Frequently Asked Questions

Sheathing Repairs

Answers from the PTI DC-80 Repair, Rehabilitation & Strengthening Committee July 2017 • Issue No. 16

Primary Author:
PTI DC-80 Repair, Rehabilitation & Strengthening Committee

Q: When unbonded post-tensioning tendons are exposed during the repair of a post-tensioned structure, does the sheathing need to be repaired?

A: In many structures, the sheathing is the primary defense to protect an embedded post-tensioning tendon from moisture intrusion, and as a result is instrumental in protecting the tendon from corrosion, along with the PT coating (commonly referred to as grease). Moisture that does enter the tendon sheathing can degrade the PT coating, eventually resulting in corrosion of the strand. Restoring the sheathing to a watertight condition is an important and highly effective means to protect post-tensioning strand from corrosion. Experience has shown that sheathing that is not repaired or that is repaired improperly will eventually result in corrosion of the strand in an exterior environment. Therefore, it is advisable to properly repair the sheathing with the goal of making the repaired sheathing watertight. Repairing the sheathing also keeps the repair concrete out of the sheathing and allows the strand to remain unbonded in the concrete so that it can continue to behave in the manner intended by the designer, and will help to facilitate tendon replacement in the future if repairs or other structural modifications become necessary.

Q: What is the proper method for performing sheathing repairs?

A: The recommended method for repairing the tendon sheathing is given in the PTI Field Procedures Manual. This technique involves cutting away damaged and deformed sheathing; cleaning and drying the exposed section of strand; applying PT coating to the exposed strand; covering the exposed portion of the strand with split-tube sheathing and overlapping the tubing 3 in. (76 mm) onto the intact existing sheathing; and then wrapping the split-tube sheathing with waterproof tape, extending the waterproof tape onto the adjacent intact section of the existing sheathing for a distance of 3 in. (76 mm). A diagram of this technique reproduced from Appendix C of the PTI Field Procedures Manual. This repair technique requires sufficient clearance all around the section of tendon where the sheathing repair is being performed, and therefore is very effective for repairing damaged sheathing on single tendons or on unstressed tendons. In the case of a spliced tendon repair, sections of new extruded sheathing or heat-shrinkable tubing may be used in lieu of split-tube sheathing on both existing and replacement sections of strand, and should be spliced to the remaining existing intact sheathing with wrapped waterproof tape.

Q: Do I need to follow the full PTI procedure if the damage to the sheathing is small and localized, such as a short slit or small gouge, and otherwise the sheathing is intact and undamaged?

A: The PTI Field Procedures Manual provides some guidance regarding this information. It indicates that small repairs such as limited punctures and slits can be repaired by using waterproofing tape wrapped over the affected area, with a 3 in. (76 mm) overlap beyond the damaged area onto undam-

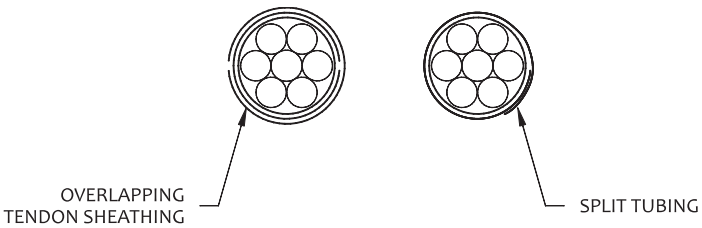
APPENDIX C — REPAIR OF DAMAGED TENDON SHEATHING

RECOMMENDATIONS

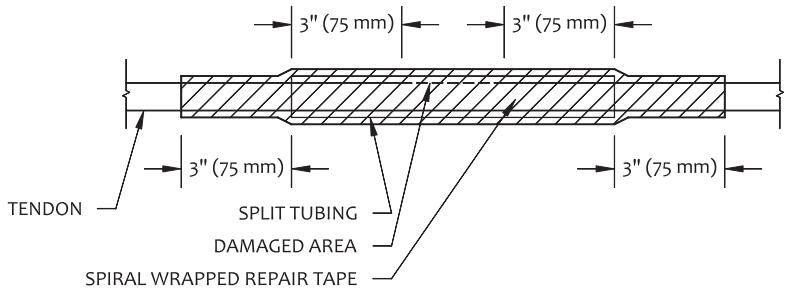
1. Restore PT coating in damaged sheathing area of tendon.

