National Concrete Bridge Council

2026 NCBC WEBINAR SERIES

Unducted Epoxy-Coated Strand in Practice: The Laurel Fork Bridge

June 10, 2026

Photo: HNTB, © Core-Visual as seen in *ASPIRE* Summer 2023.

NCBC Webinar Series 2026

NCBC
National Concrete Bridge Council

July 15: Anchoring to Concrete Updates for 2026-
Part 2: Attachments with Shear Lugs

August 19: Overview of the new M-50 Tech Note on Unducted PT with Epoxy Coated Strand

1:00 – 2:00 PM ET

September 19: Concrete Repair Topic TBD

October 21: Anchoring to Concrete Part 3: Post-installed reinforcing bars and an overview of grouted joints with confinement

November 18: Silica Fume Sustainable / Low Carbon Concrete

Photo: HNTB, © Core-Visual as seen in *ASPIRE* Summer 2023.

www.nationalconcretebridge.org

National Concrete Bridge Council

Industry Events 2026

Jun 15-17: International Bridge Conference, National Harbor, MD

Jun 28- Jul 2: AASHTO COBS Annual Meeting, Charlotte, NC

Sep 9-12: PCI Committee Days, San Antonio, TX

Sep 30-Oct 2: PTI Committee Days, San Antonio TX

Oct 11-14: ACI Convention, Atlanta, GA

Oct 15-18: NRMCA Concrete Works, Nashville, TN

Nov 8-11: ASBI Convention, San Antonio, TX

Nov 15-18: CRSI Fall Meeting, Chicago, IL

Dec 1-2: World Bridge Engineering Conference, Miami, FL

Photo: HNTB, © Core-Visual as seen in *ASPIRE* Summer 2023.

Continuing Education

NCBC is working with PCI to offer continuing education credits. PCI has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

Photo: HNTB, © Core-Visual as seen in *ASPIRE* Summer 2023.

National Concrete Bridge Council

NCBC Members

AMERICAN COMPOSITES MANUFACTURERS ASSOCIATION

aci

ASBI

CRSI

EIG

EPOXY INTEREST GROUP

ESCSI

ICRI

CONCRETE REPAIR

NRMCA

PCI

pti

SFA

SSIG

Stainless Steel Interest Group

Photo: HNTB, © Core-Visual as seen in *ASPIRE* Summer 2023.

National Concrete Bridge Council

Disclaimer

NCBC assumes no liability for the use of the information presented and does not endorse products or manufacturers. Trademarks or manufacturers' names appear in this material only because they are considered essential to the objective of the material. They are included for informational purposes only and are not intended to reflect a preference, approval, or endorsement of any one product or entity.

The views and opinions expressed in this presentation are the presenters' and do not necessarily reflect those of NCBC.

Photo: HNTB, © Core-Visual as seen in *ASPIRE* Summer 2023.

National Concrete Bridge Council

Presenters

Justin Campbell
Jon Cornelius
Jerry Pfuntner

Photo: HNTB, © Core-Visual as seen in *ASPIRE* Summer 2023.

Presentation

Photo: HNTB, © Core-Visual as seen in *ASPIRE* Summer 2023.

VSL
Civil Construction

EPOXY COATED STRANDS INSTALLATION

Presented by: Justin Campbell
June 10, 2026

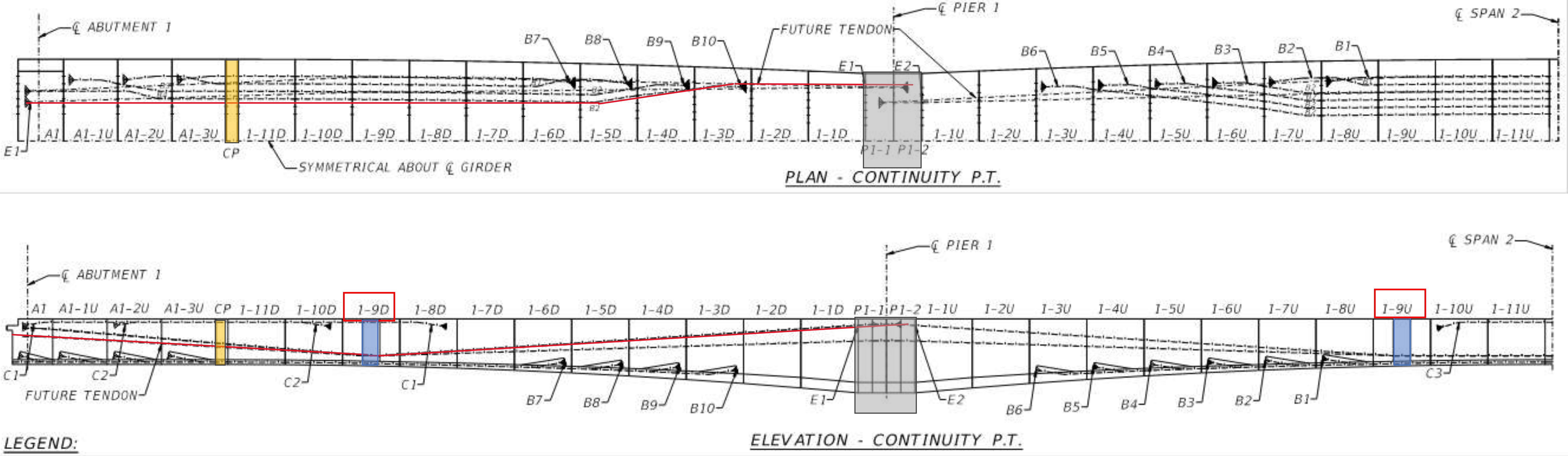
3-span 155ft x 255ft x 155ft

56x Precast Segments max. wt. 131kips

750T Crawler incl. Superlift for 120kips @ 310ft

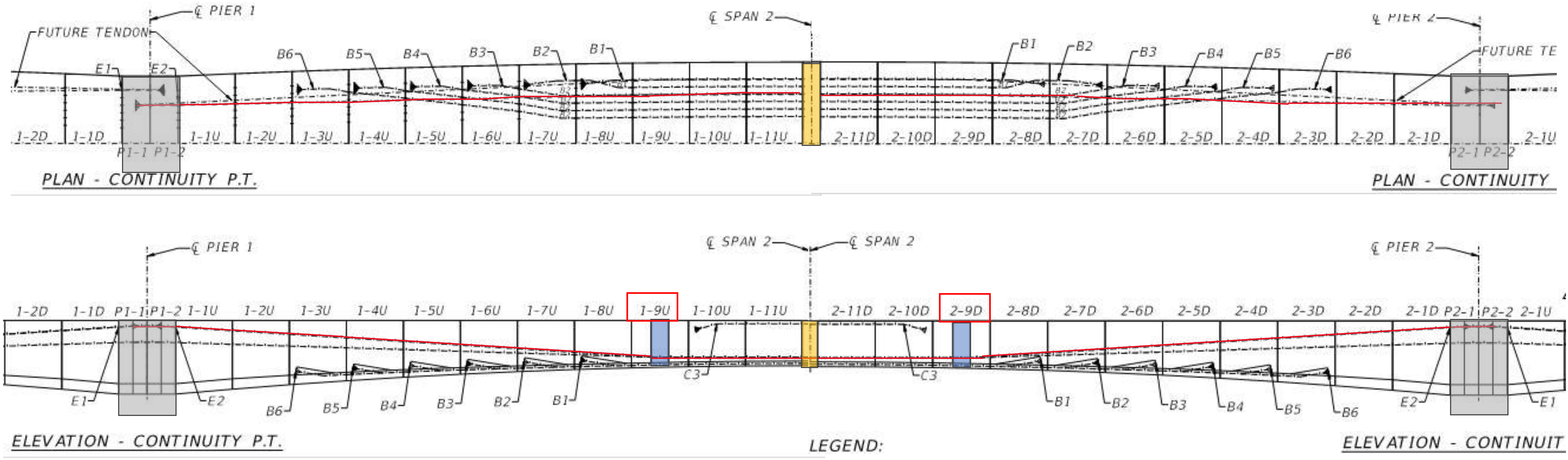
SPAN 1 & 3 EXTERNAL TENDON

- Profile of tendons within span 1 & 3 (note span 3 mirror image)
- Tendon length 155ft
- Deviation through 1x block existing in segment #9



SPAN 2 EXTERNAL TENDON

- Profile of tendons within span 2
- Tendon length 241ft
- Deviation through 2x block existing in segment #9

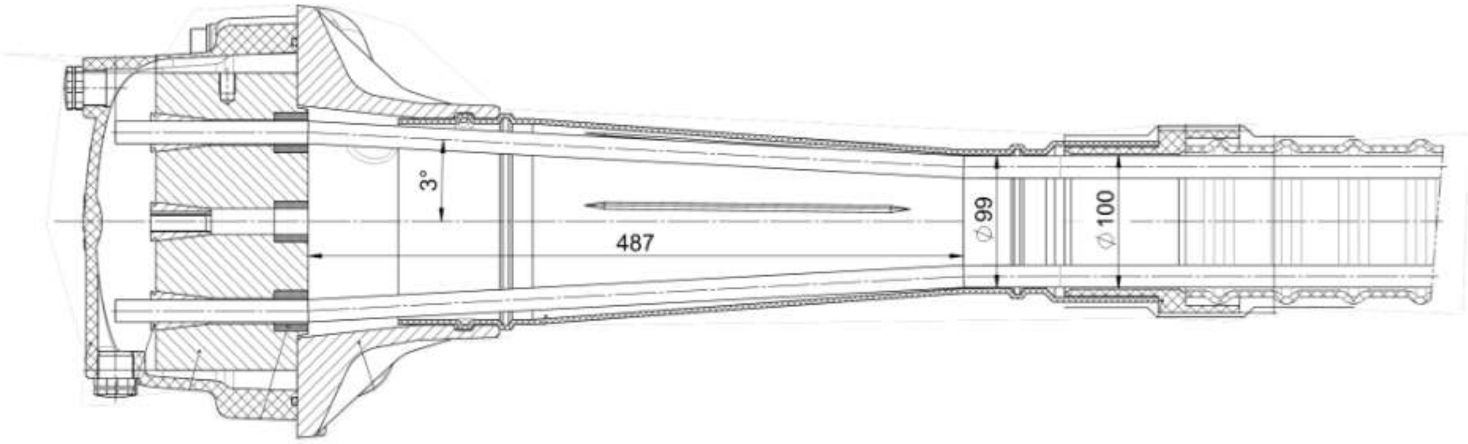



BLUE RIDGE PARKWAY
NP-BLRI 2D17
LAUREL FORK BRIDGE
DATE CAST:5- 29-
PIECE MARK: I-10D
UPSTATION
DATE CAST:5- 22- 24
PIECE MARK: I- 9D
UPSTATION

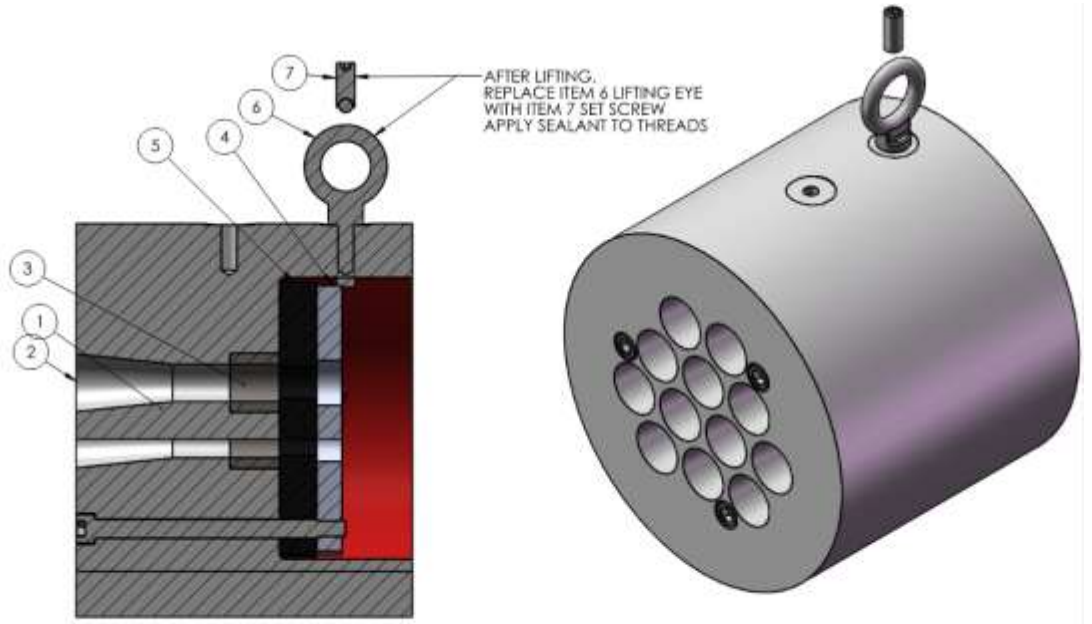
PRE-PLANNING

- 6x external non-bonded continuity tendons (2x per span)
- Small quantity of tendons on-site
- VSL ECI6-12 system embedded materials cast into segments
- 4” dia. HDPE pipe cast-in deviator and diaphragms
- Development ECS System to be compatible with VSL ECI system
- Utilization of existing equipment for all of the process
- Installation method development – adopt methods familiar for site teams

ECS ANCHOR HEAD

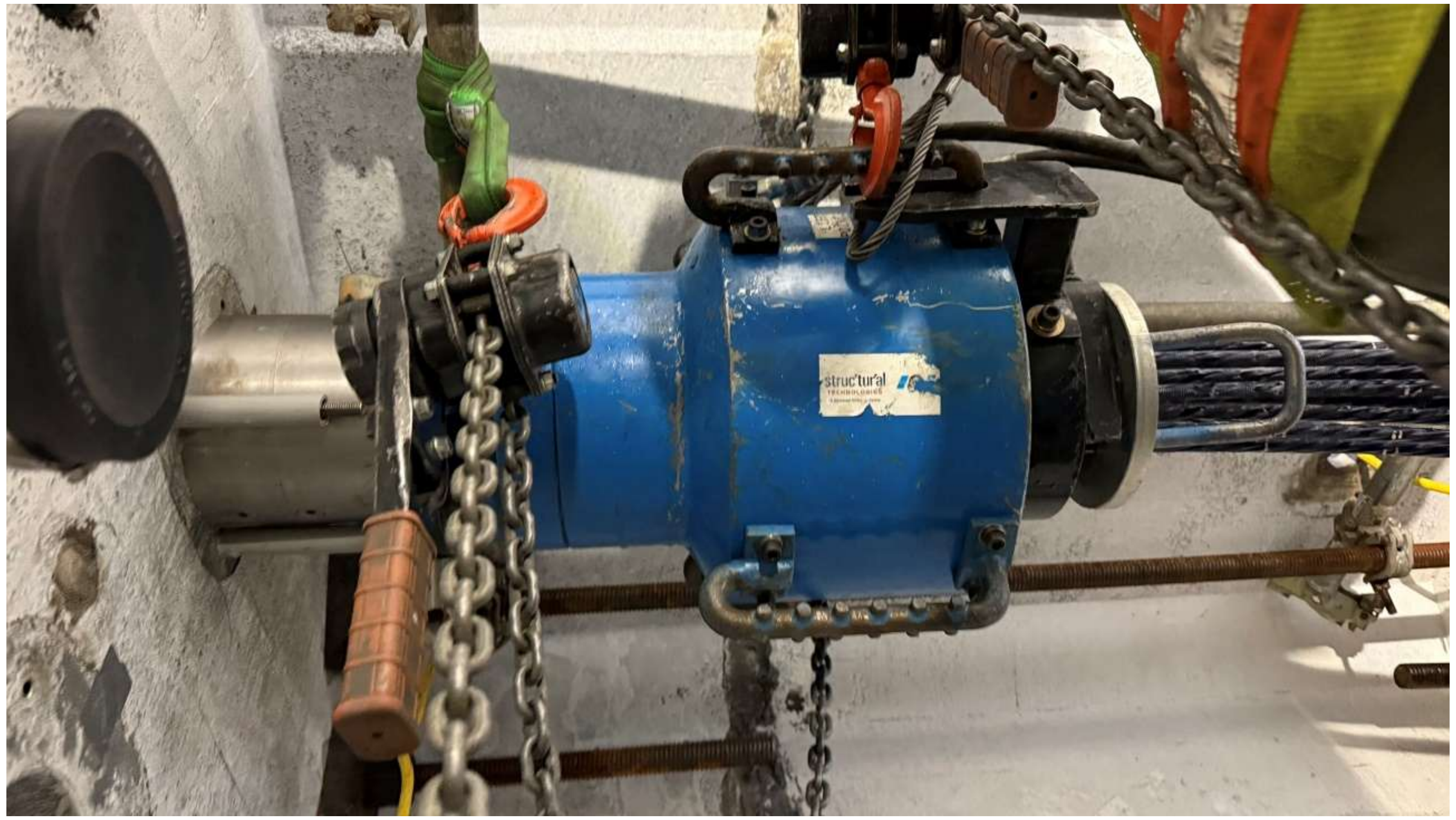


- The VSL ECS anchorage utilizes:
  - Standard anchorage components
  - Oversized bearing plate
  - ECS wedges
- Not option in Laurel Fork. Anchorages already cast into segments
- VSL designed and tested project specific anchor head
- Tests performed with independent lab results were:
  - Fatigue
    - 1x test 500,000cycles from 60% to 66% GUTS range
    - 1x test 50 cycles from 40% to 80% GUTS range
  - Tensile
    - 1 full scale static tensile test. Result pass @ 97.8% AUTS [101.7% GUTS]
- VSL detailing constraint - compatibility with installed ECI6-12 system



