Mockup Injections of Alternative Flexible Fillers for Multistrand PT Bridge Tendons

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Outline

- Objective
- Small scale component tests
- Full scale mock up construction
- Injection process and results
- Comments and Observations
- Future research



Research Project



- Research Project: Replaceable Unbonded Tendons for Post-Tensioned Bridges (FDOT Contract No. BDV31-977-15)
- Project Mangers: Will Potter and Rick Vallier
- <u>Staff of Marcus H. Ansley Structures Research Center</u>
- Co-PI Dr. Jennifer Rice
- Graduate Students: <u>Rahul Bhatia</u>, <u>Natassia Brenkus</u>, A. Abdullah



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- Freyssinet, Inc. USA
- Schwager Davis, Inc.
- VSL











 To assess the implications of using unbonded tendons with pliable filler with respect to constructability of the tendon.



FDOT Design Bulletin

Issued April 30, 2014:

"The Florida Department of Transportation will be **implementing the use of wax filler material in lieu of grout** for corrosion protection on **certain** post-tensioning tendons in the near future."

"All tendons with wax filler material will be assumed to be unbonded and must be designed and detailed to be **fully replaceable**."

	FDOT
RICK SCOTT GOVERNOR	Florida Department of Transportation 605 Suwannee Street Tallahassee, FL 32399-0450
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DATE: TO:	April 30, 2014 District Directors of Transportation Operations, District Directors of Transportation Development, District Design Engineers, District Construction Engineers, District Structures Design Engineers, District Maintenance Engineers
DATE: TO: FROM:	April 30, 2014 District Directors of Transportation Operations, District Directors of Transportation Development, District Design Engineers, District Construction Engineers, District Structures Design Engineers, District Maintenance Engineers Robert V. Robertson, P. E., State Structures Design Engineer
DATE: TO: FROM: COPIES:	April 30, 2014 District Directors of Transportation Operations, District Directors of Transportation Development, District Design Engineers, District Construction Engineers, District Structures Design Engineers, District Maintenance Engineers Robert V. Robertson, P. E., State Structures Design Engineer Brian Blanchard, Tom Byron, Duane Brautigam, David Sadler, Tim Lattner, Jeffrey Ger (FHWA)

REQUIREMENTS

The Florida Department of Transportation (FDOT) will be implementing the use of wax filler material in lieu of grout for corrosion protection on certain post-tensioning tendons in the near future.

The tendons for which was filler material will be used include external tendons and the following internal tendons:

- Tendons with vertical deviation greater than 20" as currently defined by Instructions for Design Standards 21800
- · Continuity tendons in segmental box girders
- · Tendons in I-beams and U-Girders
- · Strand tendons with vertical or predominantly vertical geometry
- · Horizontal strand tendons in hammerhead, straddle and C-piers

All tendons with wax filler material will be assumed to be unbonded and must be designed and detailed to be fully replaceable. The wax filler material that will be used will be the same as, or very similar to, that which is already being used in Europe and elsewhere for the same purpose. Smooth wall polyethethylene (PE) duct will continue to be used for external tendons and will also be used for internal tendons with wax filler material.

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Pros

- Material is formulated in plant, not on site
- Does not use water
- Corrosion prevention
- Easier to repair than grout
- Unbonded

Cons

- 105°C material
- Duct blockage or bursting
- Grease: oil separation
- Effect of voids unknown
- Material issues unknown
- Unbonded





Internal and external tendons



Internal Cantilever tendons



External tendon-Segmental box girder



Internal-Drop-In girders

Alternative Filler Materials

- Grease: semisolid lubricant that composed of liquid base oil, solid thickener, and additives. The liquid base oil is a long hydrocarbon chain or cyclic aliphatic compounds that are usually produced from refining of crude petroleum oil.
- Microstructural Wax: petroleum waxes are produced by de-oiling of petrolatum (petroleum jelly). Petroleum waxes are mostly branched isoparaffinic or naphthenic hydrocarbons and differ from paraffin waxes, which have unbranched straight hydrocarbon chains. Due to their small and thin crystal structure, petroleum waxes are more flexible than the paraffin waxes.



Filler Materials









UF

















Rheology





Filler preparation



Transfer of filler

FLORIDA



Barrel heaters



Insulation blanket



Stirring



Measurement

Small Scale Injection



Small Scale Specimens



HDPE only



HDPE with saddles





HDPE with polycarbonate tube



HDPE with PVC (Shrink wrap)





HDPE with thermocouple

HDPE with polycarbonate tube (vent)

Findings-Prolonged Injection Sag in the HDPE duct



Pressure >100 psi Duration > 8 minutes







Findings-Voids







Duct Installation





Anchorage and couplers



Welded Joints







Tendon installation





Strands tensioned with monostrand jack



Gravity deviators





West

A F



Instrumentation

PT



G.L.

East

<u>1</u>...]



Injection





Visconorust-Results





VZ inject Rate: ~75 fpm (50 gpm) Burp: yes (too fast)



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VZ inject-Results







Rate: ~60 fpm (40 gpm) Burp: yes

Valve A, B, C & D - 2"

Valve E, F & G - 1 ½ " 1" return line Barre C Barrel-A Barrel-B 1" valve —C 2" Tee 2" dlscharge Valve injection V anna Suction-Vent 3 Vent Len, jection 26 of 35 FLORIDA





Trenton 1-vacuum

Rate: ~100 fpm (65 gpm) Burp: no

FLORIDA



Vacuum

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Trenton 1-Results





Trenton 2 - Slow

Rate: ~20 fpm (13 gpm) Burp: yes



Trenton 2-Results









Findings

- Follow good grouting practice
- Preheat equipment (hoses)
- Feed wax to avoid splash (and foam) in open hopper pump
- good results using target injection speed between 50 to 80 ft/min
- No serious issues discovered with PT Anchorages or duct
- Vacuum assist greatly simplified injection
- Reversible variable speed pump allows better control of injection



Future work

- Heat transfer behavior of the injection in the tendon and compare the results with the closed form solution
- Structural implication of unbonded tendon over the bonded tendon.
- Fatigue behavior on full scale beam
- Replaceability of unbonded tendons in full scale beam
- Effect of moisture in duct prior to injection





http://www.dot.state.fl.us/structures/StructuresResearchCenter/ Progress%20Reports/BDV-31-977-15-task1.pdf