2. Repair/replace tendon sheathing

(a) Place split tubing (50 mil [1.3 mm] minimum) over damaged sheathing area and extend 3 in. (75 mm) past each side. (If split tubing is not available, tendon sheathing [50 mil (1.3 mm) minimum] can be used if two pieces are overlapped).



(b) Spirally wrap the entire length of the damaged sheathing area with repair tape and extend past tubing by 3 in. (75 mm). Tape repair should be smooth without folds.



Note: Material used should be of suitable quality to allow for seal of aforementioned tubing method to be watertight

If no significant portion of the original sheathing is missing (that is, nicks or cuts of 1/4 x 2 in. [6 x 51 mm] size), then taping can be used in place of the aforementioned method by spirally wrapping a minimum of two layers of repair tape extending a minimum of 3 in. (75 mm) past the damaged area in both directions.

aged sheathing. This approach works best if the sheathing damage does not affect the smoothness of the exterior profile of the sheathing. In the case where the roughness of the damaged area prevents the waterproof tape from being in full contact with the sheathing exterior, the damage should be removed to provide a smooth surface. Before repairing short slits or small gouges, it is imperative to verify if there is moisture inside the sheathing. If there is no moisture, then the repairs can proceed as noted previously. If the extent of removal is excessive such that a significant portion of the strand cross section is no longer covered by the existing sheathing, the PTI sheathing repair technique described previously and in the PTI Field Procedures Manual should be followed.

Q: How can I tell if the tape being used is a waterproof tape?

A: Experience has shown that many commonly available tapes such as duct tape are not waterproof, and may in fact absorb and retain water against the tendon,

thereby increasing the likelihood of future corrosion. Preferably, the waterproof nature of the tape should be verified either through manufacturer's technical data or independent testing. When evaluating tapes, it is also important that the tape meet the following criteria:

- Be nonreactive with the existing tendon sheathing,
- Tape is of size and consistency that it can be effectively installed to create a waterproof barrier. This should especially be a consideration with tapes that include solvents or petroleum products in their adhesive or primer formulations.
- Self adhesive
- Elastic
- Minimum 2 in. wide

Q: What if there isn't sufficient clearance around the strand to permit properly wrapping the waterproof tape around the strand, such as where the strand passes over support bars or conventional reinforcement, when full concrete removal around the tendon is not possible, or is part of a bundle of tendons?

A: If the tendon is not stressed, then split-tube sheathing and waterproof tape can be installed in a manner similar to the technique shown in the PTI Field Procedure Manual by prying or otherwise lifting the strand away from the repair surface. Prying may also work if the tendon is still stressed and a sufficient length of tendon is exposed, although more effort will be required.

However, in many cases, a stressed tendon cannot be moved to provide the required clearance. Locations where sufficient clearance may not be provided include multiple adjacent tendons; high points in the tendon drape; anchorage zones; and locations where tendons bear against conventional reinforcing bars, support bars, or other tendons. Repair practitioners have developed several different methods of sheathing repair as best practices for improving the water resistance of the repair in these instances. Such techniques include the following:

1. Leaving a gap in the waterproof tape at the point where the tendon is directly bearing on the surface below. This creates an obvious gap in the protection, but this gap may be limited in those cases where a tendon is bearing at a discrete point, such as over a reinforcing bar.
2. Applying the waterproof tape longitudinally onto the tendon sheathing, adhering to the remnants of the existing sheathing around the perimeter of the tape, which most likely has to be cut to fit. This may provide a watertight repair, provided that the entire perimeter of the tape is well adhered to the existing sheathing.
3. Applying a liquid product that hardens to form a waterproof plastic barrier. This technique can be very useful, provided that it will not react with the PT coating, existing sheathing, or concrete. Appropriate products can be applied over the PT coating, and must adhere to the remaining portions of the existing sheathing.
4. Applying an epoxy. This technique can be effective at protecting steel from corrosion due to direct moisture exposure at splicing and anchorage hardware, but the epoxy will need to be covered by the sheathing system where the hardware meets the sheathing. This intersection should be wrapped with waterproof tape because the epoxy cannot seal open sections of sheathing from moisture intrusion. Experience has shown that this technique is not fully effective if applied directly to the strand because moisture that enters the sheathing around the edges of the epoxy can travel along the interstices between wires and be trapped beneath the epoxy and nearby sheathing, resulting in localized corrosion of the tendon.

Q: What is the best way to terminate a sheathing repair at the hardware for repaired tendons?

A: That would depend on the protection system used at the splicing and anchoring hardware. Possible conditions include the following:

- In the case where an end anchor is being replaced with a new encapsulated anchor, the sheathing can be terminated in the transition sleeve that is a part of the new anchor encapsulation system.
- If the splicing hardware can be encapsulated with heat-shrink tubing, which is probably the best technique, the end terminations are best made using multiple sizes of heat-shrink tubing. Because the larger diameter tubing that is required to cover the hardware typically cannot shrink sufficiently to provide a smooth and tight seal to the adjacent sheathing, smaller-diameter tubing can be installed to overlap the ends of the larger tubing and also shrink down sufficiently to seal to the adjacent sheathing. The use of heat-shrinkable tubing that is self-sealing is recommended.
- Where the splicing coupler and center stressing coupler are coated with epoxy, the waterproof tape will need to extend onto the epoxy at least 3 in. (76 mm) to provide sufficient overlap for a seal. The tape should be installed after the epoxy has hardened sufficiently so that it will not be damaged by the tape installation. Preparation of the epoxy surface may be necessary to ensure that the tape will adhere to the epoxy.
- If the splicing hardware is being protected by wrapped plastic sealed with waterproof tape, the waterproof tape will just need to be continuous across the interface between the existing tendon sheathing and the wrapped plastic at the splicing and anchoring hardware.
- At end anchors that are coated with epoxy, achieving a watertight seal between the anchor hardware and the sheathing is difficult with currently available materials. If a watertight condition is determined to be required by the Licensed Design Professional, replacement of the anchor with an encapsulated system may be desirable.

Q: In addition to sheathing repairs, what can be done to protect repaired tendons from future corrosion?

A: The repair of the sheathing and the restoration of the PT coating are two primary means for protecting tendons from corrosion. However, in the repair of a post-tensioned structure, there are other lines of defense that can also limit

moisture intrusion and thereby limit future corrosion of the embedded unbonded post-tensioning system. Perhaps the most obvious additional line of defense is at the surface of the structural element, where the installation of effective waterproofing can halt the intrusion of moisture into the structure. This often consists of a waterproofing membrane system, but even the use of joint sealants will cut off the flow of moisture through cracks and joints, which are often the path of least resistance for moisture intrusion. This is particularly important that the locations of the end anchorages. Stopping water flow through the edge of the repair area is particularly critical because that point is at the end of or beyond the sheathing repair. Another important line of defense is the concrete itself, as properly performed concrete repairs greatly inhibit the penetration of moisture into the post-tensioned concrete element. The use of high-quality concrete with proper surface preparation, placement, and curing methods can minimize shrinkage cracks that provide paths for water to reach the post-tensioning tendons. Concrete placement methods should also be planned to minimize construction joints within the repair area.

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38800 Country Club Drive, Farmington Hills, MI 48331
Phone: (248) 848-3180 • Fax: (248) 848-3181 • Web: www.post-tensioning.org