FIELD QUALITY CONTROL OF ENCAPSULATION SYSTEMS

Written By Larry Krauser

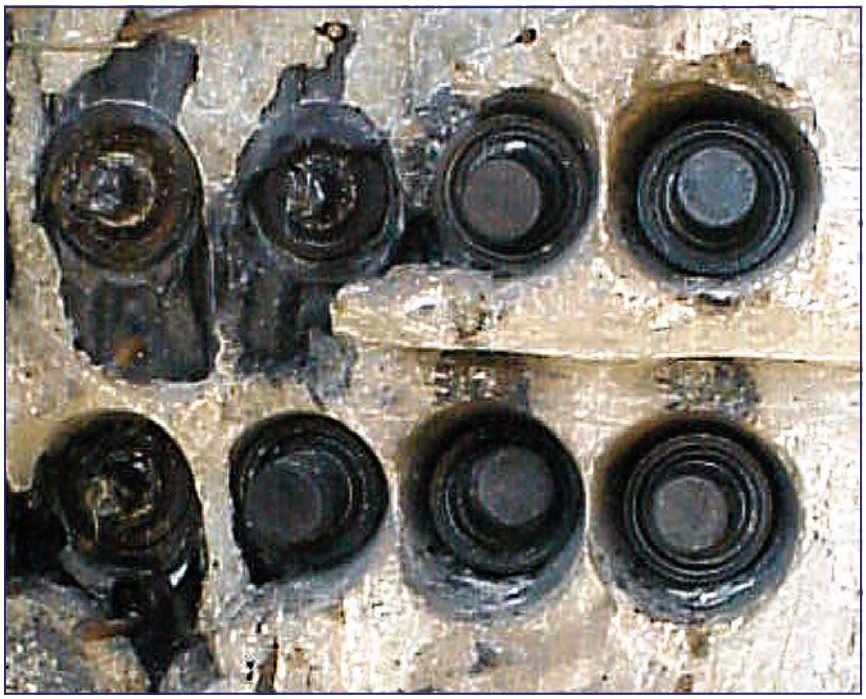

Photo Courtesy of Alan Rodriguez, Tiger Industries, Inc.

The use of encapsulation systems for unbonded post-tensioning tendons is becoming increasingly popular. Correct installation of encapsulation systems is crucial to the durability and long-term performance of the structure. When installed properly, the encapsulation system's performance will match that of other elements of the structure, however, when the encapsulation system is not installed correctly, the post-tensioning becomes susceptible to corrosion and early system rehabilitation.

This paper is intended to improve the quality of the Unbonded Post-Tensioning Industry by providing Inspectors, Engineers, Contractors, Installers, and Post-Tensioning Suppliers with knowledge that will lead to proper installation of encapsulation systems. The paper will discuss why encapsulation is necessary, requirements of design codes, expectations of suppliers, what the field requirements are, and how to perform field inspections of encapsulation systems. Field quality control information and checklists are provided.

Background

The Post-Tensioning Industry recognized the effects of chlorides and corrosion on the deterioration of parking structures in the early 1980s. As early as 1983, the Post-Tensioning Institute (PTI) began redrafting their existing specification to include requirements for encapsulating unbonded tendons; from this effort came the "Specification for Unbonded Single Strand Tendons" published in the Prestressed Concrete Institute

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(PCI) Journal, March-April 1985. Subsequently, the American Concrete Institute (ACI) issued their "Specification for Unbonded Single-Strand Tendon Materials and Commentary" which follows the PTI Document as far as corrosion protection requirements are concerned. These specifications require encapsulation of the unbonded post-tensioning system in aggressive environments.

PTI and ACI "Specifications" define *Aggressive Environment* as:

> *An environment in which structures are exposed to direct or indirect applications of deicing chemicals, seawater, brackish water, or spray from these water sources; and salt-laden air as occurs in the vicinity of coastal ways. Aggressive environments also include structures where stressing pockets are wetted or are directly in contact with soils.*

The definition of an *Encapsulated Tendon* is also provided in ACI "Specifications" as:

> *A tendon that is completely enclosed in a watertight covering from end to end, including anchorages and sheathing with coating for unbonded applications.*

In PTI "Specifications" as:

> *A tendon that is completely enclosed in a watertight covering from end to end, including a protective cap over the tendon tail at each end.*

Modern encapsulation systems are designed to prevent water intrusion into the anchorage or water collection within the anchorage. This is critical in an unbonded tendon because the force in the tendon is transmitted to the concrete by the anchorages at each end. If the strand-wedge-casting combination (anchorage) corrodes and the tendon releases then the structure does not retain its design strength and is at greater risk of deterioration. This does not mean that if one tendon releases the structure will fail or collapse, only that the structure may be at additional risk and may require some repair.

The Post-Tensioning Industry in the mid 1980s began developing encapsulation systems in earnest. The first systems were expensive and extremely labor intensive using "off-the-self" plumbing connections and grease zerks. The plumbing fittings allowed these early systems to be watertight while the grease zerks allowed filling of air voids both at the wedges and sleeves with grease. The industry has progressed as the demand for encapsulation of unbonded post-tensioning has increased. The systems today are primarily made of injection molded plastic parts. These production parts are inexpensive and made by several manufacturers within the industry.

