Who We Are

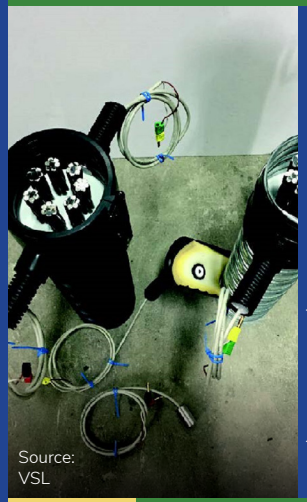
The **Office of International Programs** works to access, promote, and disseminate global best practices and technical innovations to ensure a safe and efficient United States highway transportation system.

Executive Summary

The FHWA Offices of Bridges & Structures and Research & Development leveraged the services of other offices within FHWA (Office of International Programs and the Office of Innovation Management, Education, and Partnership) to collaborate with international bridge owners and experts on advancements in post-tensioning (PT). These collaborations have resulted in the identification of several technologies that will advance the state-of-practice in the United States in PT durability, monitorability, and installation.

This brochure highlights seven identified PT advancements that will improve PT tendon resilience, intelligence, and corrosion resistance. Improvements to workforce training are also highlighted. FHWA is in the early stage of implementing these advancements with three of the PT advancements being verified through United States demonstration projects and three additional advancements being researched at FHWA and other United States universities.

EIT AND GROUT SENSOR DEMONSTRATION PROJECT (TEXAS, USA)



VOID / CORROSION SENSOR (SWITZERLAND)

PROJECT TEAM BRIDGE SITE VISIT (ITALY)

EXTERNAL PT (JAPAN)

EIT DEMONSTRATION PROJECT (PENNSYLVANIA, USA)

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Advancing Post-Tensioning Practices Through International Collaboration

U.S. Department of Transportation
Federal Highway Administration

Office of International Programs

STUDY TEAM AT EIT FIELD DEMONSTRATION (SWITZERLAND)

GLOBAL COMMON GOALS

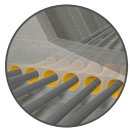
Source:
Pixabay

Bridges all over the globe are facing similar issues. Even though practices may differ in various countries, they all have similar goals when addressing these issues.

Exchanges with bridge experts and owners from other nations have revealed similar efforts from multiple countries to address pressing issues with post-tensioned (PT) bridges.[1]

Through international exchanges, the Federal Highway Administration (FHWA) has identified four common goals that are globally shared: Advance Infrastructure Intelligence, Improve Infrastructure Resilience, Improve Infrastructure Service Life, and Develop a Well-trained Workforce.

IMPROVE INFRASTRUCTURE RESILIENCE



Source:
FHWA

Many technologies offer some level of improved resilience; however, one PT technology was identified as providing greatly improved resilience. This technology is replaceable PT.[2]

Replaceability of external PT tendons can be achieved by three different means: use of flexible filler (France), use of double-enveloped grouted tendons (multiple European countries), and the use of non-ducted epoxy-coated strands (Japan).

The States of Florida and Virginia have recently deployed the use of flexible fillers in their bridge structures. In addition, the Transportation Research Board has an ongoing research project to investigate design gaps in the governing United States bridge specification (American Association of State Highway and Transportation Officials Load and Resistance Factor Design Bridge Specifications) relating to the use of replaceable PT.

ADVANCE INFRASTRUCTURE INTELLIGENCE

Source:
Sumiden

There is a desire among bridge owners to improve the ability to assess the in-service condition of their bridges. Relative to the assessment of onset of PT tendon corrosion, tendon stress level and the condition of tendon protection are most important.[3]

The following PT technologies have been identified through international collaborations:

- Electrically Isolated PT Tendons (EIT) – use of PT strand electrical isolation to assess tendon encapsulation. (Switzerland and Italy)
- Prestressing Strand with Fiber Optic Technology – use of fiber optic technology to measure the direct stress states of the PT tendon. (Japan)
- PT Tendon Electrochemical Potential Sensor – use of electrochemical potential to determine grout voids and the onset of corrosion. (Switzerland)

FHWA has completed one EIT demonstration project in Pennsylvania and has another project under construction in Texas.[4] The project in Texas is also demonstrating the electrochemical potential sensor. In addition, FHWA has initiated research at Purdue University, Indiana, to investigate the performance and applicability of prestressing strand with fiber optic technology.

DEVELOP A WELL-TRAINED WORKFORCE

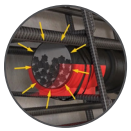
Source:
FHWA

The demands on bridge construction workforces are ever-growing as experience is lost to retirements and new technologies are implemented. There is a great need to train new workers on both past and current practices.

Exchanges with experts and bridge owners from Switzerland revealed the existence of a vocational PT training center that provides hands-on training and participant skills assessment.

FHWA has initiated research at the University of Texas, Austin, to investigate establishing a United States-based PT training and testing center.

IMPROVE INFRASTRUCTURE SERVICE LIFE



Source:
FHWA

There are extensive efforts globally to improve bridge service life, with special emphasis on PT tendons, given their criticality to a structure's load-carrying capacity.

Grout provides a key protection layer to the tendons. The following technologies were identified to improve the grouting of PT tendons.

- Automated Grout Plant – use of this specialized grouting equipment minimizes human error and ensures quality through internal grout-assessing sensors. (Switzerland)
- Vacuum-Assisted Grouting – use of vacuum-assisted grouting greatly reduces the likelihood of grouting voids in the PT tendon. (Italy)

In addition, the PT system components surrounding the prestressing steel and the encasing grout need to be designed, detailed, tested, and installed properly to provide adequate protection. The following technologies were identified to improve the corrosion protection quality of a PT system.

- Protection Level 3 (PL-3) Detailing – use of PL-3 detailing provides the most robust protection currently available for a PT tendon. (Switzerland and Italy)[5]
- Training PT Workforce – It is necessary to educate bridge designers, inspectors, and PT installers in PT durability design, and proper installation to ensure durability. (Switzerland)

FHWA is working with United States-based PT trade organizations (PT Institute and American Segmental Bridge Institute) to incorporate the above listed technologies and processes into their specifications.

1. Electrically Isolated Tendons in European Transportation Structures (FHWA-PL-20-013) https://international.fhwa.dot.gov/pubs/pl20013/fhwa_pl20013.pdf
2. Replaceable Grouted External Post-Tensioned Tendons (FHWA-HIF-19-067) https://www.fhwa.dot.gov/bridge/concrete/hif19067.pdf
3. Designing and Detailing Post-Tensioned Bridges to Accommodate Nondestructive Evaluation (FHWA-HIF-18-029) https://www.fhwa.dot.gov/bridge/concrete/
4. Construction and Field Evaluation of Electrically Isolated Tendons in a Prestressed Concrete Spliced Girder Bridge (ASCE Journal, Vol. 25, No.7, July 2020) https://ascelibrary.org/doi/full/10.1061/%28ASCE%29BE.1943-5592.0001551
5. Development of Reference Criteria for Electrically Isolated Post-Tensioning Tendons in U.S. Bridge Applications (FHWA-HIF-20-042) https://www.fhwa.dot.gov/bridge/concrete/hif20042.pdf