PT Grout with Elevated Chlorides

2014 TRB Annual Meeting

Long-Term Bridge Performance Program Workshop

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Reggie Holt, P.E.
Federal Highway Administration

Background

- PT grout with elevated chlorides was initially discovered in a PT straddle cap in TX (2010).
- PT grout used in TX bridge was a pre-bagged thixotropic product called SikaGrout 300PT.
- PT grout manufacturer, Sika, determined that its 300PT SikaGrout product from its Marion OH plant was sometimes produced with levels of chloride well above the specified limit. (0.08% by wt. of cement)
- The cement used in the 300PT product has been identified as the source of the chlorides.

Background

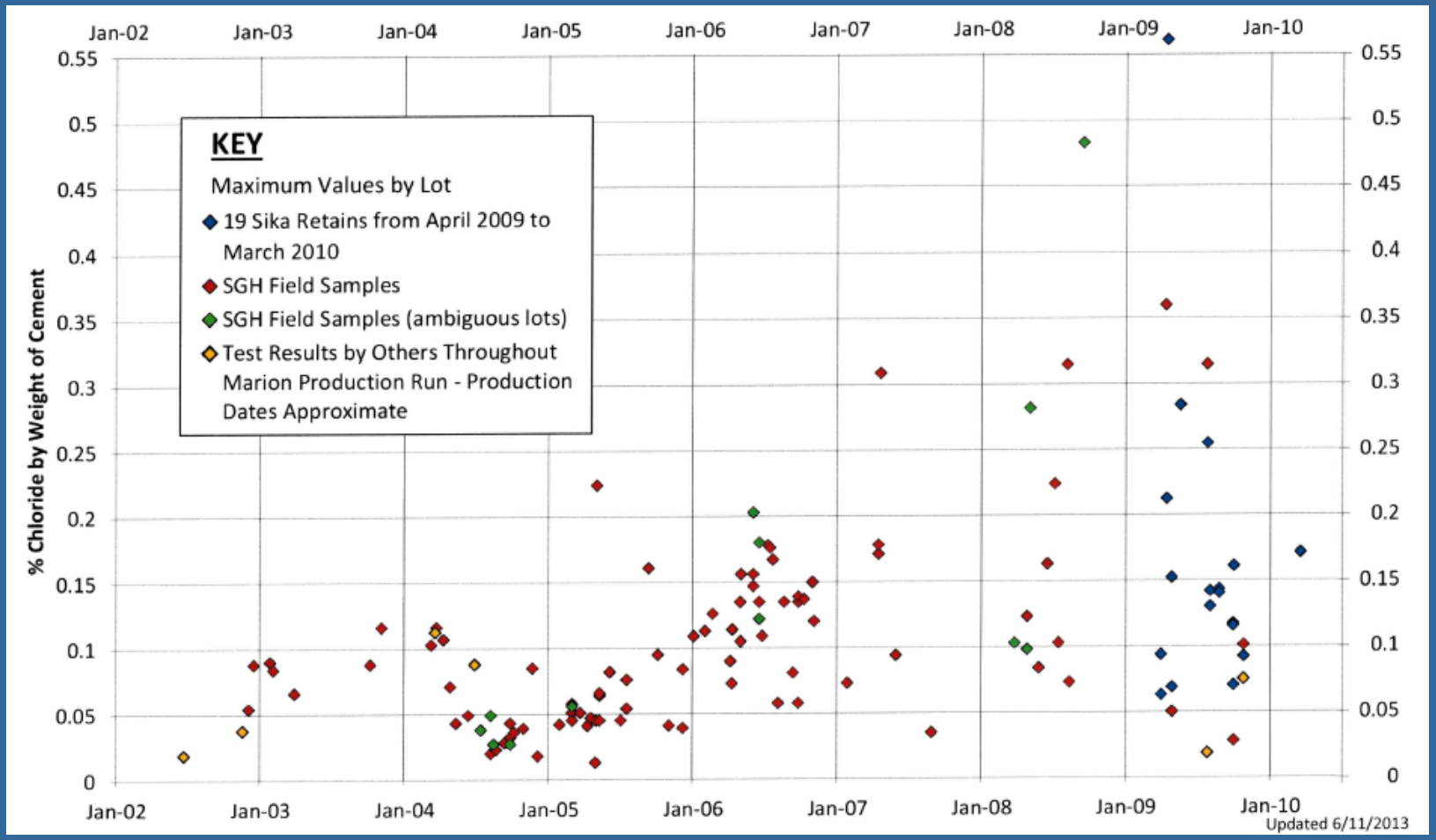
- SIkaGrout 300PT was produced at the Marion OH plant from 2001 to 2010.
- Production of 300PT was ceased at the Marion OH plant in April 2010.
- To date approximately 88% of the Marion OH produced 300PT grout has been located.
- Approximately 24M lbs. was produced with approx. 16M lbs. used in bridge applications (approx. 120 bridge projects).

