Call out for bridges worth investigating as part of a pilot project.

Crosby Road Bridge  Just north of Wilsonville Built in 1973
ADT of 8,079
Length of 350 ft. Crosses I-5

Glenn Jackson Bridge
Border Bridge between Washington and Oregon
Built in 1982
ADT of 138,100
Length of 7,434 ft.
Carries I-205
Time for some destructive testing

Step 1 GPR the area where the ducts are and chalk up anything that may be in the way
Time to open the area up

WJE/VSL used a 10-15 lbf jackhammer to remove the concrete surrounding the ducts.
Then a cutting disk was used to open up the actual duct
Next, take some grout samples for testing back in the lab.

Through the use of a flat head screwdriver, the grout is chipped away to reveal the strands to check for corrosion.
Time to patch it up and move on to the next location for some more testing
Many times when grout samples were not needed, and to get a larger sample size, a small hole was made instead. Then it was borescoped to see if any voids and/or corrosion was present.
Findings
Crosby cracks follow the PT duct line
Crosby Road
Glenn Jackson is a much bigger bridge

Only a small % of ducts could be looked at

The findings were more interesting
Glenn Jackson had reported issues with strands and voids during construction.
Glenn Jackson
Void in Duct with Rusty Tendon
Conclusions

Visual Inspections are misleading

Crosby Road looks bad from the outside, ducts are in relative good shape

Glenn Jackson looks ok from the outside, but had many voids, soft (wet) grout, and some corrosion on the inside

Voids are a sign there is most likely some corrosion
Caltrans Grout Findings, Recommendations, & Next Steps
Findings

• No evidence in the existing bridge inventory that can be directly attributed to a poor grouting operation.
• Bridge demolitions following post-earthquake repair have revealed good solid grout completely filling the inside of the duct.
• There has not been a specific investigation to identify corrosion of PT strand or voids in or near the high points of PT tendons.
• The only bridge that the Marion, Ohio Sika plant pre-packaged grout was used was the Route 405/55 project in Orange County.
• Instances of grout cross-over have occurred where, while grouting one duct, grout enters an adjacent duct which indicates a non-mortar tight duct system (addressed during construction).
• Even with the above information
  Our current design guidance and construction specifications have not kept up with the state of the art of post-tensioned structures’ materials, testing, and procedures available today.
Recommendations

• Revise specifications related to pre-stressing concrete grout to a performance specification consistent with the requirements in PTI.
• Allow the use of Class C prepackaged thixotropic grout on a case by case basis with the following conditions:
  • Prepackaged grout must be on the Caltrans’ Authorized Material List (AML).
  • The Contractor must have an approved grouting plan.
  • The Contractor must have PTI and ASBI certification.
  • The Post-tensioned Concrete Committee chair must concur with the use of prepackaged thixotropic grout for the proposed contract.
• Class C prepackaged thixotropic grout may be required for bridges in Environmental Area 3.
Recommendations

• Require pressure testing of ducts to ensure adequacy of the mortar tight connections following deck placement.
• Revised specifications to address the placement of vents in the ducts near all high points as recommended by the Post-tensioned Concrete Committee.
• Post-tensioned Concrete Committee should prepare interim guidance outlining conditions for specifying prepackaged thixotropic grout (i.e. environment conditions, unique duct placement (vertical grouting), or long frames).
Next Steps

Where might we go from here?
• Initiate an investigation into the performance and material characteristics of grout in existing post-tensioned structures.
• Physical testing on existing bridges to look for corrosion and voids
• Examine PT bridge tendons which are scheduled to be demolished
• Create an AML to begin allowing prepackaged grouts with performance criteria
• Identify some pilot bridges currently in design for prepackaged grout use and create a feedback loop on cost and construction issues
• Investigate the need for vents at the low points and develop details, if necessary.
Florida DOT PT and Grout Investigation Findings
Current FDOT PT/Grout Investigation

• Current Investigation is primarily limited to post-tensioned bridges built since 2001, using thixotropic grout

• Prior to 2001 FDOT investigated previously constructed PT bridges built using neat grout, which result in:
  - 3 bridges requiring tendon replacements
  - Re-grouting many voided tendons
9 Segmental External Tendon Bridges

- 4 bridges investigated with no problems found
- 1 - 8 year old bridge: 17 tendons replaced, and over 500 voids re-grouted or repaired with epoxy
- 1 bridge: 6 of 32 tendons had soft grout
- 3 bridges owned by expressway authority: initial inspection completed
  - Sand in duct caused minor corrosion to strand
  - Referred to authority for further action
8 year old Segmental Bridge
Tendon requiring replacement
Expressway Authority Bridge - Corrosion at bottom of tendon due to sand left in duct
23 Segmental Internal Tendon Bridges

- 21 bridges investigated to date
- 1 bridge had small amount of soft grout in one trumpet (minor issue)
- 1 bridge with neat grout built 1999 was found to have a 3’+ void with tendon corrosion, where repair will be required
- 2 bridges are still to be investigated
Bridge with Neat Grout
Corroded Tendon on Neat Grout Bridge
12 Bridges with Continuity PT

- 1 bridge was investigated and found to have extensive soft grout, galvanized duct and PT corrosion in haunched area of sloped tendons
- 4 bridges investigated with only minor problems
- 7 bridges are still to be investigated
Multi span continuous girder Bridge with Internal Tendons
Corroded Tendon on Bridge with Continuity PT
4 Simple Span Bridges with PT

- All bridges investigated with no problems
19 Bridges with PT Substructures

- 3 bridges have PT below ground line and will not be investigated
- 10 bridges investigated with no problems found
- 1 bridge investigated with no problems found, except for high chloride content (Sika Grout from Marion Ohio plant, bridge has highest chloride content observed in current FDOT investigation)
- 5 bridges still to be investigated
4 Local Prestressed Slab Bridges

- Bridges are transversely Post Tensioned
- Constructed with Sika Grout from the Marion Ohio Plant
- Owners have been notified
- No FDOT action planned
Primary Factors that Resulted in PT Corrosion in FDOT’s Neat Grout Bridges

- Low pH
- High Chloride Content
- Water
- Oxygen
Additional Factors that Resulted in PT Corrosion in FDOT’s Thixotropic Grout Bridges

- Segregation of Grout
- High Sulfate Content
- Water
- Oxygen
Figure 12. Color and consistency differences between samples of hard grout (bottom sample in each photograph) and samples of putty like grout or soft cohesive grout (top two samples in the left photograph and top sample in the right photograph).
Sounding External Tendon with Hammer
Tendon exposed for Inspection
Measuring Electrochemical Corrosion Potential
Inspecting Trumpet with Boroscope
Costs to Maintenance

- Contract costs for investigations so far approximately $1,700,000
- Does not include costs of FDOT employees
- Does not include support from FDOT Materials Office
- Does not include repair costs
Maintenace Concerns

• Investigations are expensive

• Can only sample a few locations

• As yet no reliable, economical NDE technology
Specific Concerns moving Forward

• Changes to FDOT Grout Specification?
  - Reduce Grout Temperature Specification Limit
  - Revise maximum pumping pressure limit to reduce flow rate
  - Increase amount of grout discharged from outlet
  - Revise maximum pressure limit to be anywhere within system, not just at inlet

• Greased Tendons for external tendons and complex tendon profiles?
Questions

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