EQUIPMENT

- Installation and stressing equipment to accommodate existing fleet
- Utilization of VSL ZPE460 SA 6-12 stressing jack
  - Modifications included gripper plate, gripper wedges, recess plate



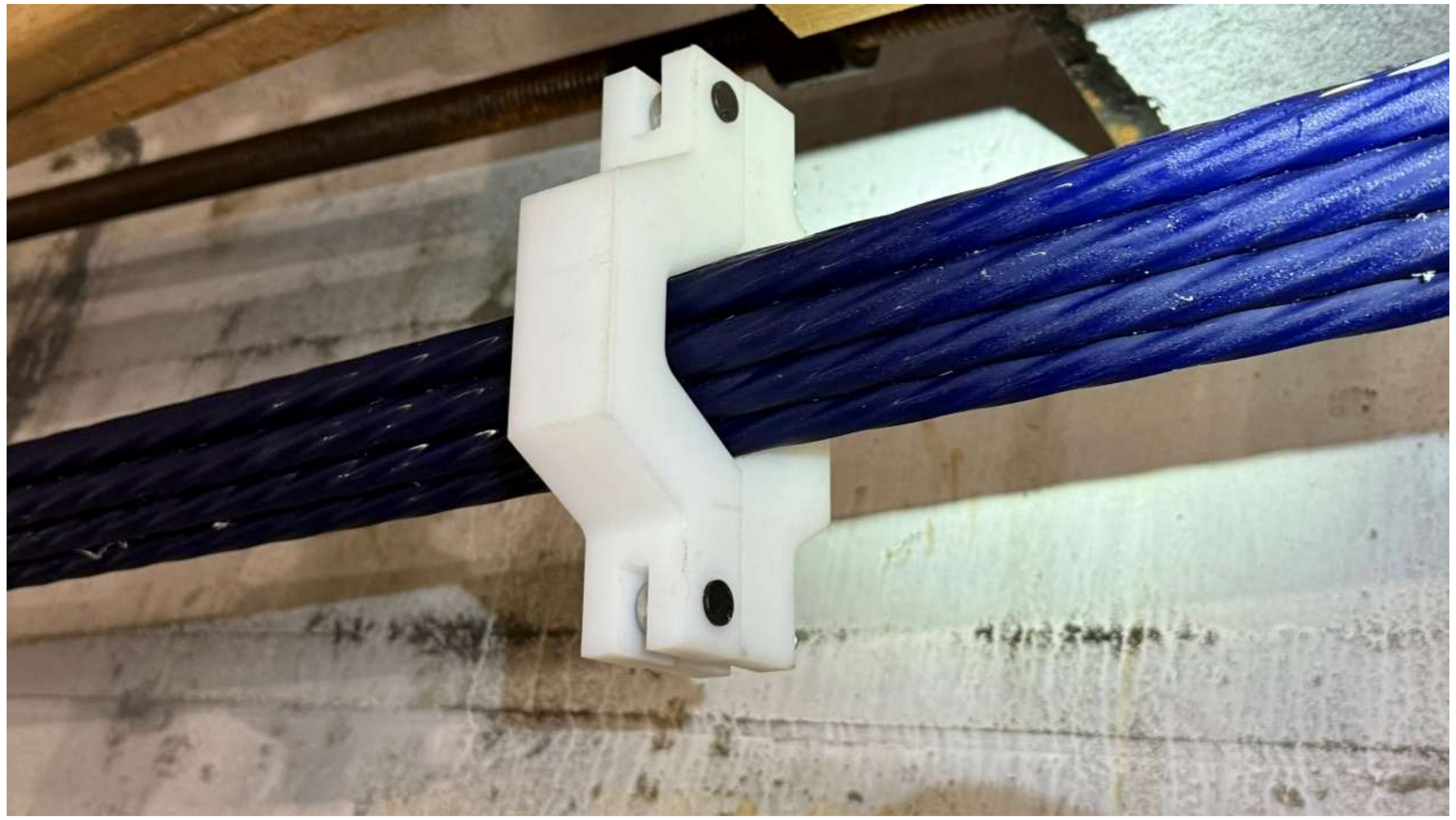
INSTALLATION METHOD

- Importance of construction site conditions / constraints
- Strand delivered on wooden reel
- Uncoiling of strand and preventing contact with objects
- Various options for ground / strand contact protection depending on site conditions

INSTALLATION METHOD

- Hand pushed tendons – short length
- Individual layering of strand
- Special tool provisions by Sumiden



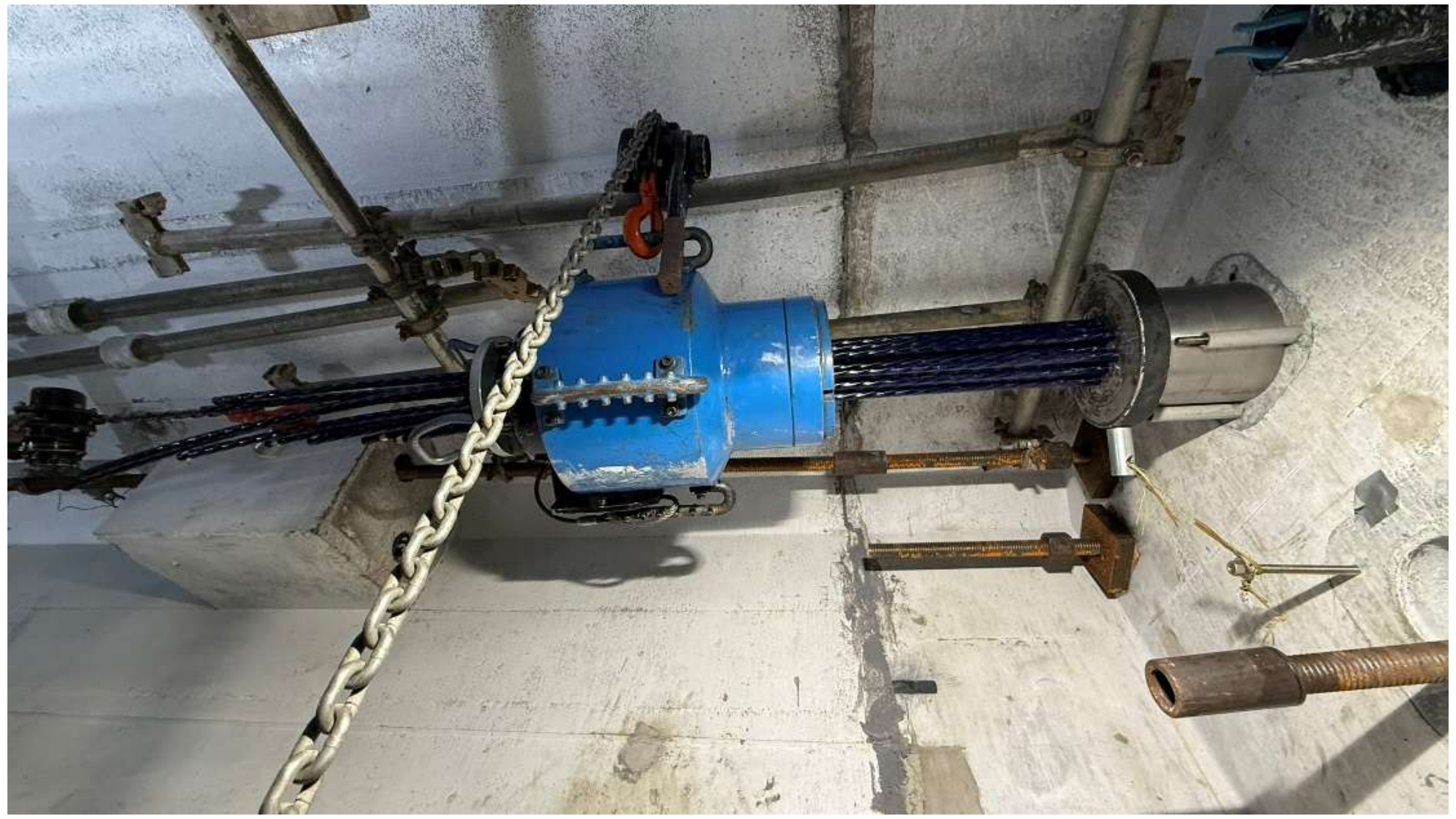
INSTALLATION METHOD

- Anchorage wedge cavities and strands identified

- Taping and containment once bundled

STRESSING PROCEDURE

- Existing PT equipment with 4” stroke
- Evaluation of recess plate depth
- Design, test and implement specific wedge grippers
- Modify wedge gripper plate to accommodate new wedge grippers
- Additional wedge seating inspection steps

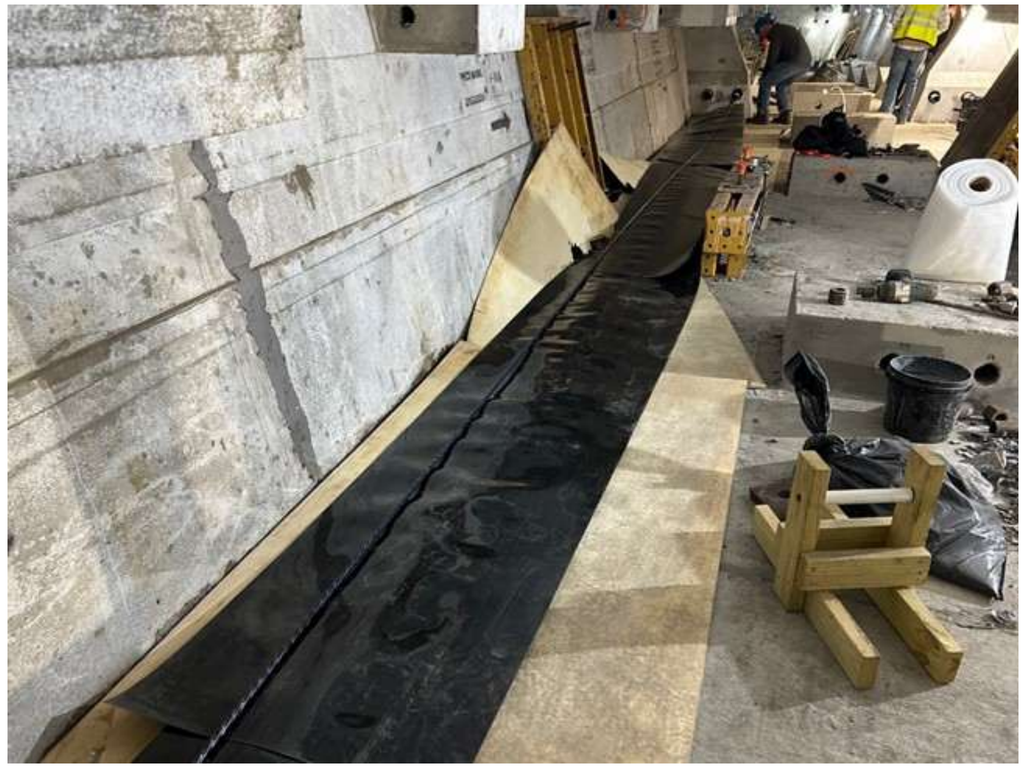


LESSONS LEARNED

- Successes:
  - 1st project in USA for un-ducted ECS in post-tensioning bridge deck
  - VSL completed their 2nd successful unducted post-tensioning project
  - Close working relationship with Sumiden
  - Hand pushing is a viable option for short tendons with additional care / efforts
  - Coating thickness on high side preferable to accommodate site constraints
  - Repair procedures workable at site
  - Stressing operation possible with existing equipment

LESSONS LEARNED

- Challenges:
  - Tight ducts at pier heads and deviator blocks – epoxy protection procedures difficult
  - Segmental joint mis-alignment resultant in reduction in void space for strand
  - Rubbing of epoxy coated strands on epoxy coated strands during install
  - Repair procedure and materials availability
  - Anchor protection cap installation constraints due to previous ECI system
  - Stressing operation – time to perform / wedge seating



SUMMARY – BENEFITS OF UDT

- Strand corrosion protection applied prior to delivery to site
- Tendons are inspectable
- Tendons are replaceable
- Grouting eliminated and associated weather limitations
- Eliminates need for corrosion inhibitors to extend grouting window
- Reduced materials overall
- Precast span-by-span construction application
- System can be adapted for ducted and grouted internal tendons

SUMMARY - OTHER NOTICEABLE

- Specification development and good practice guidance
- Strand coatings type & robustness requirements
- Is fatigue / tensile tests sufficient? Should be more like cable stays?
- Is leak tightness test required on anchorage similar to cable stays?
- Vibration of tendons
- Containment for ‘what-if’ strand failures
- Diabolo / deviator blocks shape – larger bell openings
- Diaphragms or deviator blocks without visible access to strands
- Inspections over service life – visual or other means
- Significant pre-planning required for long length tendons not hand pushed
- Installation and stressing requirements

BLUERIDGE PARKWAY LAUREL FORK, NC

3-span Precast Segmental, General Contractor JV for Supply & Erection of Superstructure.

SUMIDEN WIRE
PRODUCTS CORPORATION

ASTM A882 Epoxy-Coated PC Strand Manufacturing & Testing

Jon CORNELIUS, President
Sumiden Wire Products Corporation
June 10, 2026

SUMIDEN WIRE
PRODUCTS CORPORATION

SUMITOMO
ELECTRIC
GROUP

Brief History of Epoxy-Coated PC Strand

Invented Over 40 Years Ago in the USA!

- **1981** - Invented by Florida Wire & Cable in the USA as ***Flo-Gard***™
  - 1st version had epoxy coating **only on outside** of strand
  - Originally patented by Florida Wire & Cable
    - *Patent has now expired*
- **1991** – Added to ASTM as A882
- **1992** *(est)* – ***Flo-Fil***™
  - 2nd version of epoxy-coated strand developed with epoxy coating **on inside and outside** of strand
- **Filled only** - Only produced and sold as **Filled** epoxy-coated strand now
- **Current Global Standards**
  - ISO 14655 1999-12-15 (International)
  - JSCE-E 141-2023 (Japan)
  - ASTM A882/A882M - ~~2020~~ **2026** (USA)
    - Max relaxation reduced from 6.5% down to **3.5%**
    - Epoxy **adhesion requirements increased** to ensure durability

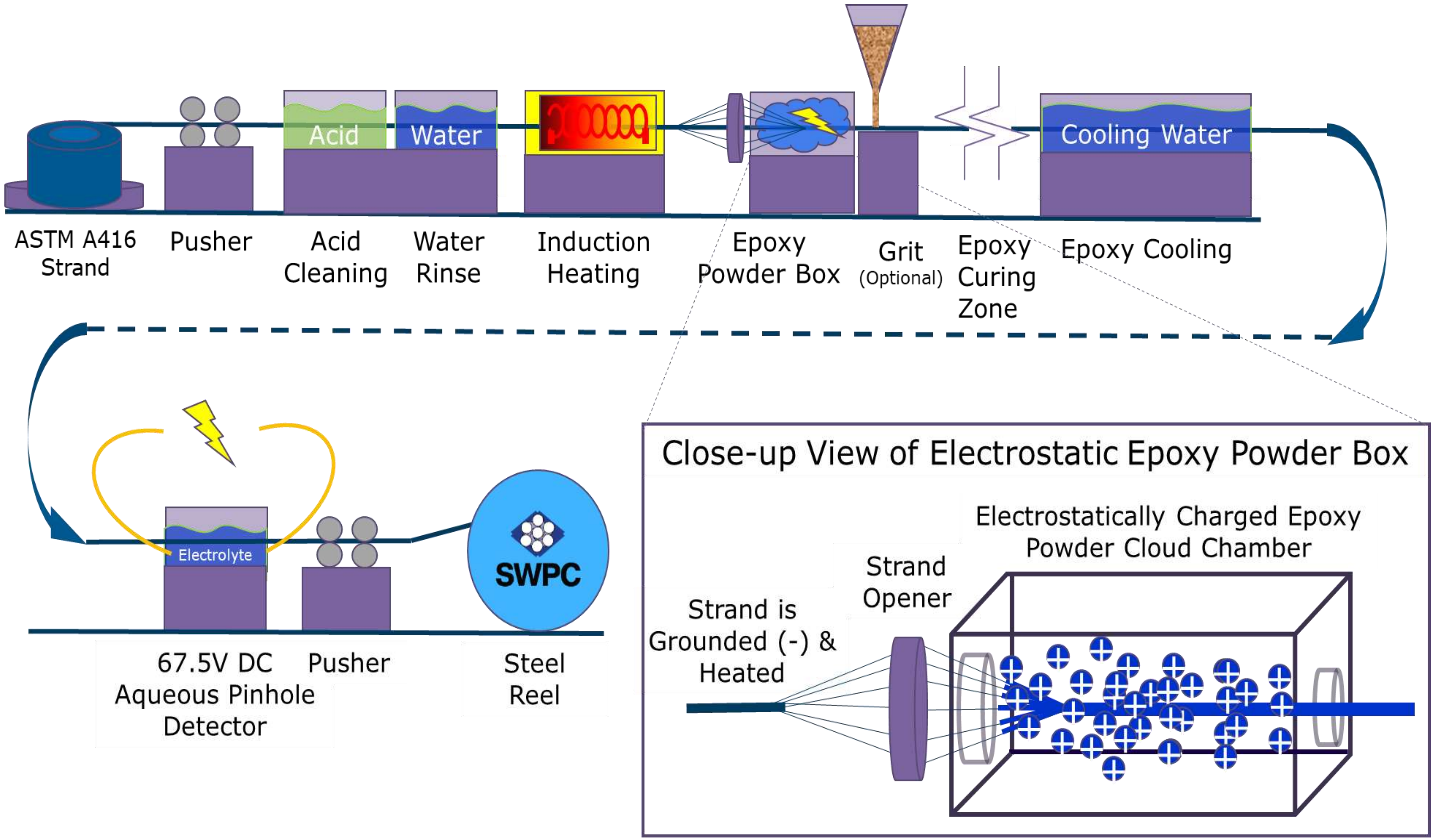
Source: *Circa 1990's Florida Wire & Cable sales brochure*