Today, there are two principal types of encapsulation systems: one is called "CPS" (Corrosion Protection System) and the second is the "Zero Void® System". Both systems perform adequately when installed correctly (which will be reviewed later). However, the components and assembly requirements of each system differ and it is important to be familiar with the specific system being installed.

The CPS consists of:

- Plastic coated (encapsulated) anchor device
- A translucent 7/8" sleeve about 12 inches long to attach to the tendon sheathing and to the encapsulated anchor casting
- A seal that fits within the sleeve creating a watertight connection between the sleeve and tendon sheathing
- An adapter or locking ring that creates a mechanical connection between the sleeve and encapsulated anchor casting
- The sleeve is completely filled with pt coating (grease) to eliminate air voids
- A translucent cap that connects into the encapsulated anchor to protect the strand-wedge-casting interface
- The translucent cap is filled with pt coating (grease) that the strand tail will displace into the strand-wedge-casting interface to eliminate air voids

The Zero Void® System consists of:

- Plastic coated (encapsulated) anchor casting
- A soft translucent plastic seal about 6 inches long with tabs that mechanically attach to the encapsulated anchor casting and provides a "void-free" seal of the anchorage to the sheathing
- A translucent cap that has a positive mechanical connection into the encapsulated anchor to

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protect the strand-wedge-casting interface

- The translucent cap is filled with pt coating (grease) that the strand tail will displace into the strand-wedge-casting interface to eliminate air voids

The two systems described herein represent the majority of the systems in use in North America today. There are other systems in use that incorporate minor variations of some of the components and features described, existing systems are being continuously improved, and new systems are being developed. While this article does provide specifics for the proper installation of two unique systems, the information and checklists can be applied to any system to ensure proper assembly and installation.

Design and Installation Drawings

The Engineer of Record (EOR) designs the structure following the Code (typically ACI 318 for concrete structures). It is the EOR's responsibility to make a determination if the structure is in an aggressive environment. PTI and ACI "Specifications" state: *The engineer should decide if the structure, or a part of the structure, is exposed to an aggressive environment.* This is accomplished taking into consideration location and usage. Owner's concerns over performance and durability can also play a role in this determination. Additional guidance can be found in PTI's "Design Fundamentals of Post-Tensioned Concrete Floors", Section 2.3.2 on Durability which references Carl Walker's proposed chart. When the EOR determines that the structure will be in an aggressive environment, the Code requires the use of encapsulated tendons.

Using encapsulated tendons does not affect the EOR's analysis of the structure; rather, it necessitates increased protection of the post-tensioning materials. The EOR performs the design and issues structural drawings per standard practice. It is the EOR's prerogative to spell out performance requirements that may be more restrictive than those required by Code or even to specify a specific encapsulation system. The EOR should include specific required encapsulation details in the drawings. These may include details of a specific type of encapsulation. Additionally, the project specification should include any specific requirements for the encapsulation system which may include specific systems or details.

The Contractor bids (or negotiates) the project per the Contract Documents unless exceptions are identified within their proposal. The same holds true for Post-Tensioning Suppliers and Installers bidding the project. In other words if no exceptions are identified and agreed upon, the encapsulation system shall be as specified. If exceptions are recognized and agreed upon, then some kind of documentation must be issued by the EOR accepting the change. Figure 1 provides a checklist for items related to encapsulation systems that the Contractor can use when purchasing materials from a Post-Tensioning Supplier to make

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Checklist Questions for Purchasing of Encapsulation Systems

General:

- Are you supplying the specified encapsulation system? If not, what are you supplying? Has it been approved by the Engineer?
- Do you have a current water-tightness test report for the system you are supplying?
- Are you contemplating mixing encapsulation systems from different suppliers on individual tendons? If so, how do you propose the jobsite control field quality issues of installing incorrect components?
- Will your Installation (Shop) Drawings include all details and instructions for the encapsulation system?
- Do you include all component parts for the encapsulation system? If not, what additional materials need to be purchased for a "complete" system?
- How do you intend to protect the tendon sheathing from defects including rips and tears prior to arrival at the jobsite?
- Do you supply a plasma cutter or hydraulic shear for cutting the tendon tails?
- Is the encapsulation system you are supplying a "CPS" or "Zero Void® System" or some other system?
- Do you include pt coating (grease) for filling of sleeves and caps, if required?
- Do you supply equipment to insert pt coating (grease) into sleeves and caps, if required?

CPS "Corrosion Protection System"

Fixed-end anchorages:

- Will the fixed-ends come shop applied?
- Will the fixed-end caps come shop installed with the pt coating (grease)?
- Will the sleeves, seals, and adapters/locking rings for the fixed-end be attached to each other as one unit?
- Will the sleeves, seals, and adapters/locking rings come installed at the fixed-ends?
- Will the pt coating (grease) be inserted into the sleeve in the shop?
- Is the sleeve long enough to provide the required four-inch overlap when the sheathing shrinks?