Background

Production Year	Number of Samples Tested	Number of Lots Represented	Total Lots Produced by Sika	Acid Soluble %Cl^- by Weight of Cement Range	Average Acid Soluble %Cl^- by Weight of Cement	Weighted Average Acid Soluble %Cl^- by Weight of Cement
2001			5			
2002	9	2	20	0.038-0.088	0.063	0.054
2003	20	5	22	0.032-0.116	0.076	0.073
2004	49	19	37	0.011-0.116	0.053	0.043
2005	63	24	44	0.010-0.224	0.051	0.048
2006	116	26	52	0.024-0.203	0.106	0.105
2007	25	6	23	0.034-0.309	0.130	0.136
2008	28	14	24	0.073-0.483	0.201	0.158
2009	25	5	18	0.018-0.360**	0.130	0.127
2009	104*	18	18	0.002-0.564	0.150	0.138
2010	14*	1	1	0.088-0.171	0.107	0.107
Total	453	120	264	0.002-0.564	0.103	0.093

Chloride Testing Data

Background



Maximum Chloride Concentrations

FHWA Technical Advisory (TA)

U.S. DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

Technical Advisory

Subject

Recommendations for Assessing and Managing Long-Term Performance of Post-Tensioned Bridges having Tendons Installed with Grout Containing Elevated Levels of Chloride

Classification Code	Date	
T 5140.33	11/12/2013	HIBT-10

Par.

1. What is the purpose of this Technical Advisory?
2. Does this Technical Advisory supersede another Technical Advisory?
3. What is this background of this Technical Advisory?
4. What are the recommendations for assessing and managing the long-term performance of post-tensioned bridges having tendons installed with grout containing elevated levels of chloride?

1. **What is the purpose of this Technical Advisory?** The purpose of this Technical Advisory is to give guidance to bridge owners on assessing and managing the long-term performance of post-tensioned bridges having tendons installed with grout containing elevated levels of chloride.

2. **Does this Technical Advisory supersede another Technical Advisory?** No. This is a new Technical Advisory.

3. **What is this background of this Technical Advisory?**

   a. The discovery in 2010 of post-tensioning grout with elevated chloride levels in a post-tensioned (PT) concrete bridge in Texas triggered a follow-up investigation by the grout manufacturer that supplied the PT grout. The preliminary investigation determined that grout produced for this project had chloride levels exceeding the specified limit. FHWA learned from Sika Corporation (Sika) that its SikaGrout® 300 PT produced at its plant in Marion, Ohio, contained varying levels of chloride sometimes well above the AASHTO and PTI specification limit of 0.08% chloride by weight of cementitious material. Sika also identified that the major ingredient by weight of product, Portland cement produced by a third-party vendor, was the source of the elevated chloride in the grout. The potential time period for this issue was from 2001, when Sika introduced its original pre-bagged PT grout under the name Sika Cable Grout, to April 2010, when production of its second-

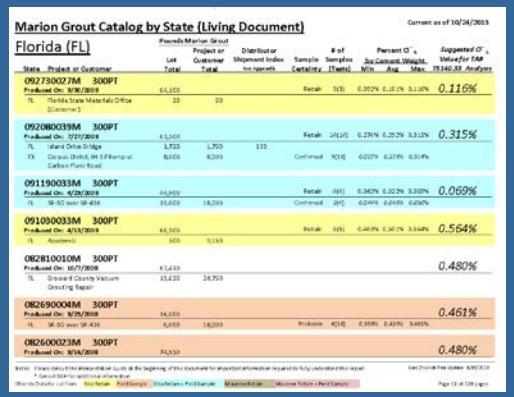
http://www.fhwa.dot.gov/bridge/t514033.pdf

FHWA Technical Advisory (TA)

- Guidance by FHWA to assess and manage long-term performance of PT bridges having tendons installed with grout containing elevated levels of chlorides.
- Steps used in TA for assessment:
  - Determine PT Grout Chloride Level
  - Determine PT System Robustness (protection level)
  - Determine Corrosion Risk Level
  - Assess Bridge System Redundancy & PT Element Ductility
  - Determine Management Follow-up Actions