Modern Epoxy-coated Strand Manufacturing Process

Modern Epoxy-coated Strand Manufacturing Process

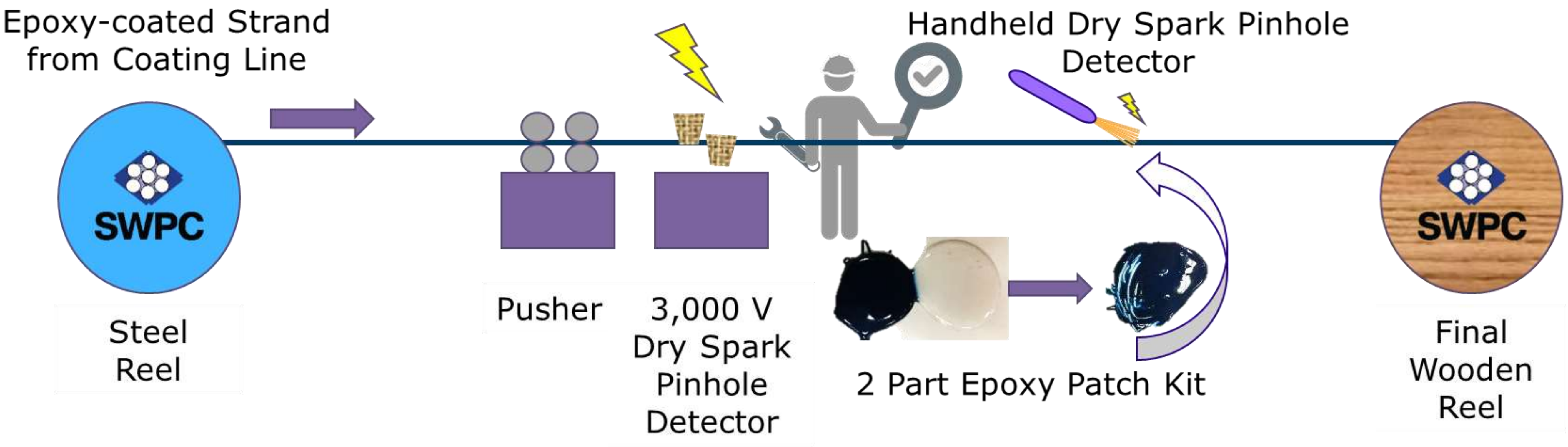
Two Step Process

Step 1: Application of epoxy coating onto the strand



Modern Epoxy-coated Strand Manufacturing Process

Step 2: Epoxy Reworking Process
Reworking is needed because the process cannot be stopped and started without producing scrap.

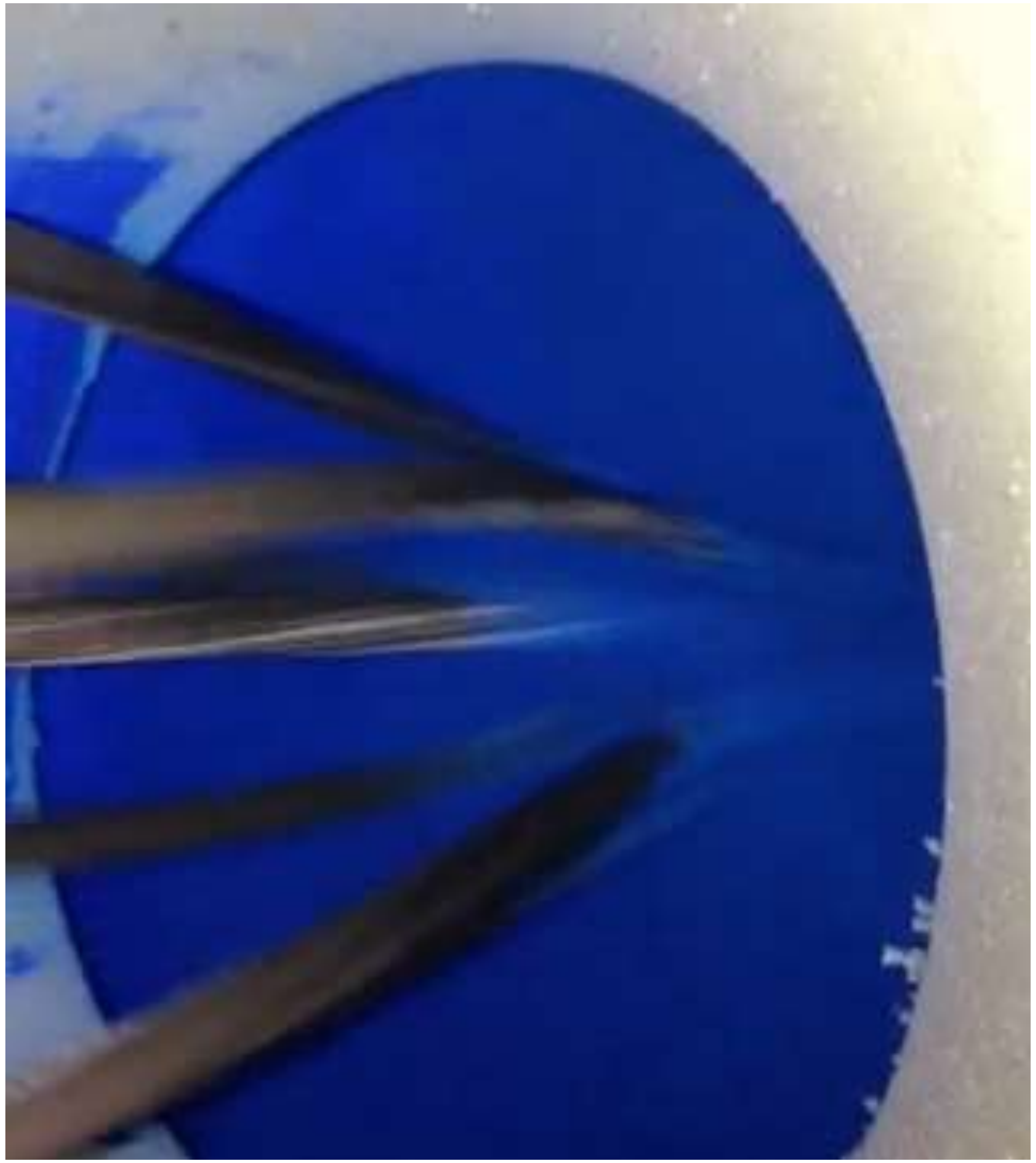


Purposes of Reworking Process:

1. Remove start-up/shut-down scrap sections
2. 2nd 100% pinhole inspection process over entire length
3. Repair any pinholes

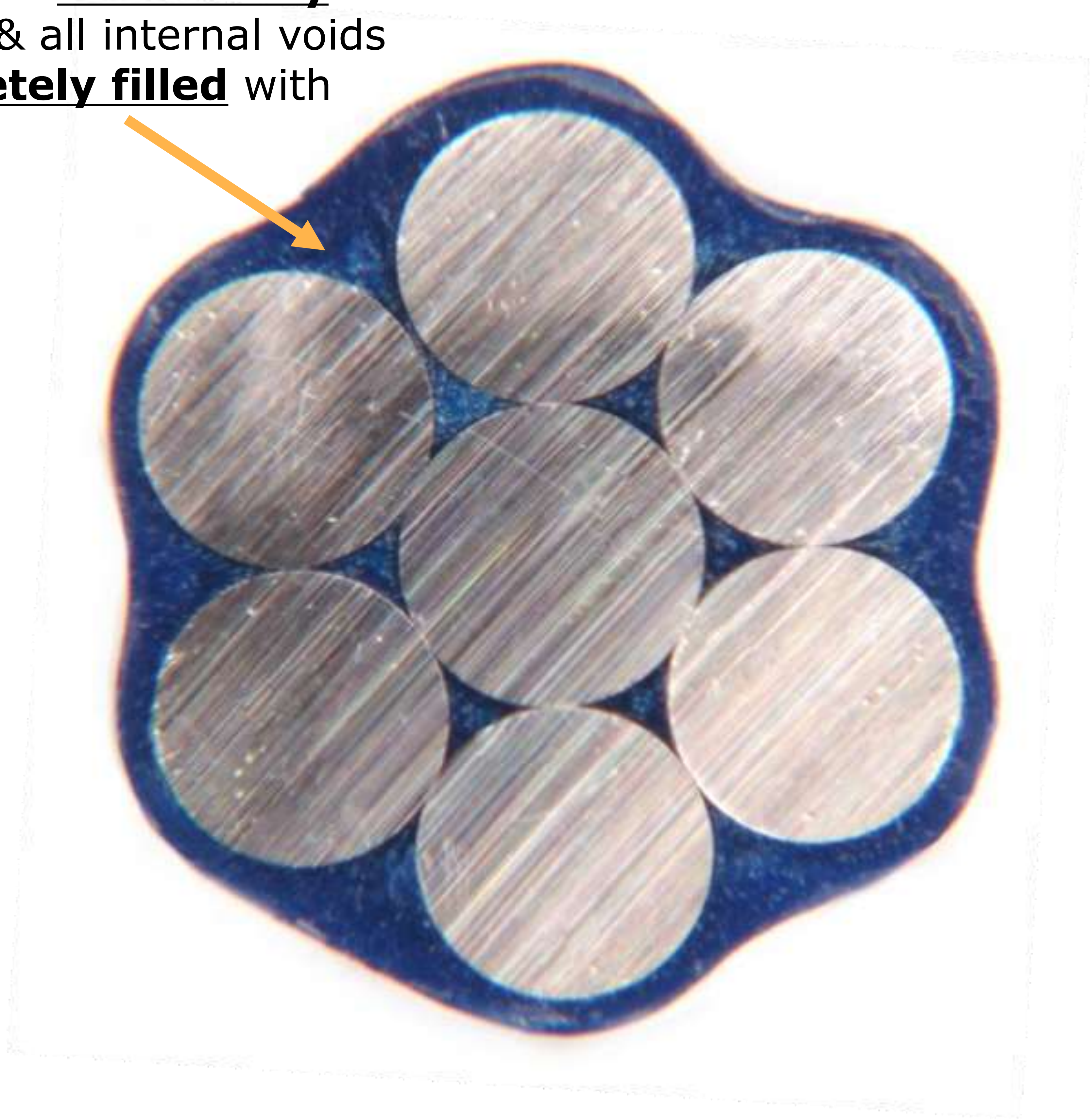
Step 1: Epoxy Coating Process – Close-up of Epoxy Application

Close-up view of the epoxy powder application onto each wire of the strand as it enters the powder box



Epoxy-Coated Strand Cross Section Close-up

Each wire **individually** coated & all internal voids **completely filled** with epoxy



Epoxy Repair Process

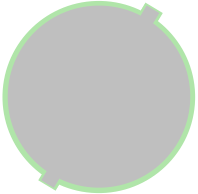
Epoxy Repair Procedure Using 2-Part Epoxy Resin

Step 1	**Clean and dry surface:** Remove all oil, grease, dust and loose, damaged coating from the area to be repaired	
Step 2	**Mix equal amounts of Part A with Part B:** Mix on a disposable surface until uniform color and consistency is achieved. DO NOT mix below 40^{0}F.	
Step 3	**Heat mixture with heat gun:** Recommended heat gun with output of 800˚F to 1000˚F. Heat up for about 10 seconds then mix (repeat if needed). The mixture will have the consistency of a thick syrup when it's ready to be used.	
Step 4	**Apply patch to strand:** Apply mixture to damaged section of strand with a disposable object such as a small spatula or trowel.	
Step 5	**Apply heat to patch with heat gun:** Hold heat gun approximately 2 inches away and heat patch for 25-30 seconds. Move heat gun around to insure consistent heating of patch. Let patch stand for about two minutes. Check for tackiness. Repeat until patch is no longer tacky to the touch.	
Step 6	**Check thickness of patch:** Use Elcometer® 456 tool (or equivalent) to measure the epoxy + patch thickness at the crown of the wire at the patch location. If thicker than 1.14mm use the rotary tool to remove material until thickness is between 0.38 mm - 1.14mm	
Step 7	**Check patch continuity:** Use the hand-held holiday detector at a setting of 3KV to ensure there is no leak on the patch.	

- *Epoxy can be repaired in the field using this same procedure.*
- *Epoxy patches have the same or better adhesion and corrosion resistance as original epoxy coating.*

Epoxy Coating Comparison:
PC Strand & Rebar

Comparison of Surface Preparation Steps
Rebar vs. Strand



Epoxy Coated Rebar Surface Preparation Steps (2 steps)

Hot Rolled Steel (Rebar) → Mill Scale Removal (Shot Blast) → Heat Treatment @ 230°C (450°F) → Epoxy Application

Hot rolled = mill scale must be removed

Epoxy Coated PC Strand Surface Preparation Steps (6 steps)

Hot Rolled Steel (Wire Rod) → Mill Scale Removal (Chemical Cleaning) → Wire Drawing (Wire rod cold drawn through 9 dies) → Stranding with Heat Treatment @ ~400°C (~750°F) → Hot Water Rinsing (Strand Cooling) → Residual Wire Drawing Lubricant Removal (Chemical Cleaning) → Heat Treatment @ >180°C (>360°F) → Epoxy Application

Bare Strand Production Process

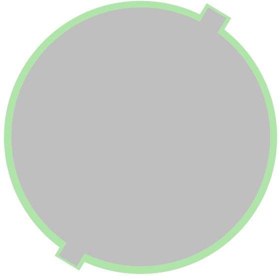
Epoxy Coated Strand Production Process

Epoxy Coating Comparison: PC Strand & Rebar (1/2)

	ASTM A882 Epoxy Coated PC Strand		ASTM A775 Epoxy Coated Rebar	
Epoxy Thickness	15 mils – 45 mils (380 μm – 1,140 μm)		#3 - #5 rebar	7mils – 12 mils (175 μm – 300μm)
			#6 - #18 rebar	7mils – 16 mils (175 μm – 400μm)
Surface Preparation	Chemical Cleaned		Shot Blast Cleaned	
Pinhole Inspection	1st Check	67.5V Aqueous	Wet Sponge @ 67.5 V	
	2nd Check*	3,000V Dry Spark		

**Not required by ASTM A882*

Epoxy Coating Comparison: PC Strand & Rebar (2/2)



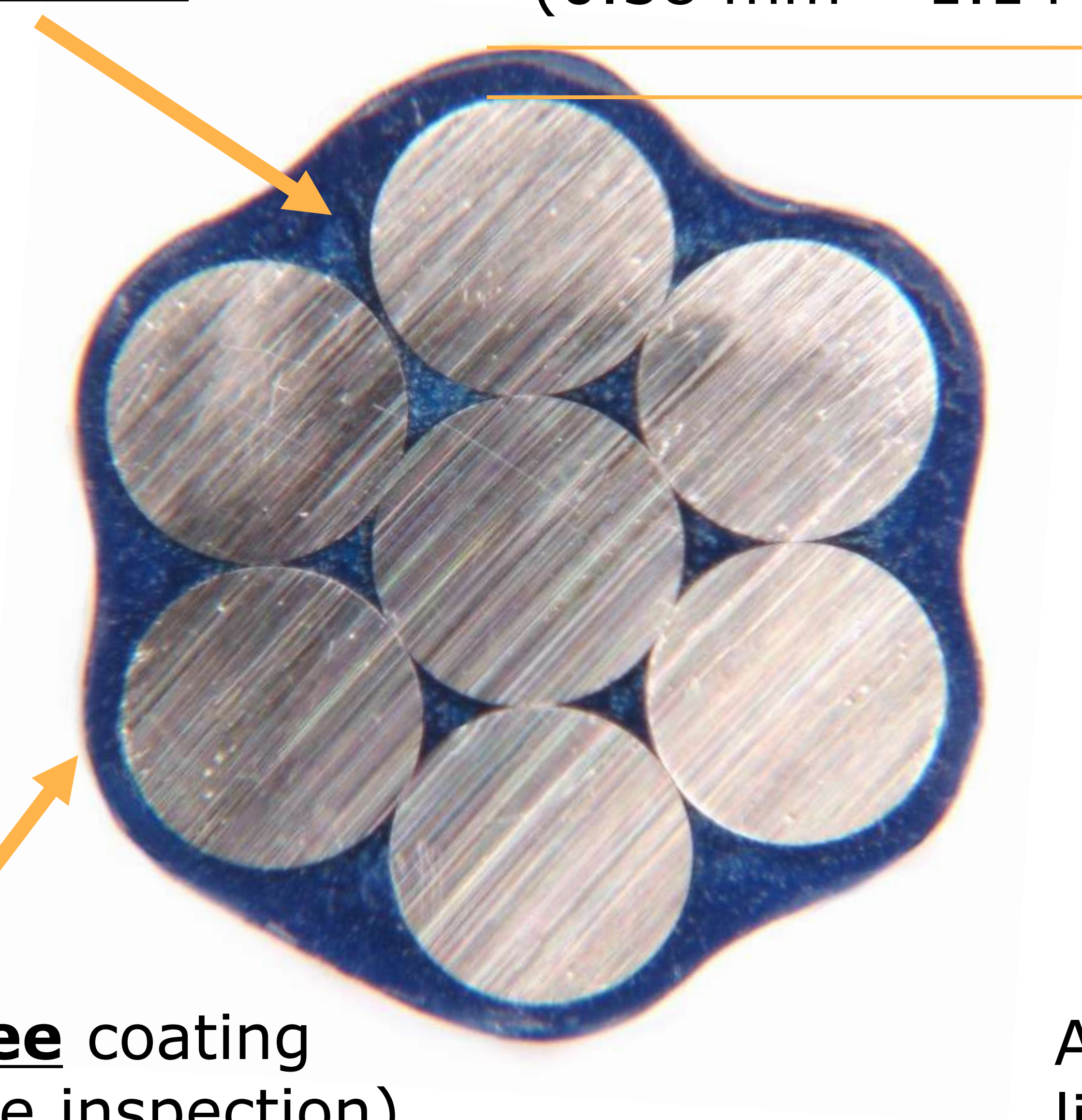
	ASTM A882 Epoxy Coated PC Strand	ASTM A775 Epoxy Coated Rebar
Allowed Pinhole Frequency	No pinholes allowed	Maximum 1 pinhole per linear foot

Epoxy coated PC strand has a thicker coating, more surface preparation steps and fewer pinholes allowed than epoxy coated rebar.