Stressing-end anchorages:

- How will the stressing-end anchors be shipped to the jobsite? Loose? In boxes?
- Will the stressing-end caps come with the pt coating (grease) in them?
- How will the stressing-end caps be shipped to the jobsite? Loose? In boxes?
- How will the sleeves, seals, and adapters/locking rings be shipped to the jobsite for the stressing-ends? Assembled? Loose? In boxes? With pt coating (grease) pre-inserted in the sleeves?
- How many uses for each pocket former are contemplated?
- What method for cutting tendon tails is contemplated? Who supplies plasma cutter? How much current and amperage is required for the plasma cutter? Who supplies hydraulic shear?
- If an oxyacetylene torch is to be used, is there a metal ring within the plastic encapsulation, or some other means to keep the plastic coating from melting? Is the metal ring thick enough not to warp when torched?

Zero Void® System

Fixed-end anchorages:

- Will the fixed-ends come shop applied?
- Will the fixed-end caps come shop installed with the pt coating (grease)?
- Will the seals come installed at the fixed-ends?
- Is the seal long enough to provide the required four-inch overlap when the sheathing shrinks?

Stressing-end anchorages:

- Will the seals come installed on the stressing-end anchors? Or, Loose?
- How will the stressing-end anchors be shipped to the jobsite? Loose? In boxes?
- How will the seals be shipped to the jobsite for the stressing-ends? Loose? In boxes?
- How will the stressing-end caps be shipped to the jobsite? Loose? In boxes?
- Will the stressing-end caps come with the pt coating (grease) and gaskets in them?
- How many uses for each pocket former are contemplated?
- With a nail-less pocket former, are all component pieces included? How many uses for each component are contemplated?
- What method for cutting tendon tails is contemplated? Who supplies plasma cutter? How much current and amperage is required for the plasma cutter? Who supplies hydraulic shear?
- If an oxyacetylene torch is to be used, is there a metal ring within the plastic encapsulation, or some other means to keep the plastic coating from melting? Is the metal ring thick enough not to warp when torched?

Checklist continued on Page 9

Figure 1 – Checklist for Contractor purchasing Encapsulated Post-Tensioning Materials

Field Quality Control of Encapsulation Systems *Continued*

Post-Tensioning Suppliers will provide details and installation instructions for the encapsulation system that they are supplying. The system is chosen based upon meeting specifications or accepted modifications, cost implications, and installer requirements. Keep in mind that at this point the Post-Tensioning Supplier has already agreed upon a price to supply a specific system. They have a responsibility to make sure that the supplied encapsulation system meets the specifications, codes, and their contractual obligations.

Mixing and matching of encapsulation systems without proper testing is not allowed. Manufacturers test their own system components per PTI and ACI "Specifications". Nothing prevents a Post-Tensioning Supplier from mixing encapsulation components from different manufacturers as long as the "new system" passes the testing requirements of PTI and ACI "Specifications". When a "new system" is proposed or supplied to a project, make sure test reports are submitted and accepted prior to use.

The author cautions that mixing encapsulation systems from different manufacturers on a jobsite (or individual tendon) can lead to quality issues. It is possible that the components can get installed on the wrong system which would

Figure 1 – Checklist for Contractor purchasing Encapsulated Post-Tensioning Materials

CPS "Corrosion Protection System"	Zero Void® System
Intermediate Anchorages (Continuation Tendons): • Will the intermediate anchors be placed on the tendon coils in the approximate location of the construction joint(s)? • Will the sleeves, seals, and adapters/locking rings on the "first pour" side be installed on the tendon coils in the approximate location of the construction joint(s)? • Will the sleeves, seals, and adapters/locking rings on the "first pour" side be attached to each other as one unit? • Will the sleeves, seals, and adapters/locking rings on the "first pour" side be attached to the intermediate anchor? • How many uses for each pocket former are contemplated? • Will the sleeves, seals, and adapters/locking rings on the "continuation pour" side be attached to each other as one unit? • Will the sleeves, seals, and intermediate caps on the "continuation pour" side be installed on the tendon coils in the approximate location of the construction joint(s)? • How will the pt coating (grease) be injected into the sleeves on both sides of the construction joint?	Intermediate Anchorages (Continuation Tendons): • Will the intermediate anchors be placed on the tendon coils in the approximate location of the construction joint(s)? • Will the sleeves, seals, and locking adapters on the "first pour" side be installed on the tendon coils in the approximate location of the construction joint(s)? • Will the sleeves, seals, and locking adapters on the "first pour" side be attached to each other as one unit? • Will the sleeves, seals, and locking adapters on the "first pour" side be attached to the intermediate anchor and to each other? • How many uses for each pocket former are contemplated? • With a nail-less pocket former, are all component pieces included? How many uses for each component are contemplated? • Will the sleeves, seals, and intermediate caps on the "continuation pour" side be attached to each other as one unit? • Will the sleeves, seals, and intermediate caps on the "continuation pour" side be installed on the tendon coils in the approximate location of the construction joint(s)? • How will the pt coating (grease) be injected into the sleeves on both sides of the construction joint? • Intermediate Anchorages (Couplers): • The stressing-end anchorages are the similar to above – ask those questions and: • How will the threaded barrel anchors be shipped to the jobsite? Loose? In boxes? • How will the threads on the threaded barrel anchors be protected? • How will the temporary intermediate cap be shipped to the jobsite? Loose? In boxes? • Will the fixed-end of the "second pour" tendon be shop applied? Including applicable seals, spacers, and shipping caps?

