlined in both the PTI's *Specification For Unbonded Single Strand Tendons*[2] and the ACI's *Specification 423.6-01*[3]. Particular attention is given to the additional requirements that should be considered when a supplier is mixing components from different manufacturers or when a supplier is proposing the use of prestressing steels not specifically identified in ASTM A 416/A 416M[4].

Unless noted otherwise, all citations herein are from PTI's Specification For Unbonded Single Strand Tendons, 2nd Edition[2]. In the author's opinion, the document produced by ACI is substantially the same as the PTI document in scope and content, and no appreciable differences exist between the two documents with respect to the topics discussed herein.

2.0 Scope of Submittal

The specifications were developed to provide specific performance criteria for materials used for unbonded single strand tendons. The term *tendon* as defined in Section 1.2[2] refers to a complete assembly consisting of anchorages, prestressing steel, P-T coating, and sheathing. A proper pre-construction materials submittal package should encompass all of these components and should include a copy of the tendon fabrication plant certification as well as stressing jack calibration certificates for the equipment that is being used on the project. A complete description of what type of documentation is required for each individual component can be found in Section 1.5 of the specification[2]. Physical properties, as well as testing requirements, for each of the individual components can be found in Part 2 of the specification[2].

There are two conditions that warrant added attention when reviewing these submittal documents. One is the mixing of components from different manufacturers, specifically the anchor and wedge system; and the other is the use of steels not specifically identified in ASTM A416/A 416M[4]. In addition, it is important that the documents submitted are properly reviewed to verify the compatibility of the prestressing steel with the anchorage system.

3.0 Mixing of Components

Proper documentation and testing in accordance the Specification assures the adequacy and compatibility of the prestressing steel, the P-T coating, and the sheathing. An issue arises when the supplier submits test reports for more than one manufacturer of an anchor/wedge system. When this happens, the reviewer should ascertain from the supplier if the intent is to provide two different anchor/wedge systems (perhaps to two different areas of the project) or if the intent is to provide

an anchor from one manufacturer and a wedge from another.

If the intent is to provide two different anchor/wedge systems, and proper documentation is provided for each individual system, then no additional tests are indicated; however, great care will have to be taken in the field to prevent components (i.e. anchors and wedges) from the two different systems from being mixed. This is a situation that has a great potential for problems in the field if incompatible components are used together, and this situation should be carefully evaluated before approval.

If the intent is to provide an anchor from one manufacturer and a wedge from another, then additional testing is required to ensure the components compatibility. This is mandated in Section 2.2.3[2]. The commentary provided states that "Due to the interrelationship of the component parts during the transferring of force to wedge type anchorages, the casting and the wedge should always be considered as one design unit." In order to ensure the components compatibility, the supplier should be required to provide static and fatigue tests (as described in Section 2.2.1.1[2] and 2.2.1.2[2]) for the complete tendon assembly using the components as they are to be supplied. *It should be noted that while these tests may substantiate the compatibility of the components (and therefore acceptance under both PTI and ACI specifications), the mixing of components from different manufacturers might violate the terms of certain ICBO Certification documents.*

4.0 The Use of Steels Not Specifically Identified in ASTM A416/A 416M

The specification allows for strand that is not specifically identified in the ASTM specifications. The commentary therein states that this will allow for "new steels" which may have improved characteristics of relaxation or improved mechanical properties. It also allows for steels with specified minimum tensile strengths over 270 ksi (1860 Mpa) and new sizes of steels.

The ASTM specification specifically identifies low-relaxation and stress-relieved strand in grades 250 (in nominal diameters of 0.25in., 0.313in., 0.375in., 0.438in., 0.500in., and 0.600in.) and 270 (in nominal diameters of 0.375in., 0.438in., 0.500in., and 0.600in.). Any proposed prestressing steel other than those listed should be permitted only when the supplier provides test data substantiating that all characteristics of the material are comparable or superior to the properties of the steels conforming to the ASTM specifications. Note that while ASTM standards allow interpolation of figures for the required 1,000-hour tests, this should not be allowed when evaluating the relaxation properties of any new steels. Commentary provided further states that this test data should be conclusive, and certified by an independent testing laboratory.

The ASTM standard also states that the stress corrosion characteristics of new steels should be carefully evaluated; however the standard gives no guidance on the evaluation of stress corrosion characteristics. This evaluation is significant because test data has shown that prestressing steel strand with a tensile strength over 270 ksi (1860 Mpa) may have more susceptibility to stress corrosion cracking[5]. The potential for stress corrosion of prestressing steel with a tensile strength over 270 ksi should be carefully evaluated using the accelerated corrosion test detailed in ISO 15630/3-2002[6] and the results should be compared against acceptable values such as those listed in PREN10138[7].