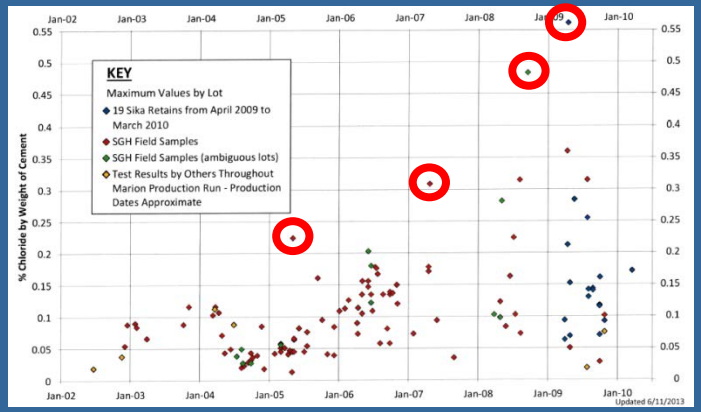
Step 1 - Determine PT Grout Chloride Level

- Check Grout Records (if available)
- Determine Chloride Level by:
  - Use Sika Production Catalog
  - Sample In-place Grout
  - Assume Highest Chloride Level for that Production Year


Marion Grout Catalog by State (Living Document)

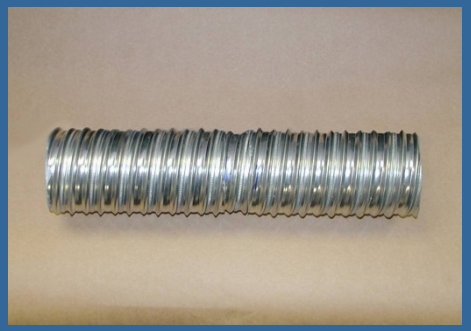
Florida (FL)

Project or Customer	Suggested Cl⁻ Value for TAR
092730027M 300PT	0.116%
092080039M 300PT	0.315%
091190033M 300PT	0.069%
091080033M 300PT	0.564%
082810010M 300PT	0.480%
082690004M 300PT	0.461%
082600023M 300PT	0.480%



Step 2 - Determine PT Tendon Robustness

- Review Bridge Drawings to Identify PT Details and Components
- Compare Details & Components to Protection Level Requirements in PTI / ASBI *Guide Specification for Grouted Post-Tensioning (June 2012)*
  - PL1A, PL1B, PL2 & PL3



Step 3 - Determine Corrosion Risk Level

- Research was needed to provide basis on which tolerable chloride concentrations could be identified.

Sika Research

FHWA Research

Step 3 - Determine Corrosion Risk Level

- Research findings
  - Both research teams agreed that sustained corrosion was definitively observed at chloride concentrations above 0.75%.
  - One researcher observed minor and possibly sustained corrosion at 0.40% and suggested that additional research should be directed at understanding the long term importance of this observation.

Step 3 - Determine Corrosion Risk Level

Protection Level	Chloride Concentration (% Cl^- per wt. of cement)				
	$\leq$ 0.08%	0.08%< Cl^- $\leq$0.30%	0.30%< Cl^- $\leq$0.50%	0.50%< Cl^- $\leq$0.65%	> 0.65%
PL-1A	No Risk	RL 1	RL 2	RL 3	RL 4
PL-1B		RL 1	RL 2	RL 3	RL 4
PL-2 & PL-3		RL 1	RL 2	RL 2	RL 4

Corrosion Risk Level

Step 4 - Assess Bridge System Redundancy and Element Ductility

Structure Class	Redundancy & Ductility Indicators	**Expected Performance**
S1	System factor (Øs) ≥ 1.10 & Pass ductility check	A highly redundant bridge that will develop easily detectable cracking before debilitating strength loss.
S2	1.10 > System factor (Øs) ≥ 1.0 & Pass ductility check	A moderately redundant bridge that will develop easily detectable cracking before debilitating strength loss
S3	System factor (Øs) < 1.0 or Fail ductility check	A bridge with limited ductility and/or redundancy.

Structure Classification

Step 5 - Determine Management Follow-up Actions

- Using results from previous 4 steps, management and follow-up actions are determined.
- The follow-up actions range from:
  - No additional measures needed
  - Biennial in-depth inspection needed *
  - Annual in-depth inspection *
  - Plan repairs / replacement

*Undesirable inspection findings should activate special inspection or monitoring.

Step 5 – Determine Management Follow-up Actions

	Structure Classification		
Corrosion Risk Level	S1	**S2**	S3
RL 1	FA I	FA I	FA II
RL 2	FA I	FA II	FA III
RL 3	FA II	FA III	FA III
RL 4	FA IV	FA IV	FA IV

Management Follow-up Actions

Management Follow-up Actions (FA)

FA I – no additional measures needed
FA II – biennial in-depth inspection needed *
FA III – annual in-depth inspection needed *
FA IV - plan repairs / replacement

* Undesirable inspection findings should activate special inspection or monitoring

Next Steps

- Follow-up with DOT's.
- Possible additional in-place sampling to provide data for production years with limited data.

Thank You

Reggie Holt, P.E.
Federal Highway Administration
Reggie.holt@dot.gov