Field Quality Control of Encapsulation Systems Continued

invalidate water-tightness test reports and could lead to failure of the encapsulation system. Additionally, each manufacturer's anchorage system is mechanically tested (static and fatigue); installing wedges for one system in the anchorages for another system can lead to tendon failures. The warranties provided by manufactures for their systems may be invalidated when any of this occurs.

The Post-Tensioning Supplier should include all details and instructions for the encapsulation system that they are supplying on their Installation (Shop) Drawings. This should include at a minimum:

- Jobsite handling and care instructions
- Special installation guidelines including insertion of pt coating (grease) when necessary
- Instructions for fixed-ends, intermediates, and stressing-ends (sleeves, seals, pocket formers, etc.)
- Special care/requirements when cutting tendon tails
- Application of caps

Field Requirements

Code requires that the Installer's field crews be certified in unbonded single-strand post-tensioning installation to further the quality assurance provided to the project. The author recommends that at a minimum, the foreman should be certified to Level 2 with the workers certified to Level 1.

Installers are many times at the mercy of the Post-Tensioning Supplier with regards to which encapsulation system is used. It is imperative that Installers clearly define what they are bidding within their proposal. Certainly, CPS encapsulation is more labor intensive than the Zero Void® System. Furthermore, Post-Tensioning Suppliers may supply component parts in various stages of assembly requiring the Installer to assemble pieces in the field. This is especially true for the CPS at the fixed-ends – many Post-Tensioning Suppliers are not installing the sleeves, seals, and adapters/ locking rings nor are they inserting the pt coating (grease) into the sleeves. This then becomes a field requirement.

The Contractor should coordinate between the Post-Tensioning Supplier and Installer to confirm that they understand the requirements of the project and what will be expected. Early recognition of the method to be used to remove the tendon tail (plasma cutting, hydraulic shear, oxyacetylene torch) will ensure that proper components (pocket formers) are on site. Figure 2 provides a checklist for items related to encapsulation systems that the Contractor can use when subcontracting installation from an Installer, additionally supplement these checklist items with the responses from the purchasing checklist (Figure 1) as necessary.

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Checklist Questions for Installation of Encapsulation Systems

General:

- Are your field crews certified for unbonded single-strand post-tensioning installation? Foreman to Level 2? Workers to Level 1?
- What encapsulation system did you bid? "CPS" or "Zero Void® System" or some other system?
- Are you familiar with this encapsulation system? Have you installed it before? How many times?
- How will you handle the materials at the site? All rips and tears in the tendon sheathing must be repaired prior to concrete placement.
- Do you supply a plasma cutter, hydraulic shear, or oxyacetylene torch for cutting the tendon tails?
- Do you include pt coating (grease) for filling of sleeves and caps, if required?
- Do you supply equipment to insert pt coating (grease) into sleeves and caps, if required?

Figure 2 – Checklist for Contractor subcontracting Installation **Continued on Page 14**

Field Quality Control of Encapsulation Systems Continued

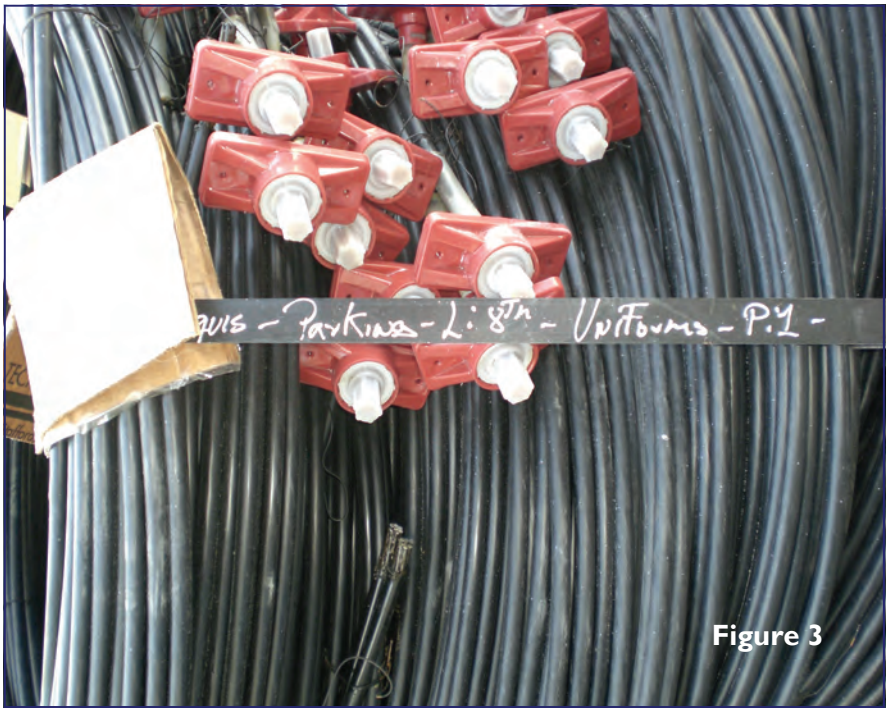
Installation drawings provide instructions to the Installer for placing the specific encapsulation system on the project. The Installer must make sure that all components are installed correctly and completely prior to concrete placement. This includes anchorages and repairing all rips or tears to the sheathing.