5.0 Determining Compatibility of the Prestressing Steel and Anchorage System

An often overlooked step in the evaluation of the materials submittal package is the verification of the adequacy of the entire tendon system. Section 2.2.5.1[2] states, "The adequacy of a tendon system shall be confirmed by satisfactory static and fatigue tests in accordance with the minimum requirements outlined in Sections 2.2.1.1 and 2.2.1.2." This confirmation is often satisfied by the test data submitted for the anchorage system. However, if the material supplier is proposing the use of a grade or size of prestressing steel other than the one the anchorage system was tested with, further documentation is required. Section 2.2.1[2] states that anchorages of unbonded tendons shall be designed to develop at least 95% of the actual breaking strength of the prestressing steel.

This is to be determined by performing both static tests and fatigue tests performed in conformance with ASTM standards.

The static test is a tensile test of an assembled tendon. The test specimen should be assembled using standard production quality components, and the test should represent as closely as possible the actual conditions under which a tendon has to perform in a structure. In other words, for a standard anchorage system, the test should include an anchor assembly embedded in concrete to duplicate the actual working conditions of the anchorage in its environment.

Fatigue tests are conducted to prove that the tendon assembly has the capacity to resist cyclic loading resulting from the expected service loads, building vibrations, and the dynamic effects of earthquakes. Again, the fatigue tests should be performed on standard production quality components. Note that it is not required to use the same specimen for static and fatigue tests.

6.0 Ensuring That Material Submittal Documents Represent the Material Actually Being Used On The Project.

The documents submitted for approval must represent the material actually supplied to the project. Requiring material and stressing equipment to be supplied by a PTI Certified Plant, proper review of shop drawing submittals, and review of mill certificates and shipping documents for the material being delivered, will help to substantially decrease the possibility of inadvertent substitution of materials differing from those that have been approved in the review of the materials submittal package.

Both the PTI specification and the ACI specification require the materials to be fabricated by a facility that has been certified by an externally audited quality assurance program. Both specifications recognize only the Post-Tensioning Institute's Plant Certification Program as meeting the requirements of the specification. The PTI's Plant Certification Program is intended to verify a plant's capability to produce unbonded single strand tendons that meet the requirements of the PTI's *Specification For Unbonded Single Strand Tendons*. Certificates should be current and if any questions arise, a plant's status within the program can be verified by calling the Post-Tensioning Institute.

When the material supplier submits the installation drawings they should be reviewed to verify that the anchorage system called out in the drawings is the anchorage system for which test data was submitted. In addition, the material specifications noted on the drawings should be reviewed for conformance to the project specifications. It is typically the responsibility of the material supplier to convert the final effective forces called out in the engineer's plans to the number of tendons required in the field. If this is the case, the supplier's documents should be reviewed to determine what grade of steel is being used in determining the required number of tendons, then correlate that back to the materials submittal to ensure that they match. *For example, if the supplier is using a "new" grade 290 prestressing steel in determining the required number of tendons in a given member, they should also have supplied the necessary additional test data for the prestressing steel as well as the additional test data required to substantiate that the anchorage devices are compatible with 290 ksi strand.*

As the project progresses and material is being shipped, there may be a requirement for the submittal of mill certificates for each coil or pack of strand being utilized on the project. These should be checked to verify that the grade, size, and type of prestressing steel (normal relaxation or low relaxation) are the same as the materials described in the original submittal package. Additionally, all PTI Certified Plants are required to maintain traceability of the manufacturer and lot numbers (heat number, date code, etc.) of the anchors and wedges being shipped to the job site. While this is not always shown on the shipping documents, the information should be available upon request, and the information received should correspond to the test data that has been previously submitted.

7.0 Conclusions and Additional Considerations

With the publication of the current PTI Specification For Unbonded Single Strand Tendons and the ACI Specification 423.6-01, there is a complete reference as to the documents that should be required in a materials submittal package for unbonded single strand tendons. These documents should be reviewed to verify that the individual components are compatible with each other.

When a supplier proposes "new steels", or intends to mix components from different manufacturers, additional testing is warranted and should be mandated prior to use of the materials. Care should be taken to verify that the prestressing steel being used is compatible with the anchorage system being used. This should be checked from the materials submittal phase to the shop drawing review phase, all the way through to the review of the mill certificates for material actually delivered to the project.

6.0 References

1. James D. Rogers is Director of Certification Programs and Construction Technologies at the Post-Tensioning Institute, Phoenix, AZ

2. Post-Tensioning Institute (2000). *Specification for Unbonded Single Strand Tendons*, 2nd Ed, Phoenix, AZ

3. American Concrete Institute (2001). *423.6-01 Specification for Unbonded Single Strand Tendons and Commentary*, Farmington Hills, MI, www.aci-int.org

4. American Society for Testing and Materials (1999), *Designation: A 416/A416M-99, Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete*, West Conshohocken, PA, www.astm.org

5. (FIP) International Federation for Prestressing (now a part of FIB) (1980), *Report on Prestressing Steel: 5. Stress Corrosion Cracking Resistance Test for Prestressing Tendons*, www.fib.epfl.ch

6. ISO 15630-3:2002 Section 10 – *Stress Corrosion Test in a Solution of Thiocyanate*, www.iso.org

7. European Committee for Standardization, PREN10138 – *Acceptance Standards for Prestressing Steel*, www.cenorm.be

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