Epoxy Coating Comparison: PC Strand & Rebar

Each wire **individually** coated & all internal voids **completely filled** with epoxy

Coating thickness @ crown of wire:
15 mils – 45 mils
(0.38 mm – 1.14 mm)

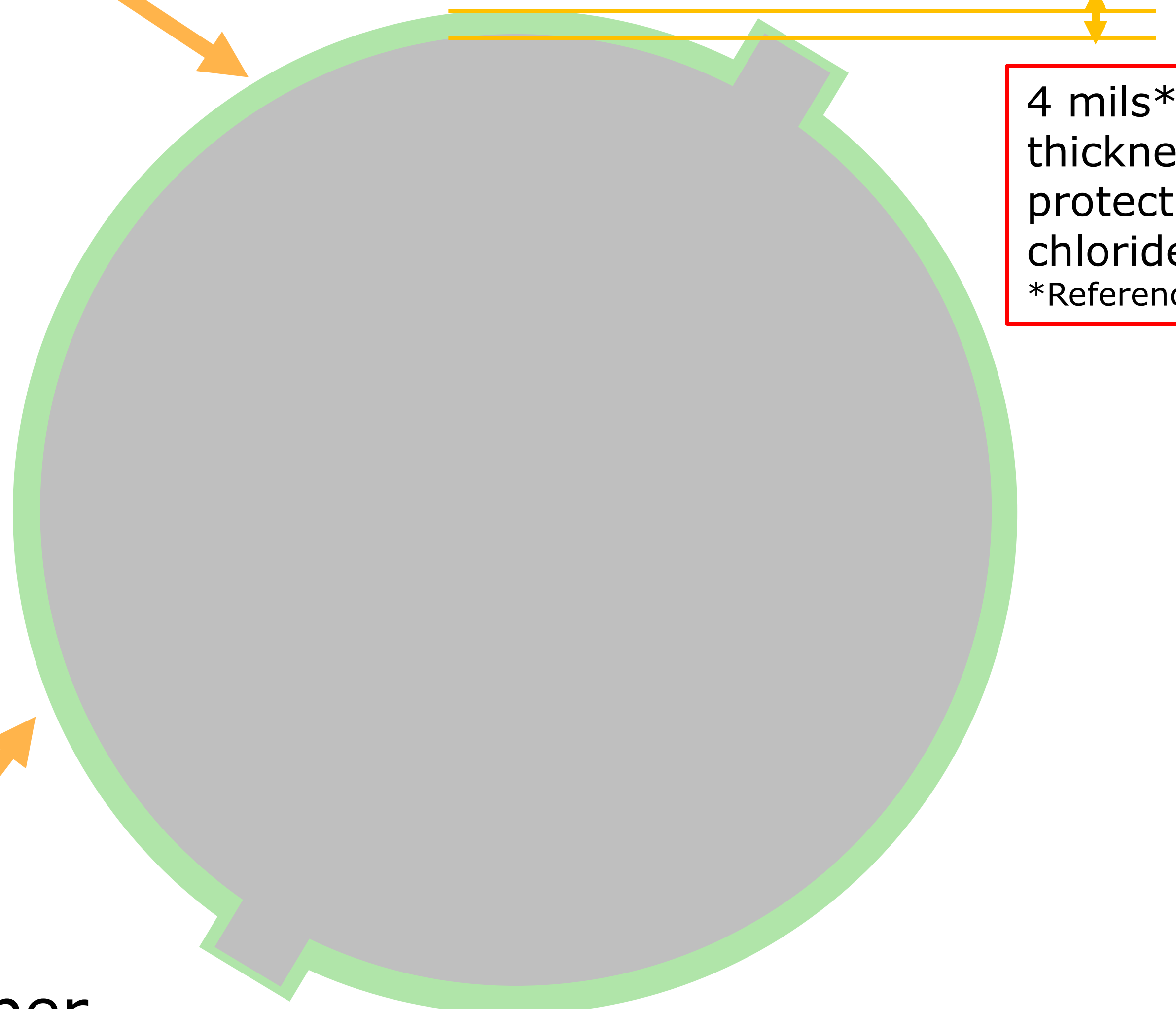


Pinhole-free coating
(100% inline inspection)

Epoxy protection on **outside** of steel only

Coating thickness @
7 mils – 16 mils
(0.18 mm – 0.41 mm)

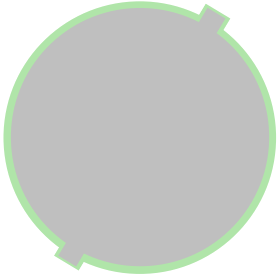
4 mils* epoxy thickness is enough to protect steel from chloride attack
*Reference: FHWA-RD-74-18



Average **1 pinhole** per linear foot allowed

Different products developed for different applications!

Epoxy Coating Comparison: PC Strand & Rebar Handling



Epoxy-coated strand is shipped and handled in the field using protective wooden spools.

Epoxy-coated rebar is shipped and handled in the field with many points of contact during handling, storage and installation

Corrosion Resistance Testing

Comparative Corrosion Resistance

Material Comparison after 1000-Hour Salt Fog Test

Bare strand

Corrosion

Galvanized strand

Corrosion (chalking)

Epoxy-coated strand

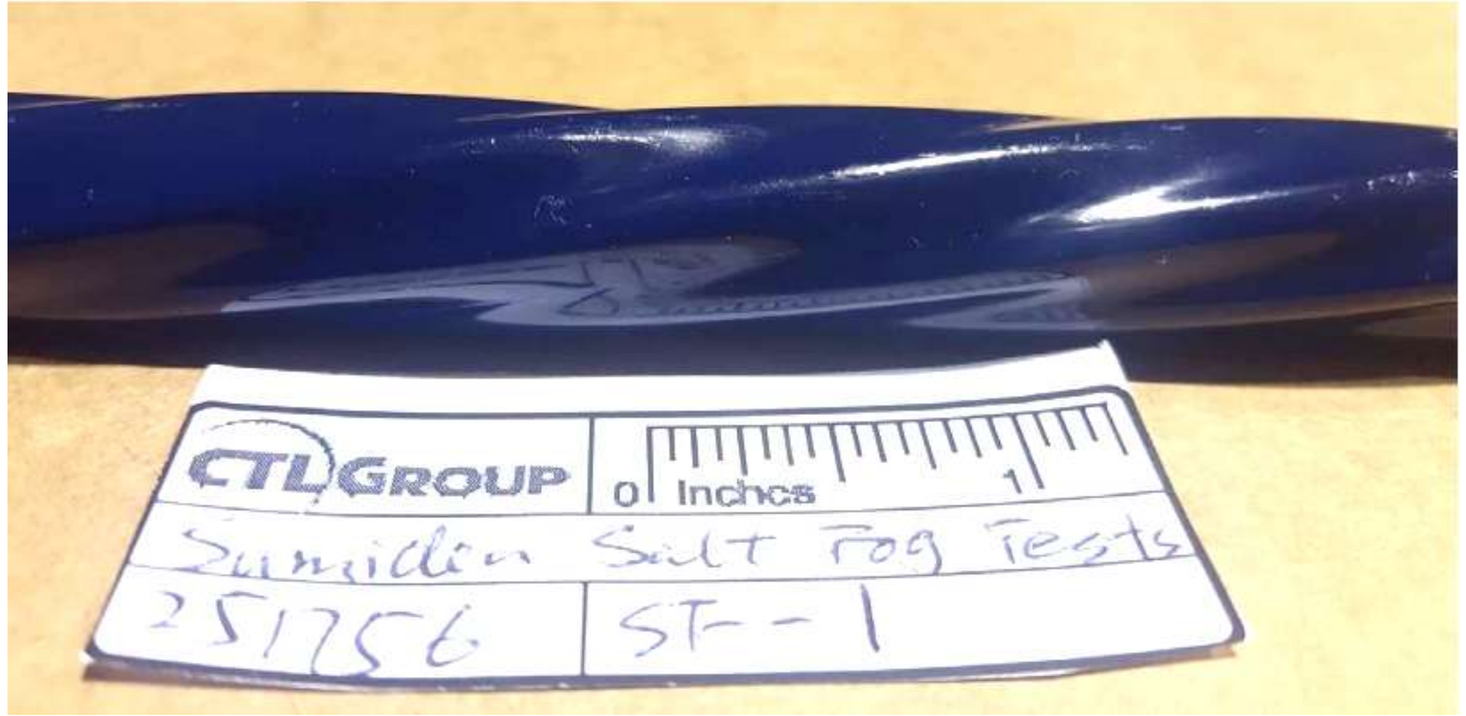
No corrosion

7,200-hours salt fog test on epoxy-coated strand
⇒ **No corrosion**
⇒ **Other chemical resistance tests also performed ($CaCl_2$, NaOH, $Ca(OH)_2$)**

Epoxy-Coated Strand Epoxy Corrosion Resistance and Adhesion

3,000 Hour Salt Fog Test @ CTL

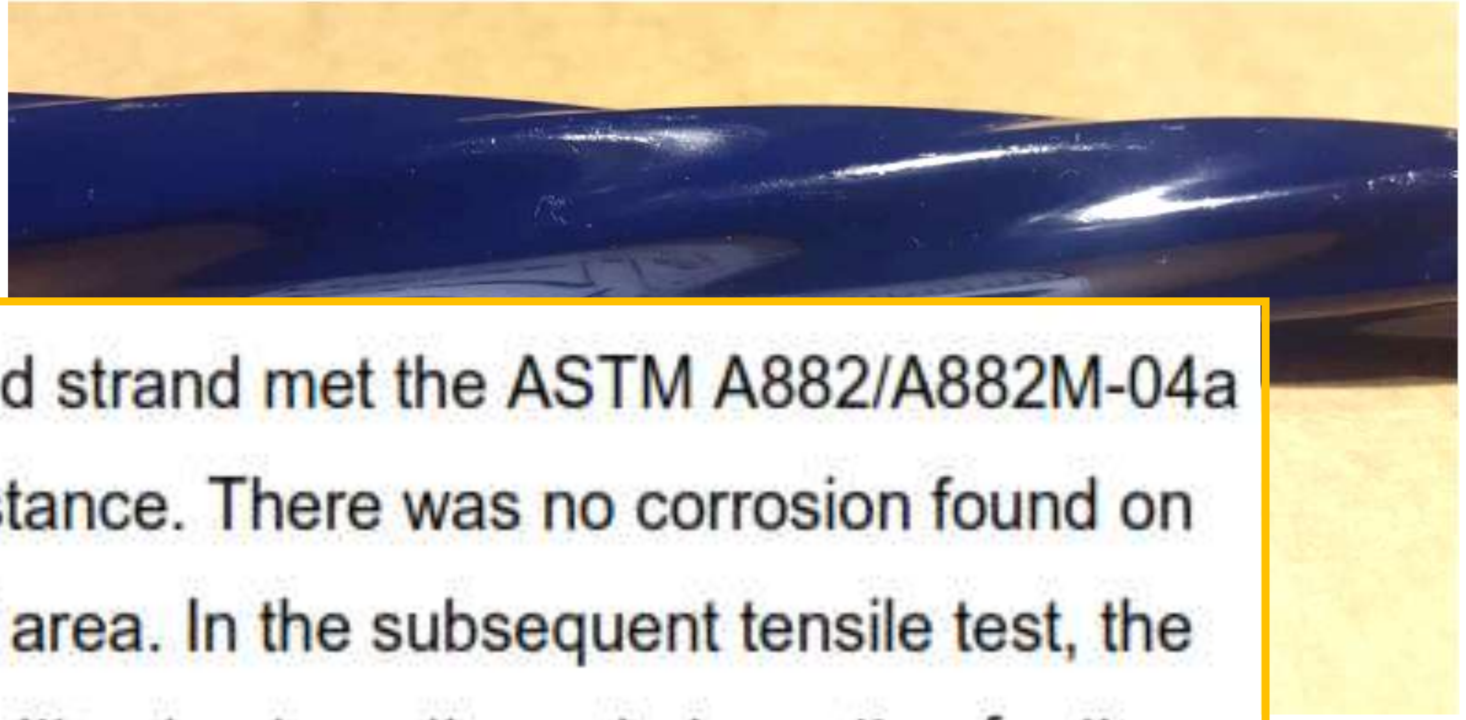
- Testing Conditions (ASTM A882)
  - Strand stressed 70% GUTS
  - **Intentional** Damage
- Test Results
  - **No loss** of tensile strength
  - **No corrosion** on wire except on the exposed wire surface.
    - **No corrosion migration** nor loss of epoxy adhesion



Epoxy-Coated Strand Epoxy Adhesion

3,000 Hour Salt Fog Test @ CTL

- Testing Conditions



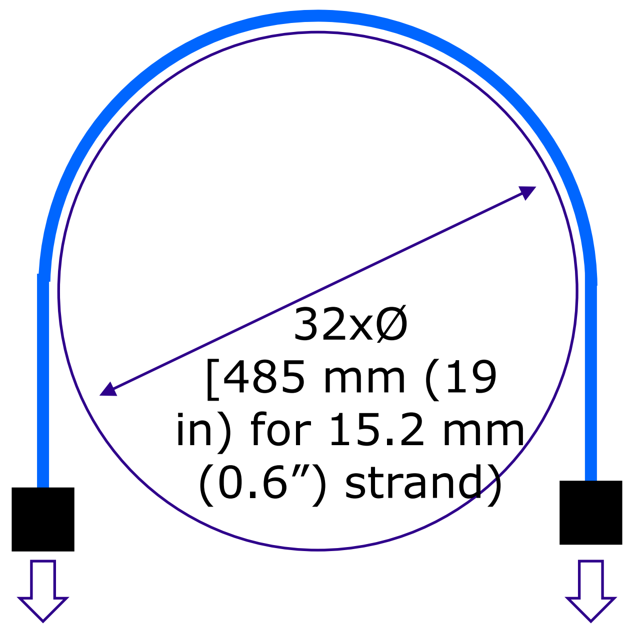
Based on these test results and inspection, the epoxy-coated strand met the ASTM A882/A882M-04a (Reapproved 2010) requirements for Salt Spray (Fog) Resistance. There was no corrosion found on the wire surfaces. No corrosion was migrated from exposed area. In the subsequent tensile test, the sample satisfied the requirements for the yielding strength, ultimate strength, and elongation for the strand with a nominal diameter of 0.6 in. (15.24 mm) in ASTM A416/A416M – 17.