PTI and ACI "Specifications" state: *In aggressive environments, it is recommended that the cutting of the tendon tails be performed within one working day after approval of elongations by the Engineer*. The Installer or Contractor cuts the tendon tails; this is accomplished using plasma cutting, hydraulic shear, or oxyacetylene torch. Note that care must be taken using an oxyacetylene torch to cut the tendon tail to the correct dimension and not to damage the plastic or warp the metal ring otherwise the encapsulation cap will not fit correctly. Figure 3 shows what can happen when a oxyacetylene torch melts the plastic coating . The cut length of the tendon

CPS "Corrosion Protection System"	Zero Void® System
Fixed-end anchorages: • Do you include applying fixed-ends in the field? • Do you include installing fixed-end caps in the field? • Do you include inserting the pt coating (grease) into the fixed-end caps? • Do you include assembling the sleeves, seals, and adapters/locking rings for the fixed-ends? • Do you include installing the sleeves, seals, and adapters/locking rings at the fixed-ends? • Do you include installing the pt coating (grease) into the sleeve at the fixed-ends?	Fixed-end anchorages: • Do you include applying fixed-ends in the field? • Do you include installing fixed-end caps in the field? • Do you include inserting the pt coating (grease) into the fixed-end caps? • Do you include installing the seals at the fixed-ends?
Stressing-end anchorages: • Do you include installing stressing-ends in the field? • Do you include installing stressing-end caps in the field? • Do you include inserting the pt coating (grease) into the stressing-end caps? • Do you include assembling the sleeves, seals, and adapters/locking rings for the stressing-ends? • Do you include installing the sleeves, seals, and adapters/locking rings at the stressing-ends? • Do you include installing the pt coating (grease) into the sleeve at the stressing-ends? • The Post-Tensioning Supplier has figured ___ uses for each pocket former? Will this work for you? How will you protect the pocket formers to get this many uses? • What method for cutting tendon tails did you figure? Do you supply the oxyacetylene torch? Do you supply plasma cutter? Do you supply hydraulic shear? • Will you bring temporary power for the plasma cutter? If not, how much current and amperage is required for the plasma cutter? • If an oxyacetylene torch is to be used, how will you protect the metal ring from warping?	Stressing-end anchorages: • Do you include installing stressing-ends in the field? • Do you include installing stressing-end caps in the field? • Do you include inserting the pt coating (grease) into the stressing-end caps? • Do you include installing the seals at the stressing-ends? • The Post-Tensioning Supplier has figured ___ uses for each pocket former? Will this work for you? How will you protect the pocket formers to get this many uses? • What method for cutting tendon tails did you figure? Do you supply the oxyacetylene torch? Do you supply plasma cutter? Do you supply hydraulic shear? • Will you bring temporary power for the plasma cutter? If not, how much current and amperage is required for the plasma cutter? • If an oxyacetylene torch is to be used, how will you protect the metal ring from warping?
	Figure 2 Checklist Continued on Page 16

Field Quality Control of Encapsulation Systems

tails must match the requirements of the encapsulation system to ensure a watertight connection of the encapsulation cap.
PTI and ACI "Specifications" state: *Encapsulation caps should be installed within one working day after cutting off tendon tails* . The Installer or Contractor is responsible to install the encapsulation caps on anchorages in a timely fashion.



Encapsulated Fixed-End Anchors In Bundles of Fabricated Tendons Delivered to Job Site

Field Inspections

The ultimate goal of field inspections is to confirm that the material is installed per the Contract Documents and accepted Installation (Shop) Drawings. Everyone involved in a project – from Design Professional to Worker – has responsibility for some part of the quality control on the project. For encapsulated tendons, the Installer is responsible for making sure the material is installed per the Installation Drawings; the Post-Tensioning Supplier is responsible for supplying the correct material meeting quality control checks; the Contractor is responsible for overseeing the work; the Engineer is responsible for making sure the project meets acceptable practice and codes to achieve the Owner's requirements; and the Inspector is responsible to observe and report that the installed material complies or does not comply with the requirements of the project.

Field inspections are crucial to the overall performance of the structure. How and when they are performed and specific responsibilities should be identified in a "pre-construction" meeting with all parties. The Inspector must be knowledgeable in the materials involved and how to inspect them. The PTI Level 2 – Inspector's Certification is a must for Inspectors that review post-tensioning; the corresponding workshop identifies and reviews the processes involved in inspecting unbonded tendons.

Field quality control of encapsulated tendons is a portion of the overall field inspections of unbonded post-tensioned tendons. Encapsulated tendons have individual idiosyncrasies and requirements that may be different than "standard" post-tensioning tendons. Installers, Post-Tensioning Suppliers, Contractors, Engineers, and Inspectors need to be well versed in the system that is being utilized on the project so that the overall quality required for the project is achieved.

