

# Post-Tensioning Grouts: Challenges and a Path Forward



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**T**wo recent issues with post-tensioning (PT) grout have generated concern over the long-term performance of PT tendons. These two independent issues occurred close to the same time, which has led to confusion by many in the bridge community. This article will provide background information on these two issues, as well as measures developed to address each issue.

## Elevated Chlorides

In 2010, the discovery of PT grout with elevated chloride levels in a straddle bent cap in Texas triggered a follow-up investigation by the grout manufacturer, Sika. Their investigation revealed that its SikaGrout 300PT product was sometimes produced at its Marion, Ohio, plant with levels of chloride compounds that exceeded the American Association of State Highway and Transportation (AASHTO) and the Post-Tensioning Institute (PTI) specified limit of 0.08% by weight of cement. Approximately 24 million pounds of SikaGrout 300PT were produced at this plant from 2001 to the time production ceased in 2010. At that time, approximately 16 million pounds were used in bridge applications in the United States.

The investigation revealed that cement provided by a third-party supplier, and used in the SikaGrout 300PT production, was the source of the chlorides. Chloride levels ranged from well above to well below the specified limit. The governing ASTM specification for portland cement, ASTM C150, does not include limits on chloride. In addition, the AASHTO and PTI specifications only specified chloride thresholds for PT grouts, not for constituent materials of those grouts. Consequently, this issue went undetected for many years with very limited chloride level data being captured for PT grouts. The PTI M55.1-12 *Specification for Grouting of Post-Tensioned Structures* has since added requirements for frequent chloride testing during production.

Subsequent to the identification of this issue, Sika and Federal Highway Administration (FHWA) each started independent efforts to collect chloride data, identify end users, and perform research to determine the long-term performance of PT strand exposed to high levels



*Post-tensioning tendon corrosion testing on stressed tendons. Photo: FHWA Turner Fairbank Research Center.*

of chloride. Results from these efforts were used to develop an FHWA technical advisory (TA) on assessing and managing the long-term performance of post-tensioned bridges having tendons installed with grout containing elevated levels of chloride ([www.fhwa.dot.gov/bridge/t514033.pdf](http://www.fhwa.dot.gov/bridge/t514033.pdf)). This TA, released in November 2013, provides guidance on identifying SikaGrout 300PT end-users, assessing PT tendon service life risks, as well as recommended management practices.

## Segregated PT Grout

A second issue deals with segregation of prepackaged, thixotropic PT grouts during or immediately after the grouting of PT ducts. PT grouts commonly used in the United States have sporadically been observed to exhibit this condition. When it forms, the grout matrix is typically separated into three common layers, with a top layer of soft (putty-like) grout, a middle layer of friable grout, and a lower layer of hard grout. The upper soft layer in segregated grout is highly corrosive and is therefore of

great concern. Segregated grout formations are typically isolated to tendon high point and anchorage locations with volumes generally varying from minimal to filling the upper third of the of the PT duct along a limited length



*Segregated grout at post-tensioning tendon end anchorage. Soft grout is located in upper layer. Photo: Texas Department of Transportation.*

# STRENGTH

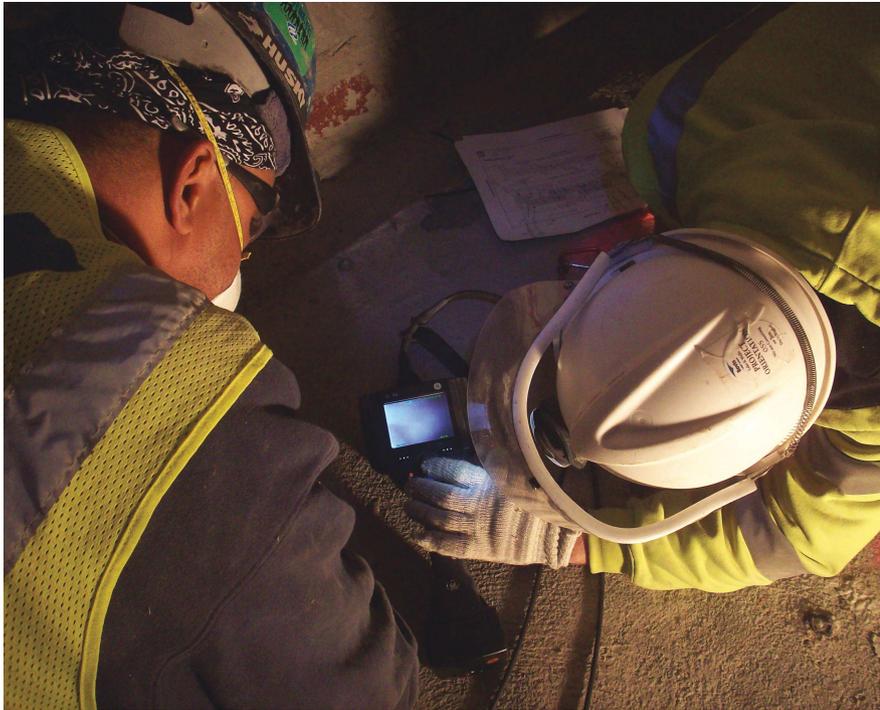
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Inspectors visually examining a post-tensioning tendon using a boroscope. Photo: Structural/VSL.

within the tendon or anchorage.

There are multiple research projects underway investigating segregated grouts, as well as research developing new qualification testing procedures that can identify PT grouts susceptible to segregation. Preliminary research results and observations from in-place tendons have revealed a strong correlation between the creation of segregated grout and excess water in the grout matrix. Observations have also shown that the use of inert material in the grout mix, the use of expired pre-bagged grout, the inadequate mixing of the grout, and tendons with highly draped tendon paths can further increase the susceptibility to the occurrence of segregated grout. Equally noticeable is the non-occurrence of segregated grout in PT tendons with moderate to flat profiles. One can see that each of the previously listed features could generate excess/free water by either reducing the ability of the mixed-in water to react with materials in the grout or alter the dispersion of water within the grouted tendon.

The PTI M55.1-12 *Specification for Grouting of Post-Tensioned Structures* was recently updated to address concerns with grout segregation and strengthen its bleed water provisions.<sup>1</sup> In addition, extra care should be taken before tendon grouting to ensure that excess water is not inadvertently introduced into the PT grout from residual water in the grout mixer, conveyance, or duct. Because segregated grout formation is typically isolated to tendon high points and anchorages, post-

grouting inspections at these locations are highly recommended. More information is needed to fully understand segregated grout; however, following the above requirements and recommendations should both greatly reduce the occurrence of segregated grout and provide a means to identify segregated grout during bridge construction when it occurs.

## Going Forward

These rare but worrisome issues are unfortunate; however, they should not contaminate the excellent track record of our robust and well-performing post-tensioned bridges and structures. These issues have highlighted an overreliance on proper manufacturing and field installation of this highly engineered product, leading the bridge community to focus additional efforts toward replacement, inspection, and monitoring of PT tendons. Fortunately, many technologies that can advance the post-tensioning state-of-practice are available and the FHWA, industry, and state departments of transportation are working together on researching and developing PT tendons with these desired attributes.

## Reference

1. Hunsicker, G., T. L. Neff, and M. F. Vejvoda. 2014. "Further Improvements in Post-Tensioning Grout Materials" *ASPIRE*, Winter, Precast/Prestressed Concrete Institute: Chicago, IL. pp 40-41. 

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