- Te
  - **No corrosion** on wire except on the exposed wire surface.
    - **No corrosion migration** nor loss of epoxy adhesion

Epoxy Coating Elongation Property

- Epoxy coating can elongate >50%.
- Elongation and adhesion confirmed by 32 x strand diameter mandrel bending test and tensile test
- Long-term elongation property confirmed by performing mandrel test and tensile test on strand taken from 800 mm ID wooden spools in warehouse after 10+ years storage.
  - No cracking or disbonding of epoxy coating in tensile test
  - No cracking or disbonding of epoxy coating in mandrel test

Example tensile test result after 10+ years storage

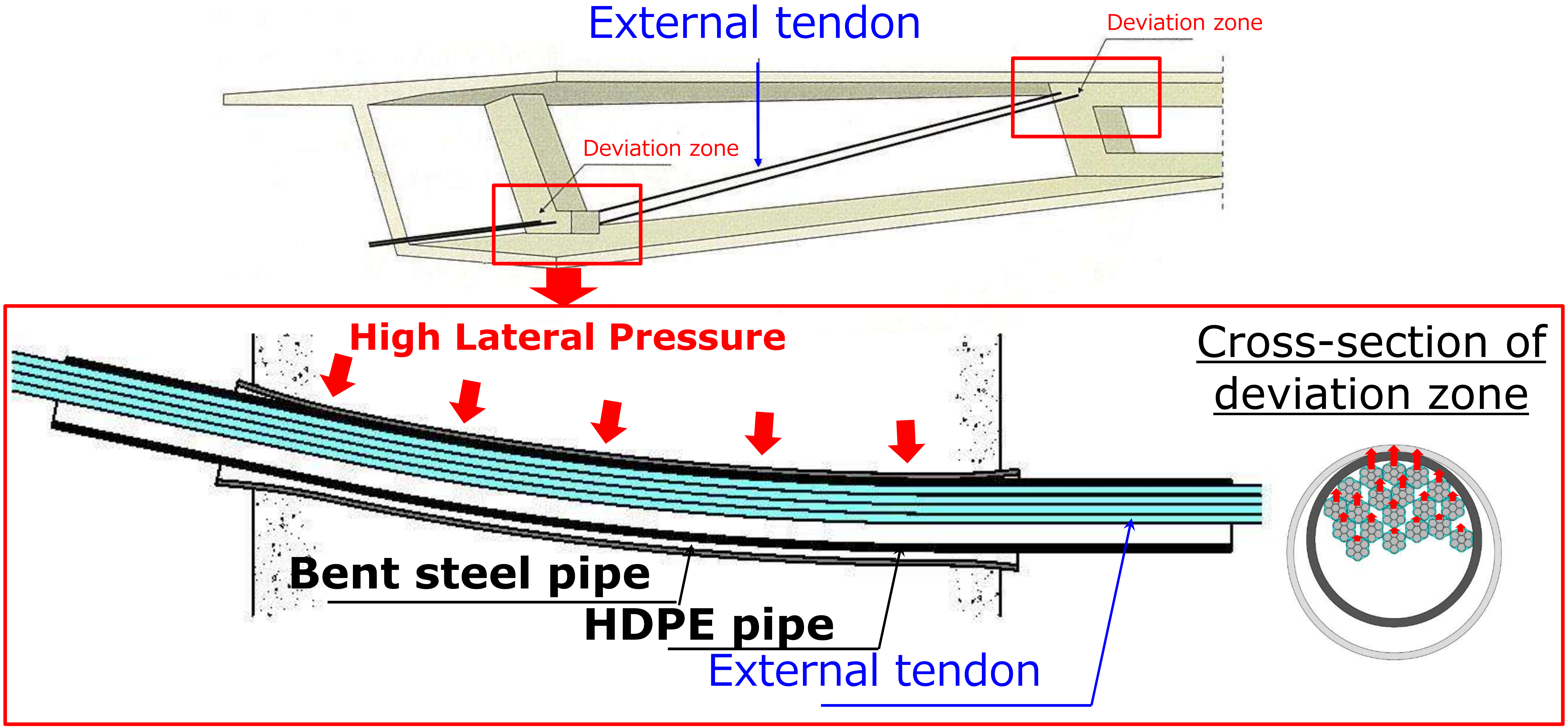


Mandrel test diagram

Durability Testing for External Tendon Applications

External Tendon Deviation Zone Concerns

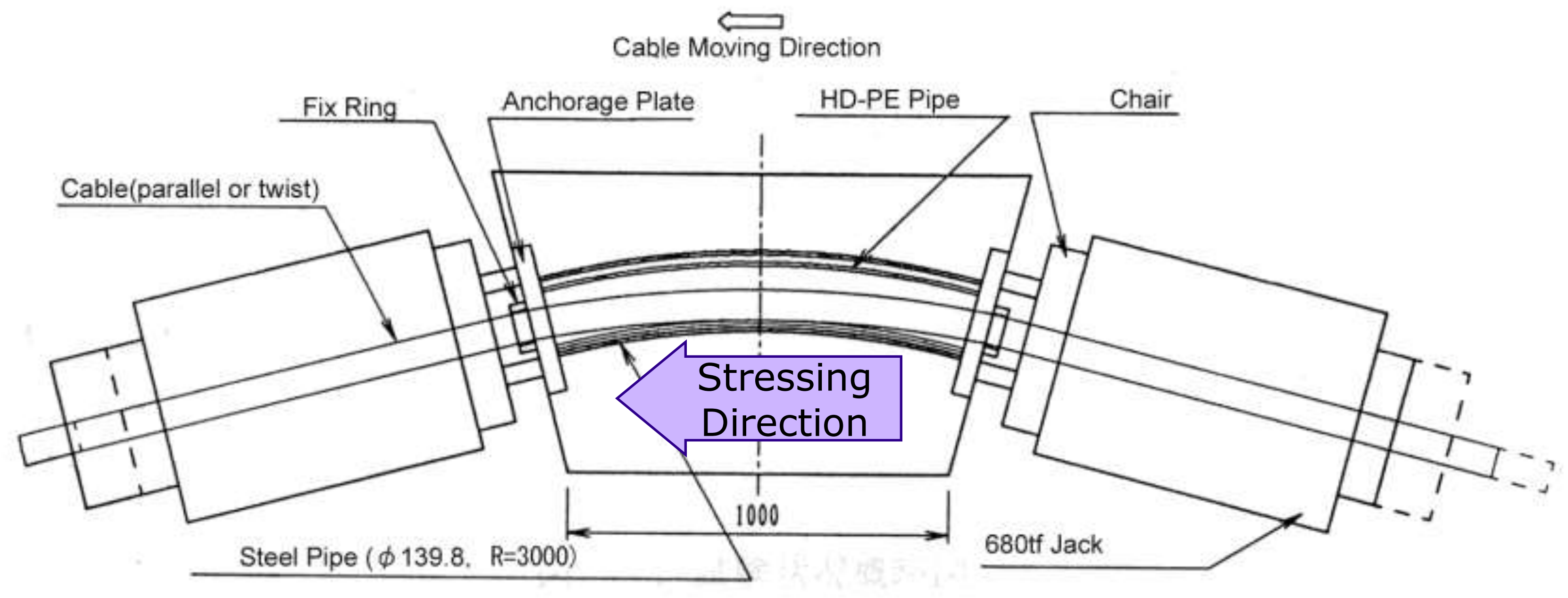
Lateral pressure is loaded to external tendon in deviation zones.



Stressing Tests at Deviators

19 Strand Full-Scale Stressing Test at Deviator

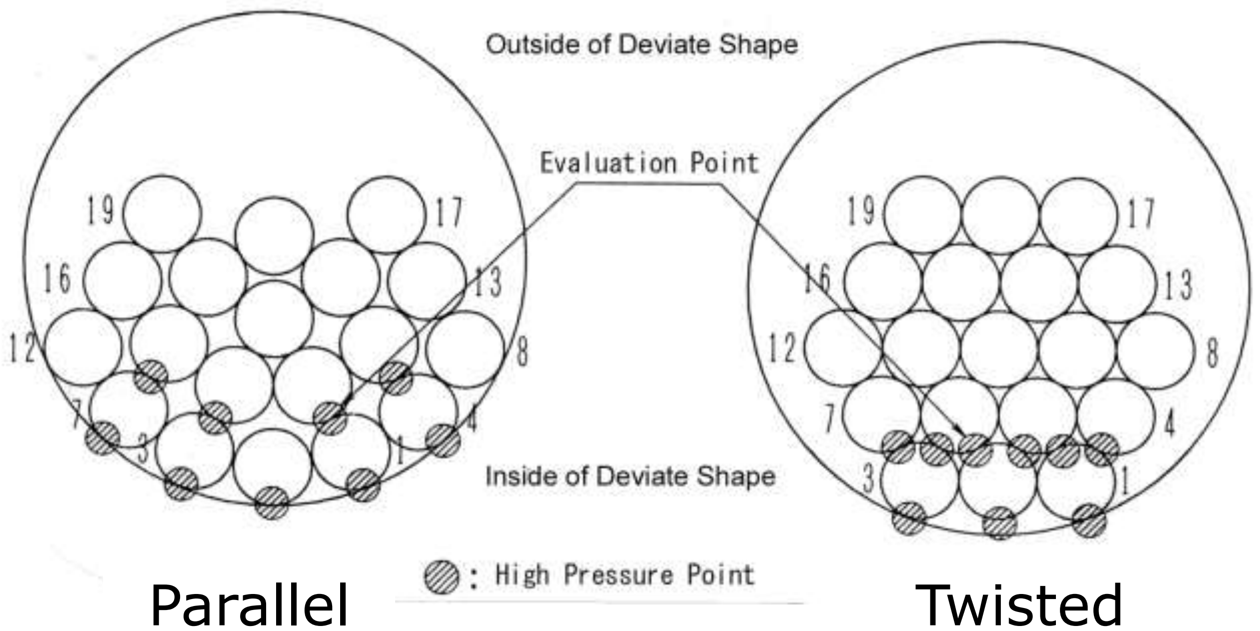
Test Set-Up



Testing Conditions	
Deviator Radius	r = 3,000 mm (118 in or 9.8 ft)
Stressing Load	3,789.9 kN* (852 kip)
Tendon Movement	200 mm (7.9 in)
Tendon Types	19 x 0.6" Strand Tendons Parallel Strands and Twisted Strands

*90% of nominal yield point

Results



Parallel Strands

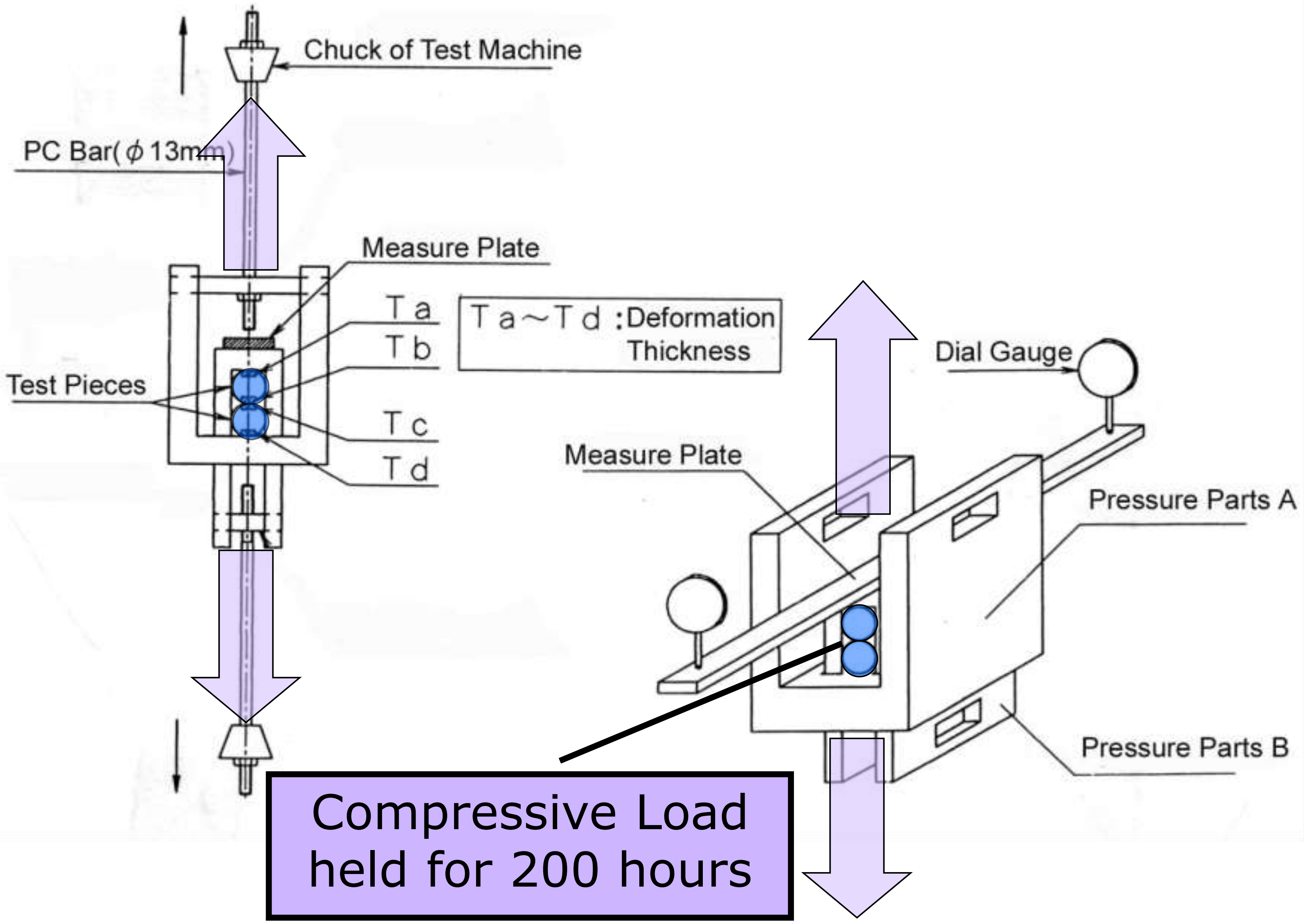
Twisted Strands

Epoxy Creep Test Under Compressive Load

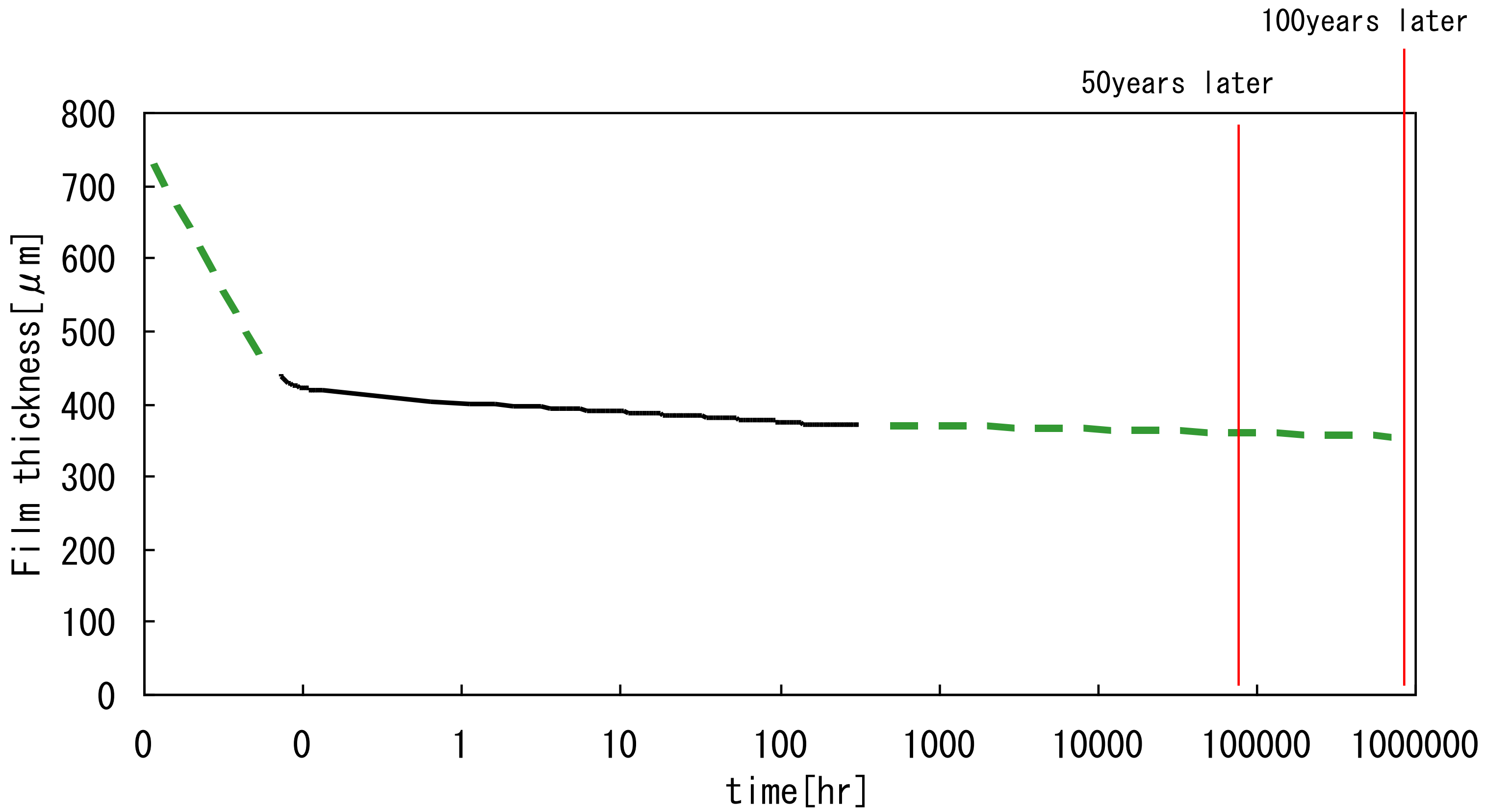
Epoxy Creep Test Under Compressive Load

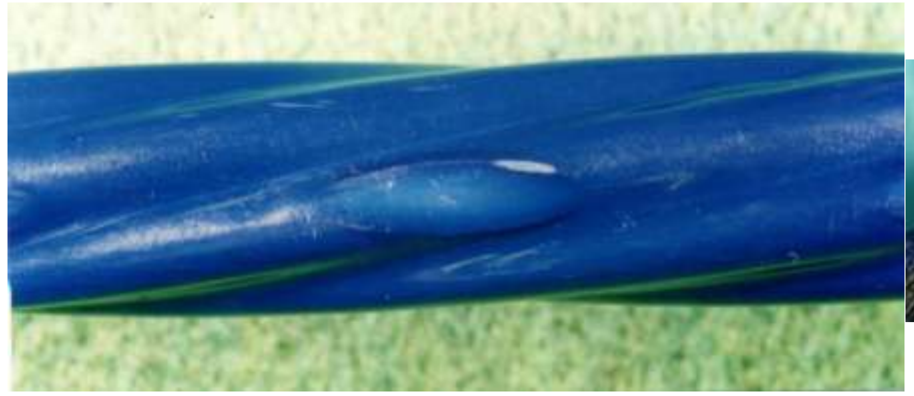
Test Set-Up

Test conditions to simulate max compressive load on 15.2 mm (0.6”) strand in a 19 strand tendon	
Initial load	3.4 tf/100 mm (7.5 kip-force/3.9 inch)