Checklists are a great way for the Inspector to confirm that they have inspected what is required. Additionally, it is recommended that the Installer and Contractor utilize checklists prior to asking for inspection. Figure 4 is a checklist that can be used for reviewing encapsulated tendons. The author suggests that Inspectors add the relevant portions of this checklist to their specific project checklists as necessary. *Note that this checklist only identifies requirements specific to the encapsulation components and is not a complete checklist for unbonded single-strand post-tensioning tendons.*

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CPS "Corrosion Protection System"	Zero Void® System
Intermediate Anchorages (Continuation Tendons): • Do you include threading onto the tendon the intermediate anchors, sleeves, seals, adapters/ locking rings, and intermediate caps at the construction joint(s)? • Do you include assembling the sleeves, seals, and adapters/locking rings for the intermediate anchorages at the construction joint(s)? • Do you include installing the sleeves, seals, and adapters/locking rings for the intermediate anchorages at the construction joint(s)? • Do you include installing the pt coating (grease) into the sleeve for the "first pour" intermediate anchorages at the construction joint(s)? • The Post-Tensioning Supplier has figured ___ uses for each pocket former? Will this work for you? How will you protect the pocket formers to get this many uses? • Do you include assembling the sleeves, seals, and intermediate caps on the stressing side for the intermediate anchorages at the construction joint(s)? • Do you include installing the sleeves, seals, and intermediate caps on the stressing side for the intermediate anchorages at the construction joint(s)? • Do you include installing the pt coating (grease) into the sleeve and intermediate cap on the stressing side for the intermediate anchorages at the construction joint(s)?	Intermediate Anchorages (Continuation Tendons): • Do you include threading onto the tendon the intermediate anchors, sleeves, seals, locking adapters, and intermediate caps at the construction joint (s)? • Do you include assembling the sleeves, seals, and locking adapters for the intermediate anchorages at the construction joint(s)? • Do you include installing the sleeves, seals, and locking adapters for the intermediate anchorages at the construction joint(s)? • Do you include installing the pt coating (grease) into the sleeve for the "first pour" intermediate anchorages at the construction joint(s)? • The Post-Tensioning Supplier has figured ___ uses for each pocket former? Will this work for you? How will you protect the pocket formers to get this many uses? • Do you include assembling the sleeves, seals, and intermediate caps on the stressing side for the intermediate anchorages at the construction joint(s)? • Do you include installing the sleeves, seals, and intermediate caps on the stressing side for the intermediate anchorages at the construction joint(s)? • Do you include installing the pt coating (grease) into the sleeve and intermediate cap on the stressing side for the intermediate anchorages at the construction joint(s)? • Intermediate Anchorages (Couplers): • The stressing-end anchorages are the similar to above – ask those questions and: • Do you understand that the threaded barrel anchors sit on the casting and are stressed; no wedges are inserted into the casting? • Do you include installing the temporary intermediate cap? • Do you include installing the coupler housing of the "second pour" tendon onto the threaded barrel anchor that was stressed for the "first pour"?

Figure 2 – Checklist for Contractor subcontracting Installation
Continued From Page 14

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Encapsulation Tendons Field Quality Control Inspection Checklist	
General: • Have the Contract Documents been reviewed for encapsulation system requirements? • Have the Installation (Shop) Drawings been reviewed for encapsulation system requirements? • What encapsulation system is being used on the project? "CPS" or "Zero Void® System" or some other system? • Have the relevant water-tightness test reports been submitted and accepted?	
Tendon Storage and Installation: • Is material movement at the jobsite adequate to properly protect tendon sheathing from damage? • Will jobsite storage methods protect the tendons and anchorage components from corrosion that could be caused by weather, salt spray, etc. • Have all defects including rips and tears been properly repaired or tendons replaced?	
CPS "Corrosion Protection System"	**Zero Void® System**
Fixed-end anchorages: • Have fixed-end anchorages been properly applied? • Are the fixed-end caps properly seated in the encapsulation protecting the wedges? • Has the pt coating (grease) been properly inserted into the fixed-end caps? • Are the sleeves, seals, and adapters/locking rings completely installed at the fixed-ends? • Has the pt coating (grease) been properly inserted into the sleeve at the fixed-ends removing any air voids?	Fixed-end anchorages: • Have fixed-end anchorages been properly applied? • Are the fixed-end caps properly seated in the encapsulation protecting the wedges? • Has the pt coating (grease) been properly inserted into the fixed-end caps? • Are the seals properly installed at the fixed-ends?
Stressing-end anchorages: • Have stressing-end anchorages been properly installed? • Are the correct anchorages used when cutting tendon tails with an oxyacetylene torch? Metal ring or some other means to keep the plastic coating from melting. • Are the sleeves, seals, and adapters/locking rings completely installed at the stressing-ends? • Has the pt coating (grease) been properly inserted into the sleeve at the stressing-ends removing any air voids? • Are the correct pocket formers for the method of tendon tail removal installed? Teardrop shape oriented correctly for plasma cutting? Larger circular pocket former for hydraulic shear? • Are pocket formers installed correctly and tightly so no displacement occurs during concrete placement?	Stressing-end anchorages: • Have stressing-end anchorages been properly installed? • Are the correct anchorages used when cutting tendon tails with an oxyacetylene torch? Metal ring or some other means to keep the plastic coating from melting. • Are the seals properly installed at the stressing-ends? • Are the correct pocket formers for the method of tendon tail removal installed? Teardrop shape oriented correctly for plasma cutting? Larger circular pocket former for hydraulic shear? • Are pocket formers installed correctly and tightly so no displacement occurs during concrete placement?

Figure 4 – Encapsulation Tendons Field Quality Control Inspection Checklist **Continued on Page 19**

Figure 4 – Encapsulation Tendons Field Quality Control Inspection Checklist Continued

Intermediate Anchorages (Continuation Tendons – "First Pour"):

- Have intermediate anchorages been properly installed?
- Are the sleeves, seals, and adapters/locking rings completely installed at the intermediate anchorages?
- Has the pt coating (grease) been properly inserted into the sleeve at the intermediate anchorages removing any air voids?
- Are pocket formers installed correctly and tightly so no displacement occurs during concrete placement?

- Intermediate Anchorages (Continuation Tendons – "Second Pour"):

- Are the sleeves, seals, and intermediate cap completely and tightly installed at the stressing side of the intermediate anchorages?
- Has the pt coating (grease) been properly inserted into the sleeve and intermediate cap at the stressing side of the intermediate anchorages removing any air voids?

Intermediate Anchorages (Continuation Tendons – "First Pour"):

- Have intermediate anchorages been properly installed?
- Are the sleeves, seals, and locking adapters completely installed at the intermediate anchorages?
- Has the pt coating (grease) been properly inserted into the sleeve at the intermediate anchorages removing any air voids?
- Are pocket formers installed correctly and tightly so no displacement occurs during concrete placement?

- Intermediate Anchorages (Continuation Tendons – "Second Pour"):

- Are the sleeves, seals, and intermediate cap completely and tightly installed at the stressing side of the intermediate anchorages?
- Has the pt coating (grease) been properly inserted into the sleeve and intermediate cap at the stressing side of the intermediate anchorages removing any air voids?

- Intermediate Anchorages (Couplers – "First Pour"):
- Have stressing-end anchorages been properly installed at the construction joint?
- Are the correct anchorages used when cutting tendon tails with an oxyacetylene torch? Metal ring or some other means to keep the plastic coating from melting.
- Are the seals properly installed at the construction joint stressing-end anchorages?
- Are pocket formers installed correctly and tightly so no displacement occurs during concrete placement?

- Intermediate Anchorages (Couplers – "Second Pour"):
- Are the threaded barrel anchors properly seated on the anchor casting and stressed onto the tendon? Confirm that no wedges were inserted into the anchor castings.
- Does the coupler housing contain the required spacers and o-ring?
- Are the seals properly attached to the coupler housing?
- Is the coupler housing completely and tightly threaded onto the threaded barrel anchor?
- Does the step in the coupler housing match the step in the pocket former recess? An even step confirms the coupler housing has been threaded completely.

Conclusions to Field Quality Control of Encapsulation Systems

The Post-Tensioning Industry must continue to provide extraordinary quality control of encapsulated tendons. The material needs to be completely installed and installed correctly so that there are no detrimental long-term performance affects to the structure. This includes Owners, Engineers, Contractors, Post-Tensioning Suppliers, and Installers realizing the affects of actions that allow inferior or incomplete encapsulation systems to be installed.

The Post-Tensioning Supplier should perform in-house quality control and confirm that what is supplied meets the intended specifications. They should also supply "complete" systems that are confirmed to meet the water-tightness requirements of the Contract Documents and the Code. Shop installed anchorages (fixed-ends) should come to the jobsite complete including attachments to the sheathing. Post-Tensioning Suppliers should not leave to the field what can more effectively and economically (on the project scale) be performed in the shop, such as installing caps, sleeves, seals, adapters/ locking nuts, and pt coating in the sleeves at fixed-end anchorages.

The Installer and subsequently the Inspector must know the quality requirements for the encapsulation system used on the specific project. The Installer should follow the instructions on the Installation (Shop) Drawings and make sure the system is complete. The Inspector should confirm that all items are installed correctly or note the deficiencies on their inspection reports.

Engineers, Contractors, Post-Tensioning Suppliers, Installers, and Inspectors can use the checklists provided at various stages of the project. The checklists or portions can better define scope of supply/work for Contractors, Post-Tensioning Suppliers, and Installers. Contractors and Installers can adapt the "Inspection Checklist" to perform a quality check prior to requesting inspection. Engineers and Inspectors can utilize the "Inspection Checklist" to assist in confirming that the installation is correctly installed.

Encapsulated systems for unbonded post-tensioning tendons provide needed protection from the elements for durability and long-term performance of the structure. By providing adequate quality control of the installed materials, the encapsulation system performance will match the project's design life. The Post-Tensioning Industry needs to take a pro-active approach to ensuring that encapsulation systems are installed correctly so that Owners continue to receive quality post-tensioned structures.

References for Article listed on page 27

Cutting Tendon Tails (General):

- Have elongations been accepted by the Engineer of Record?

Cutting Tendon Tails (Oxyacetylene Torch):

- Are the tendon tails cut within one working day of acceptance of the stressing records? Do not use oxyacetylene torch when there is no metal ring or other method used to protect the plastic encapsulation.
- Are the tendon tails cut to the dimensions required for the encapsulation system supplied? If not, the cap may not fit properly.
- Did the metal ring warp from the heat of the oxyacetylene torch? If the metal ring is warped the cap will not fit properly.