Results

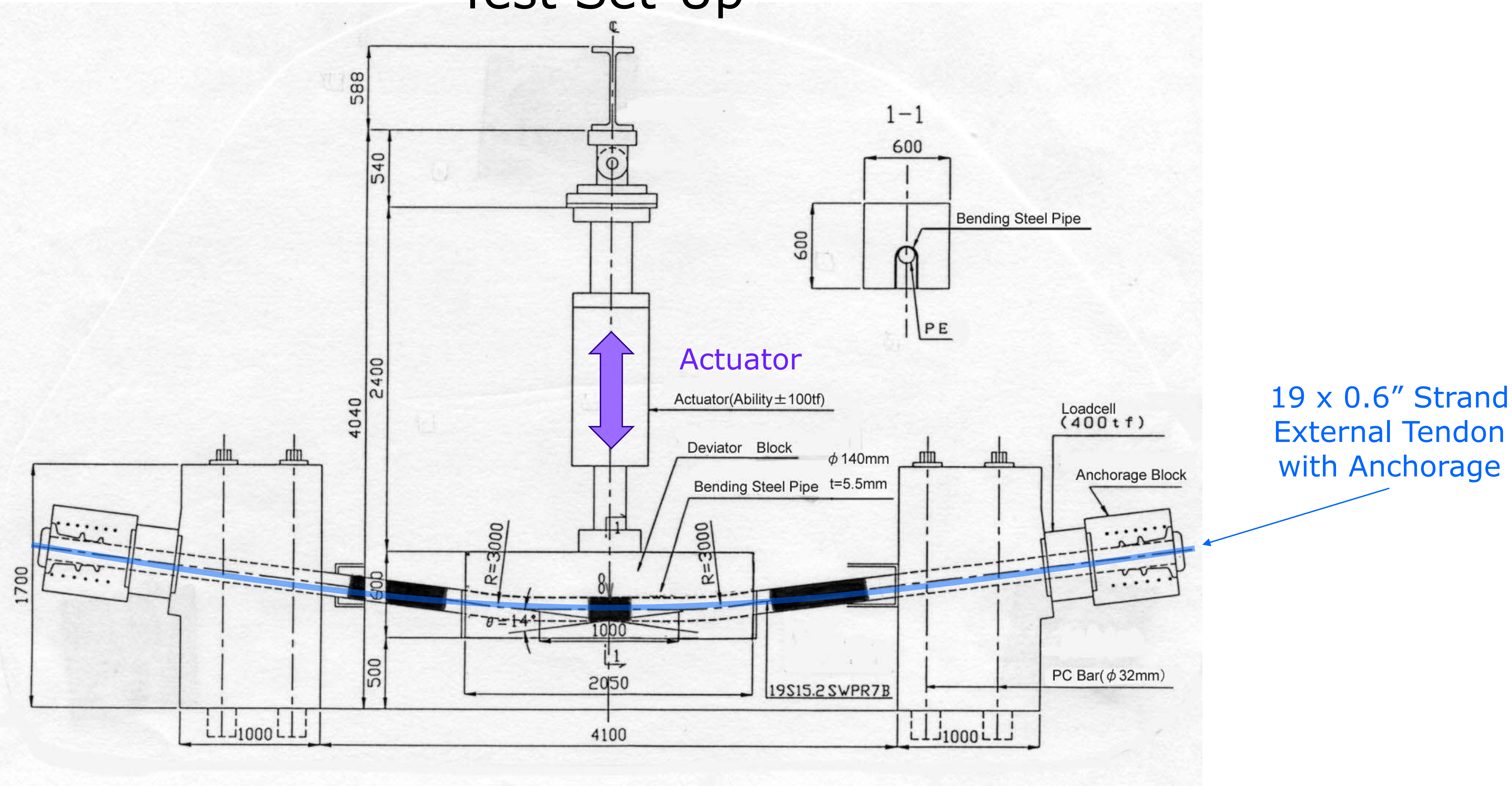




Full-scale Fretting Fatigue Test at Deviator Zone

Full-scale Fretting Fatigue Test at Deviator Zone

Test Set-Up



Full-scale test detailed diagram

Full-scale Fretting Fatigue Test at Deviator Zone

Item	Condition
Cable spec.	19S15.2 (19 x 0.6" strand)
Lower stress	$0.6P_u$: 2975.4 kN (669 kips)
Stress range	49 MPa (7 ksi)
Deviator	Radius 3,000 mm (118 in or 9.8 ft)
Cycles	**3 Million (3×10^6)**

3 Million Cycle Fatigue Test @ Deviator

Tested 3 Strand Types: *Bare strand, HDPE-coated strand, Epoxy-coated strand*

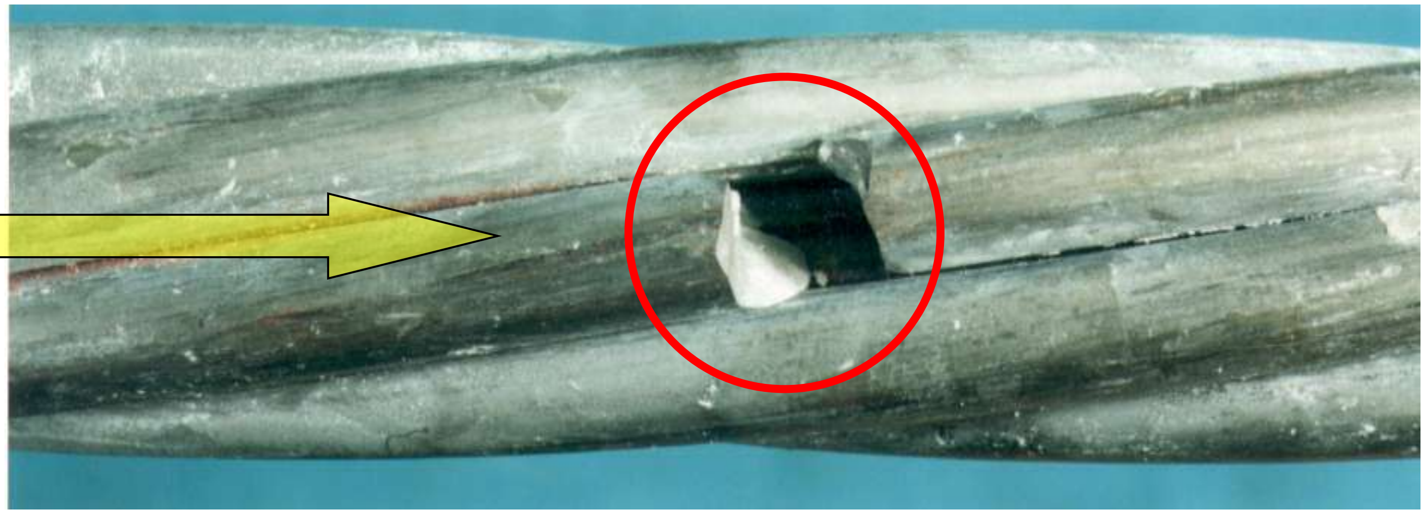
Results of Full-scale Fretting Fatigue Test at Deviator Zone

Results after 3 million cycles

Bare strand

- **13 wire breaks**

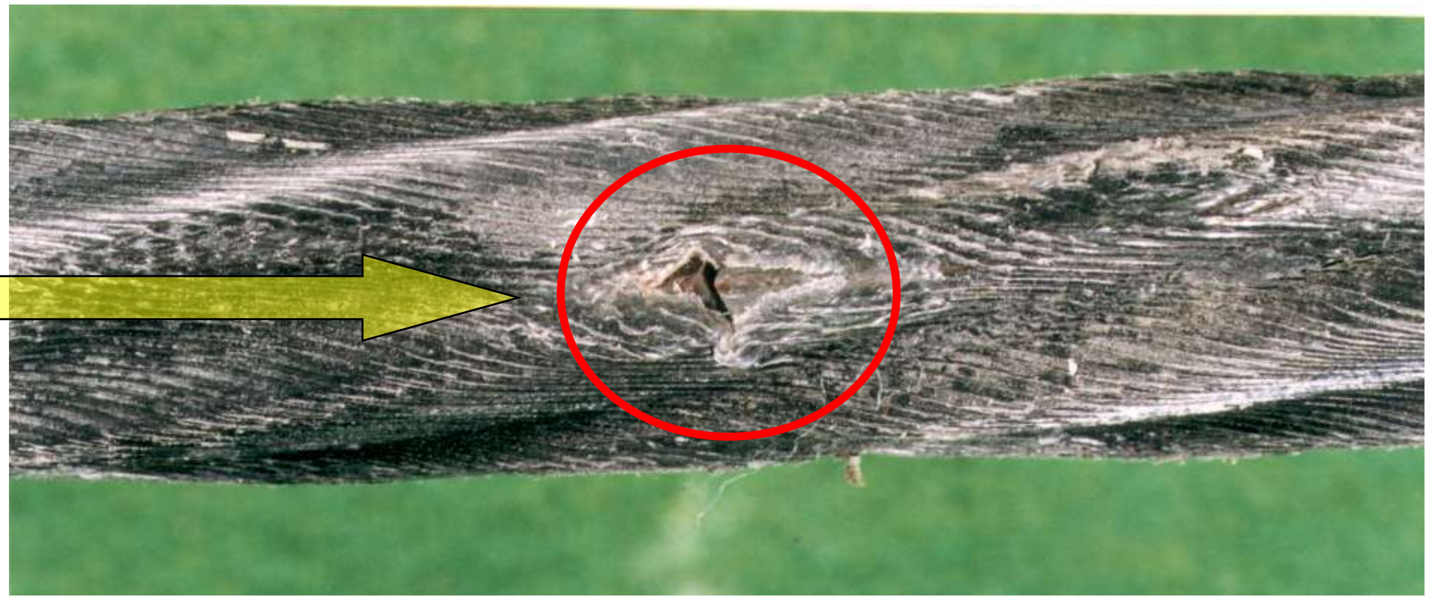
  at the contact point of each strands



HDPE-coated strand

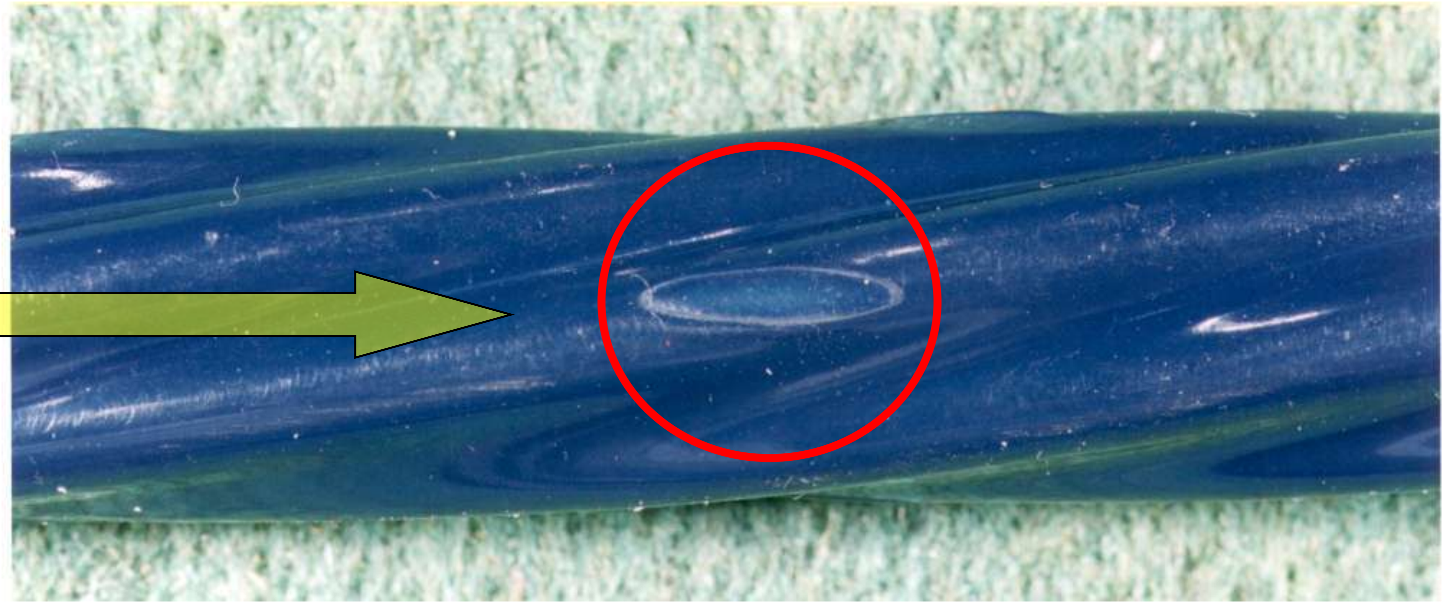
- **4 wire breaks**

  at the contact point of each strands
- **Steel surface exposed**



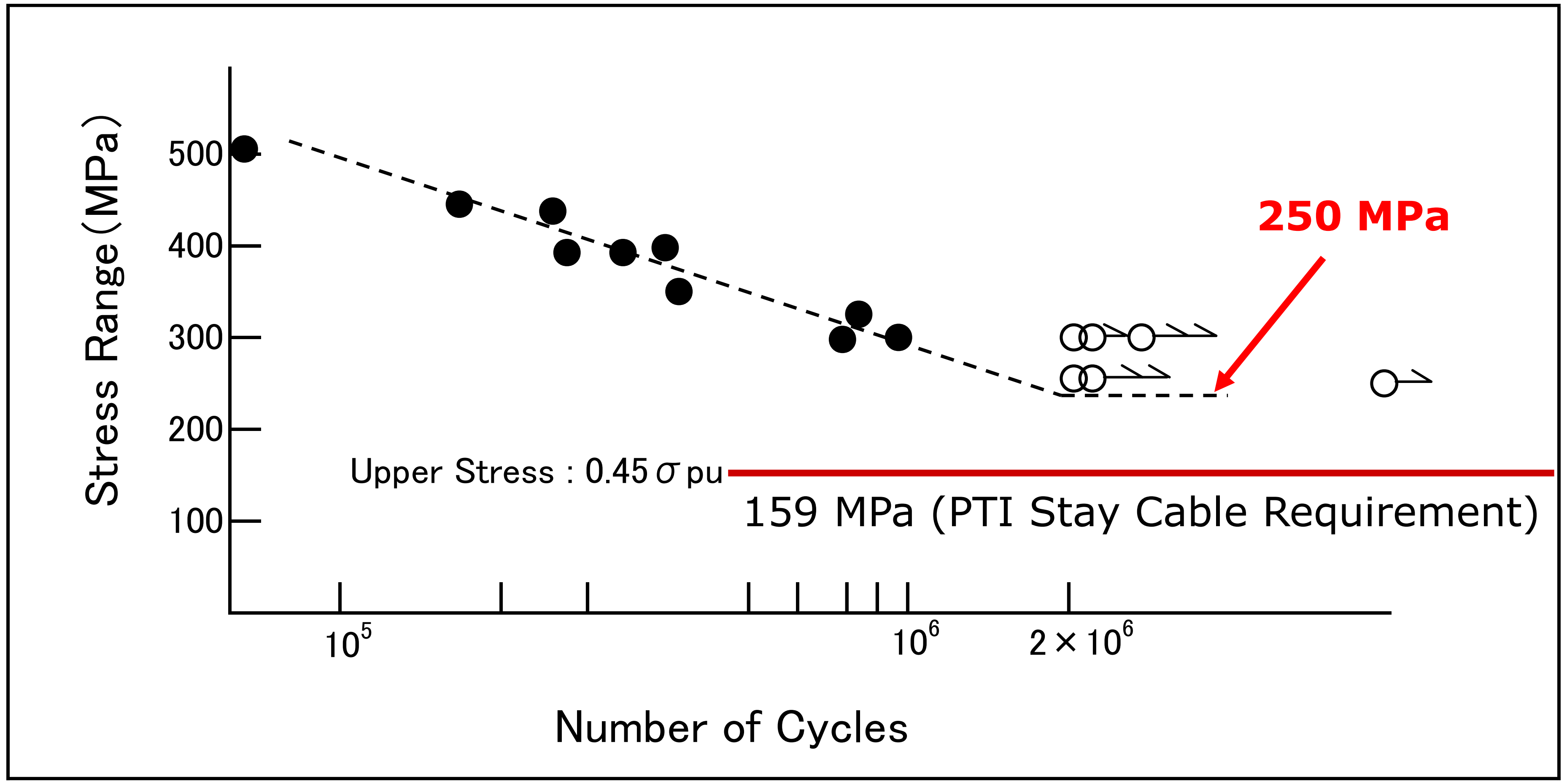
Epoxy-coated strand

- **No wire breaks**
- **Steel surface not exposed**



Anti-Fatigue Performance at Anchorage

Bite-through Wedge Anchored **Single** ECS Tendon



Bite-through Wedge Anchored **Multiple** ECS Tendon

Test	Number of ECS Cable	Grouting	Stress Range	Max Deviation Angle	Test Results
1	4 Cables	None	100 MPa	7.65″	No wire failure after 2 million cycles
2	2 Cables	None	50 MPa	2.5″	
3	9 Cables	None	160 MPa	3.8″	
4	9 Cables	Done	160 MPa	3.8″	
5	9 Cables	Done	200 MPa	3.8″	
6	12 Cables	Done	100 MPa	3.6″	
7	19 Cables	Done	67 MPa	3.0″	
8-1	19 Cables	None	50 MPa	14.0″	
8-2	19 Cables	None	50 MPa	14.0″	
9	48 Cables	None	80 MPa	2.5″	

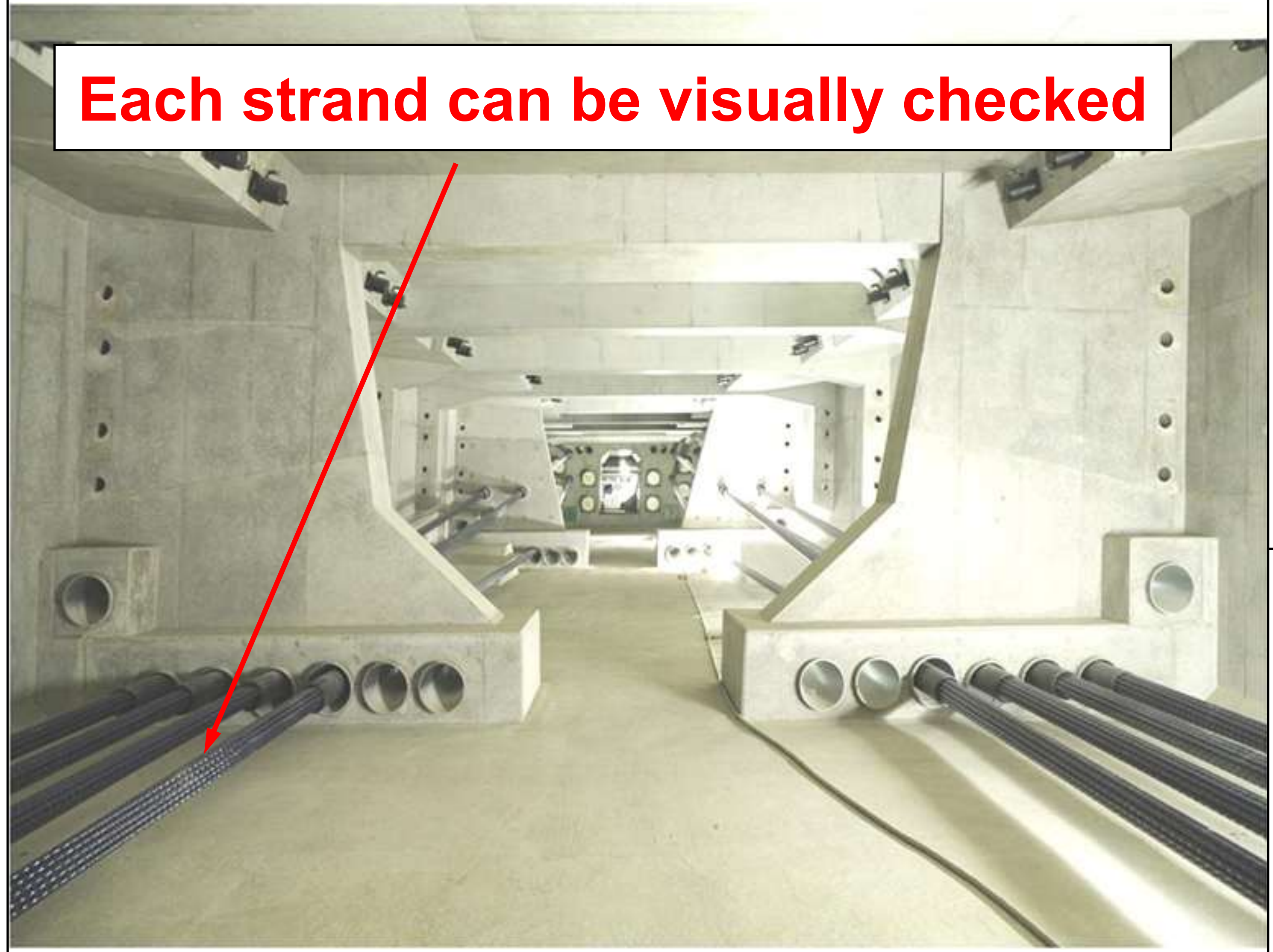
Epoxy-Coated PC Strand with Bite-Through Wedges Meets or Exceeds All Fatigue Requirements!

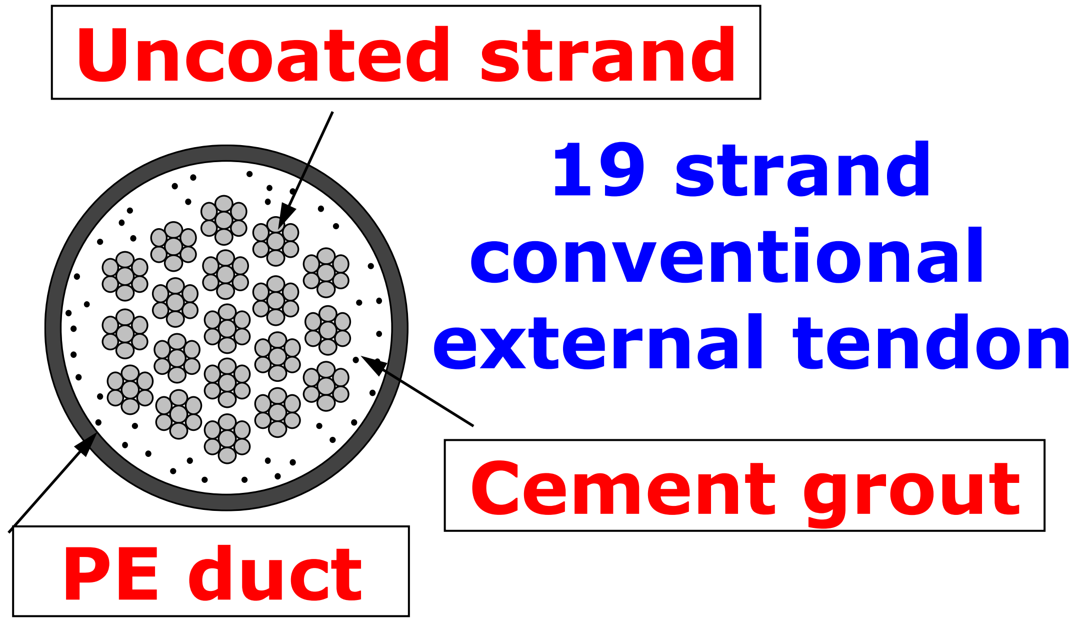
Advantages of Epoxy-Coated PC Strands for External Tendons

Epoxy-Coated Strand External Tendons with <u>No Grout and No Duct</u>

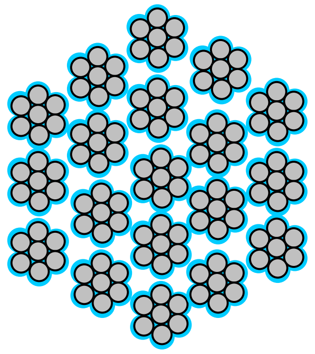
Advantages of No Grout & No PE Duct

1. **High durability** (Corrosion & fatigue resistance)
2. **Easy inspection and maintenance**
3. **Reduction of Installation time and Cost** (No welding PE duct, No grouting)
4. **Replaceable**





19 strand conventional external tendon



19 strand epoxy-coated external tendon (No grout at free length)

Blue Ridge Parkway – Laurel Fork Bridge

Presented by Jerry Pfuntner

COWI

Blue Ridge Parkway – Laurel Fork Bridge

FHWA Demonstration Project for ECS continuity tendons

- Owner: National Park Service
- Prime Engineer: EFLHD
- Segmental Bridge Engineer: COWI
- Contractor: Structural Technologies/Vannoy JV
- ECS Supplier: Sumiden Wire Products

Epoxy Coated Strand(ECS)

- ASTM A416 0.6” dia. post-tensioning strand
- ASTM A882 Strand coating specification has a minimum epoxy thickness at the crown of 0.38mm

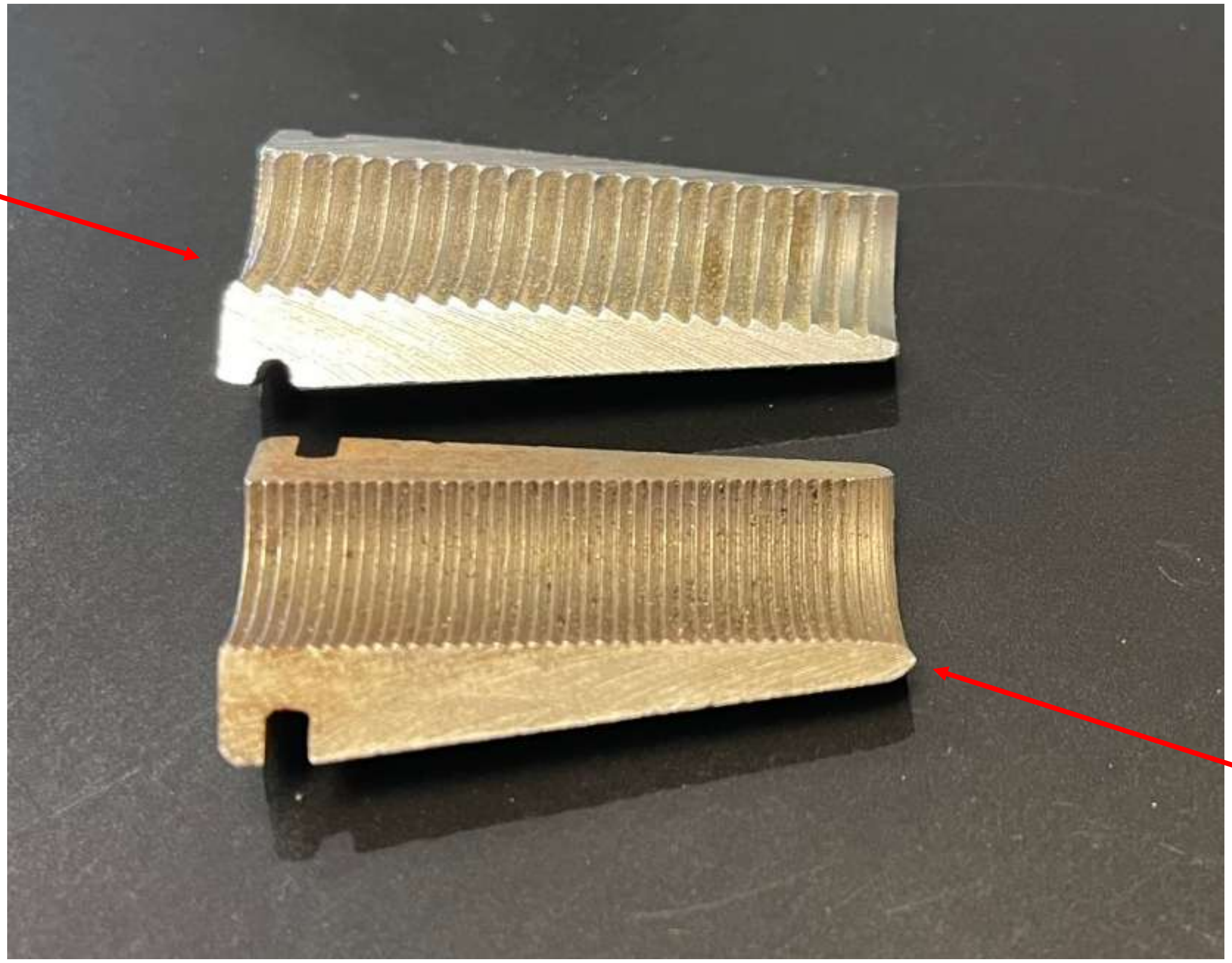
Per Sumiden:

- Epoxy coating can be manufactured from 0.45 – 1.1mm thickness
- They selected wire with a 0.6-0.8mm epoxy thickness was selected for this project referenced that they knew it was going to be pushed.
- Following strand installation, field measurements showed epoxy coating residual thickness >0.45mm

Tendon Stressing

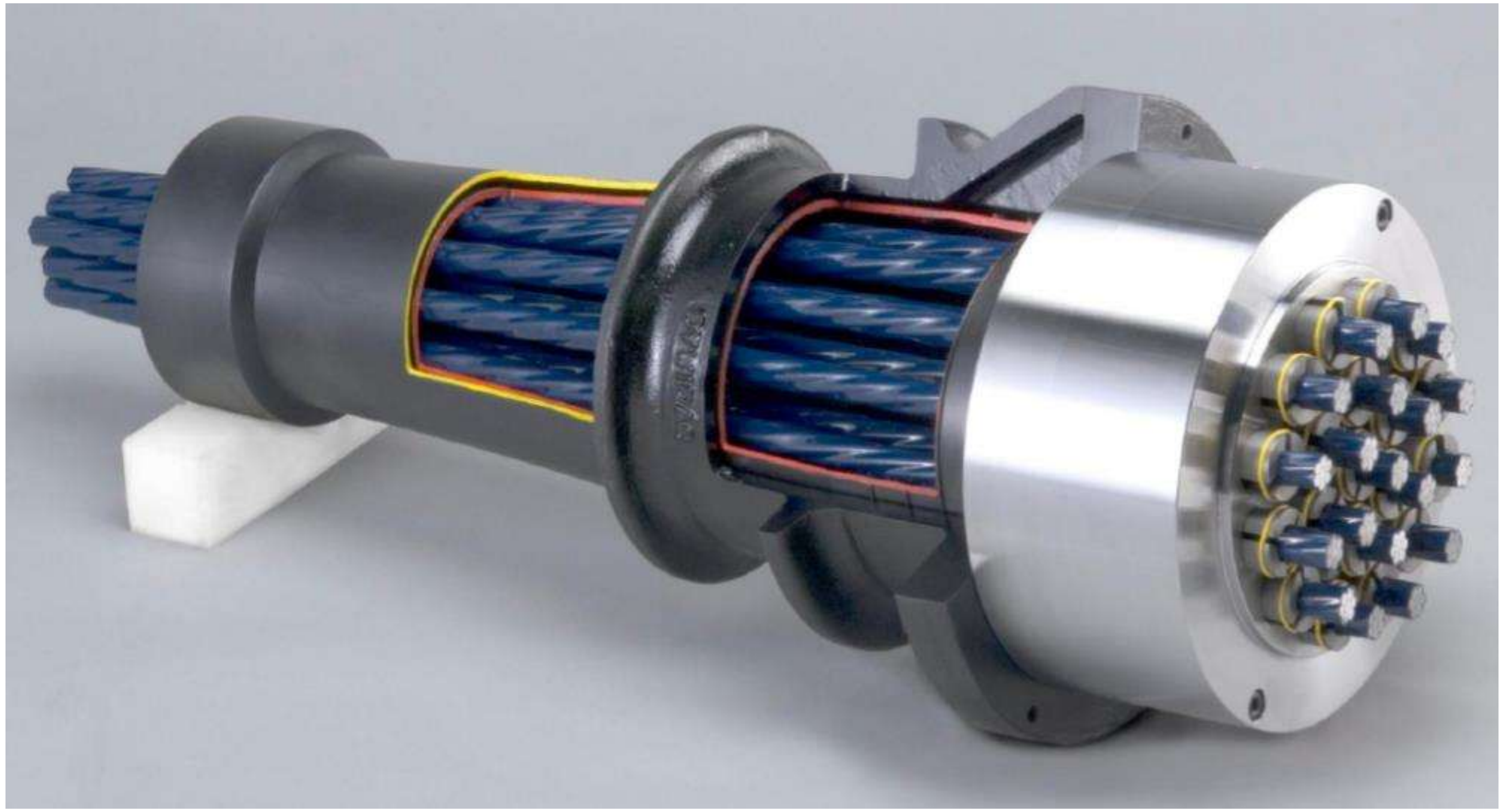
Epoxy Coated Strand
'Bite Thru' Wedges

- Deeper Teeth
- Approx. ¼" longer

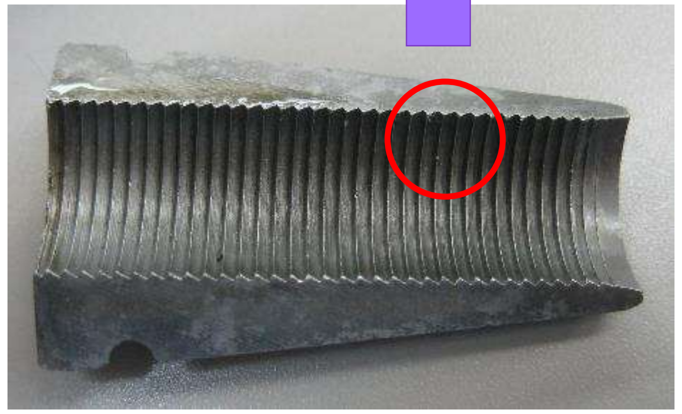


Bare Strand Wedge

Typical External Tendon Anchorage System



<u>Bite into steel through epoxy coating without stripping</u>



Standard wedge for bare strand

Inspection after removing epoxy coating

Tendon Stressing

Anchor Wedge marks

Tendon Stressing

Pulling Head Wedge marks

Tendon Stressing

- After stressing, the epoxy from one strand tail was removed to examine the effectiveness of the wedge grip

Pulling Head Wedge marks fully engaged strand steel
<u>Note:</u> Pulling head wedges are longer than anchor wedges

Anchor Head Wedge marks also fully engaged strand steel

Tendon Stressing

Fully stressed tendon with parallel strands.