Cutting Tendon Tails (Plasma Cutter):

- Are the tendon tails cut within one working day of acceptance of the stressing records?
- Are the tendon tails cut to the dimensions required for the encapsulation system supplied? If not, the cap may not fit properly.

Cutting Tendon Tails (Hydraulic Shears):

- Are the tendon tails cut within one working day of acceptance of the stressing records?
- Are the tendon tails cut to the dimensions required for the encapsulation system supplied? If not, the cap may not fit properly.

Installing Caps:

- Are the stressing-end caps installed within one working day after cutting of tendon tails?
- Are the stressing-end caps properly seated in the encapsulation protecting the wedges?
- Has the pt coating (grease) been properly inserted into the fixed-end caps?

Figure 4 – Encapsulation Tendons Field Quality Control Inspection Checklist Final

References - Field Quality Control of Encapsulation Systems

1. Aalami, Bijan O. and Bommer Allan, "Design Fundamentals of Post-Tensioned Concrete Floors," Post-Tensioning Institute, Phoenix, AZ, April 1999.
2. ACI Committee 423, "ACI 423.6-01, Specification for Unbonded Single-Strand Tendons and Commentary," American Concrete Institute, Farmington Hills, MI, October 2001.
3. ACI Committee 423, "ACI 423.7-07, Specification for Unbonded Single-Strand Tendon Materials and Commentary," American Concrete Institute, Farmington Hills, MI, January 2008.
4. Bedon, Raul A., "Repair of Partially Greased-Filled Encapsulated Monostrand Post-Tensioning Tendons," PTI Journal, Post-Tensioning Institute, Phoenix, AZ, July 2007.
5. Krauser, Larry B., "Repairs, Modifications, and Strengthening with Post-Tensioning," PTI Journal, Post-Tensioning Institute, Phoenix, AZ, July 2006.
6. Krauser, Larry B., "ACI and PTI Requirements for Encapsulation Systems," PTI Journal, Post-Tensioning Institute, Phoenix, AZ, July 2007.
7. PTI, "Field Procedures Manual for Unbonded Single Strand Tendons, 3rd Edition," Post-Tensioning Institute, Phoenix, AZ, October, 2000.
8. PTI, "SPECIFICATION for UNBONDED SINGLE STRAND TENDONS, 2nd Edition," Post-Tensioning Institute, Phoenix, AZ, December 2000.
9. PTI, "Addenda to the Specification for Unbonded Single Strand Tendons, 2nd Edition," Post-Tensioning Institute, Phoenix, AZ, November 2003.
10. PTI, "Addendum #2, Addenda to the Specification for Unbonded Single Strand Tendons, 2nd Edition," Post-Tensioning Institute, Phoenix, AZ, March 2007.
11. PTI, "Training and Certification of Field Personnel for Unbonded Post-Tensioning, Level 2 – Post-Tensioning Inspector," Post-Tensioning Institute.
12. Schupack, Morris, "Evaluating Buildings with Unbonded Tendons," Concrete International, American Concrete Institute, Farmington Hills, MI, October 1991.
13. Walker, H. Carl, "Durability Systems for Concrete Parking Structures," Carl Walker Engineers, Inc., Kalamazoo, MI, November 1990.
14. Walker, H. Carl, "Parking Structure Durability," Concrete International, American Concrete Institute, Farmington Hills, MI, July 1998.

EVENTS CALENDAR

FEBRUARY 2009

3 - 6: World of Concrete, Las Vegas Convention Center www.worldofconcrete.com

8 - 12: North American Iron Worker/IMPACT Labor - Management Conference, Las Vegas, NV – Paris Resort & Casino. Presentations will include: Construction Forecast, Leadership for the Coming Hard Insurance Market, Future Work Opportunities, Owner/Contractor Panel. The luncheon special guest speaker will be the 2000 Greco-Roman Wrestling Olympic Gold Medalist, Rulon Gardner

19: Construction Safety Council's 18th Annual Convention, Chicago, IL – This is the second year that this convention will include an 8 hour safety course on post-tensioned reinforcing (February 14th) – for more information go to www.buildsafe.org.

MARCH 2009

5 - 6: Better Buildings: Better Business Conference 2009, Wisconsin Dells, Wisconsin – for more information go to www.ecw.org/university/

15 - 19: American Concrete Institute Spring Convention, San Antonio, TX – Includes technical paper sessions, symposia on specialized subjects, educational seminars, and committee meetings for all ACI Technical Committees – for more information go to www.concrete.org

MAY 2009

3 - 5: Post-Tensioning Institute Annual Conference & Exhibition, Portland, Oregon –

JUNE 2009

17 - 19: 4th Annual Conference on The Concrete Future Coimbra, Portugal – for more information email: cipremie@singnet.com.sg

JULY 2009

14-24: 25th Annual Ironworker Instructor Training Program, University of San Diego, California – Hundreds of Ironworker Instructors will be participating. Courses to be taught include a 40-hour unbounded post-tensioning train-the-trainer program and a 20-hour bonded post-tensioning train-the-trainer course with hands-on demonstrations in mixing and grouting.