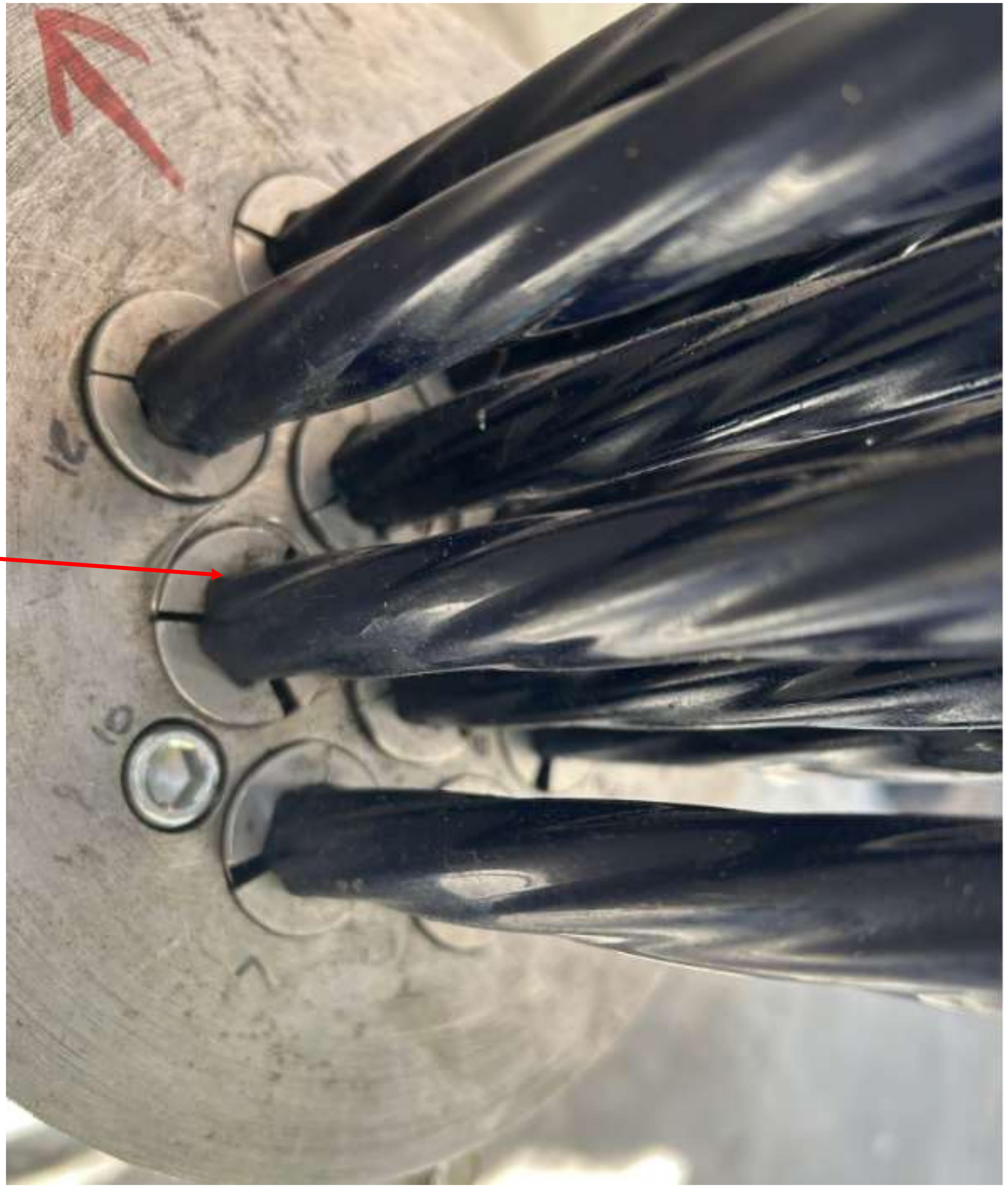
- Left tendon shown had approx. ¼ turn along its length, stressing not affected, no apparent impacts to the epoxy coating observed

Tendon Stressing

Live end wedges fully seated
with 16mm nose plate recess

Tendon Stressing

Dead end wedges fully seated.



Tendon Stressing Results:

Tendon	Elongation %	LE AS	DE AS
1L	102.3	¾”	3/16”
1R	99.2	¾”	¼”
2L	104.2	5/8”	3/16”
2R	102.3	5/8”	¼”
3L	104.8	7/8”	¼”
3R	104.6	¾”	3/16”

- Design stressing values for friction were 0.17
- DE wedges were pre-seated using a pipe sleeve on each wedge

Strand Installation

Contractor utilized a series of supports along the length of the tendon to minimize the sag between supports. This is necessary to minimize the relative difference in strand position relative to each to maintain equal elongation/force in all strands.

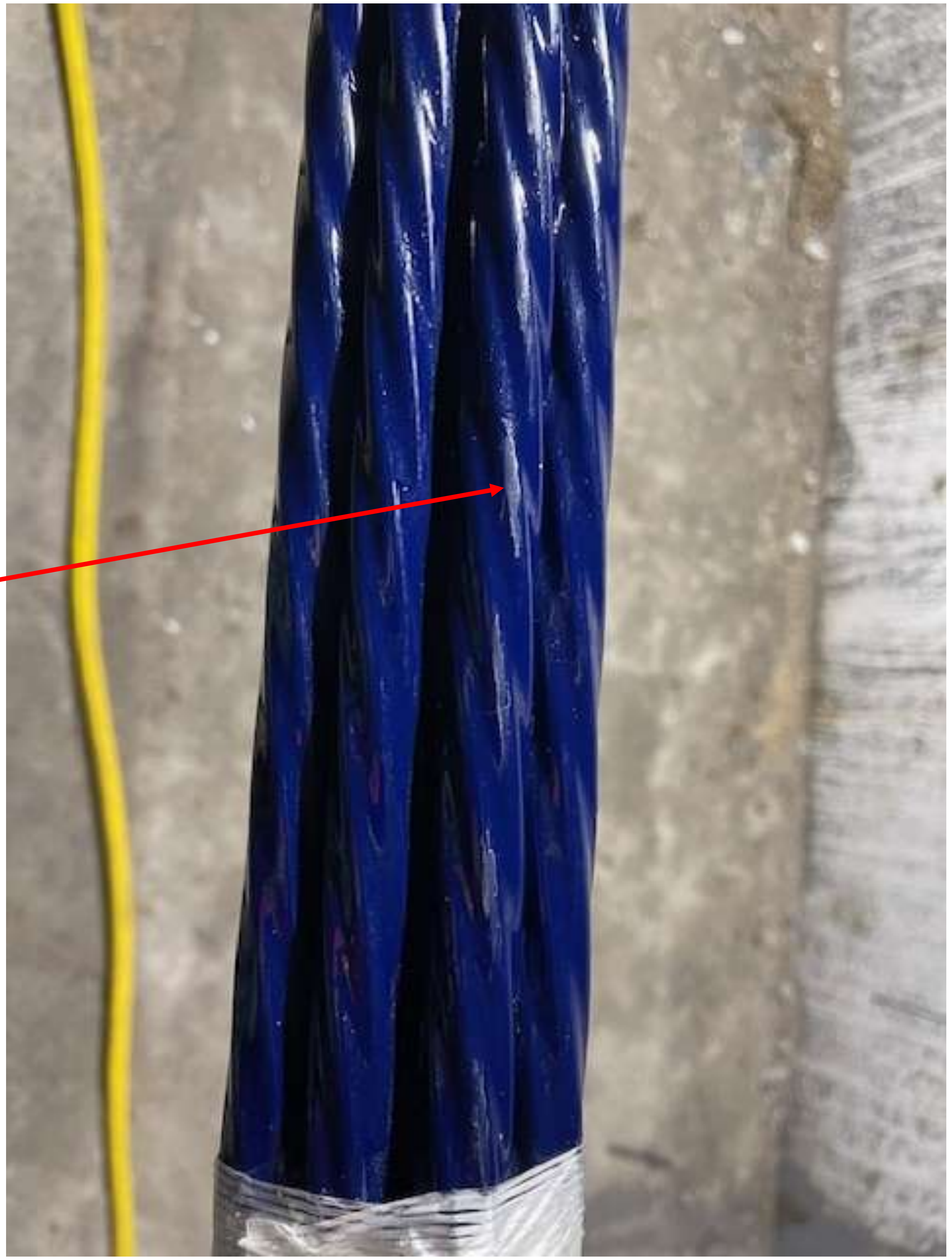
Note: PVC sleeves were used to minimize abrasion of the strand epoxy.

Strand Installation

Strand compactors were utilized during strand installation to help maintain the strands parallel.

Strand Installation

Contractor chose to ‘push’ the strand as the installation method. Some abrasion of the strand did occur while installing the strand through a multitude of temporary supports



Strand Installation

Contractor developed an elongated anchor head that allows use of standard bare strand anchor bearing plates

Strand Installation

Interior of the anchor head contains a rubber diaphragm and plate that allows the three bolts to be tightened to compress the rubber diaphragm and seal the strands for grouting.

Strand Installation

Note: Segments were detailed and precast for external post-tensioning ducts.

The PE duct served as a plastic sleeve for the epoxy coated strand and the diabolos accommodated the angle break and allowed the strand to bear 6+” to the interior of the diaphragm as intended

Epoxy Coating Repair

During strand installation, some abrasion was deep enough to require repair of the epoxy strand coating

Epoxy Coating Repair

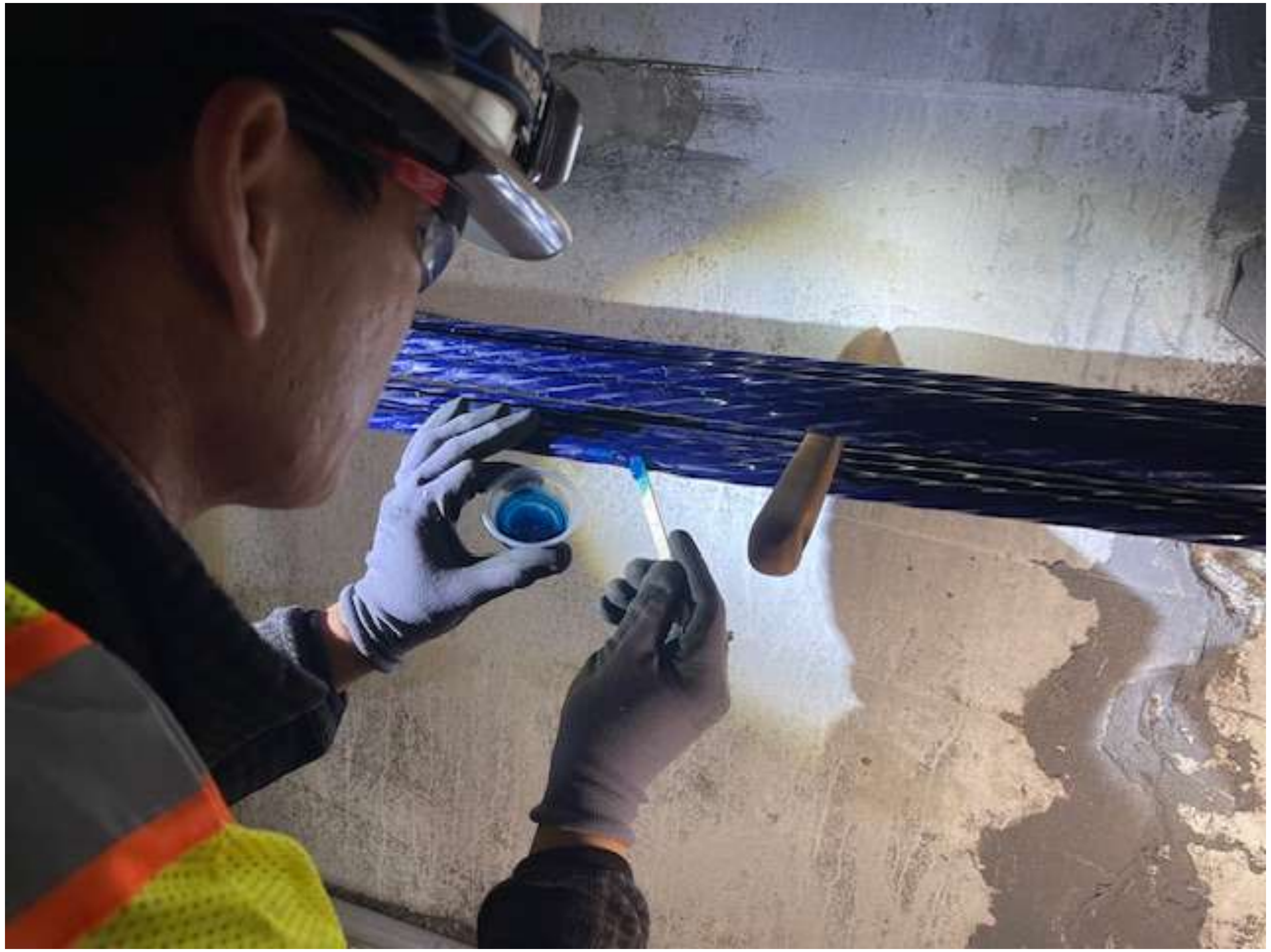
Epoxy coating repair materials are a two-part epoxy system that can easily be mixed on-site

Epoxy Coating Repair

During cold weather, the portable handheld heater was used to assist with getting the epoxy reaction started

Epoxy Coating Repair

Epoxy repair coating was easily applied to the strand to be visibly thicker than the surrounding epoxy



Epoxy Coating Repair

Epoxy Coating Repair

The portable handheld heater was again used to cure the epoxy.

The total time for this observed repair was less than one hour and stressing was able to be performed upon completion.

Tendon Vibration

Following stressing, it was immediately noticeable that the ECS tendons would vibrate even by striking with your fist.

From a dynamic analysis of the completed structure, the following frequencies for each span were determined for the first vertical mode of vibration:

$$f = 3.286 \text{ Hz}$$

Tendon Vibration

Based on the closest tendon segment frequency and the span vertical frequency the following ratios were determined for each span:

52ft	86ft	56ft
12.36Hz	7.47Hz	11.48Hz

Tendon Vibration

Ratio of Strand vs. Superstructure frequencies:

52ft	86ft	56ft
3.76	2.27	3.49

Tendon Free Length required to have FS = 1.5

130 ft → **well outside of typical segmental external tendon layouts**

Conclusions - Design:

- ECS is a viable alternate for external continuity tendons in segmental bridges (and other bridges types as well)
- Benefits:
  - Visible Inspection of strand epoxy coating
  - Replaceability of tendons
  - Elimination of grouting external tendons

- Design:
  - Oversize details(ducts, diabolos, etc.) are necessary
  - Slightly longer anchor set
  - ECS tendons only have two levels of protection(may not meet current PT specs)

Questions
Key Takeaways

Thank you!

Please sign up for future NCBC webinars

www.nationalconcretebridge.org

Photo: HNTB, © Core-Visual as seen in *ASPIRE* Summer 2023.