REAL-WORLD NEED

Adhesive anchors—bolt systems augmented by structural adhesives—add holding strength to steel-to-concrete connections such as concrete construction panels. However, well-publicized panel failures focused attention on adhesive anchor systems, leading state departments of transportation to request an NCHRP study to develop standard AASHTO test methods and specifications along with installation guidelines for these anchor systems.

RESEARCH SOLUTION

Investigators developed draft AASHTO test standards for evaluating structural adhesive performance, as well as guidelines for designing and installing adhesive anchor systems. Researchers found that existing short-term tests do not accurately predict the long-term performance of adhesives, especially those exposed to high temperatures for significant portions of their service lives. They proposed that designers assume that adhesives will be half as strong under long-term sustained loading as predicted by short-term loading. Also, only approved adhesives that have passed sustained load qualification testing at elevated temperatures should be used. NCHRP Report 757: Long-Term Performance of Epoxy Adhesive Anchor Systems includes a full suite of testing and materials specifications, design guidelines and specifications, and construction and quality assurance guidelines. The study results were incorporated into new AASHTO specifications and formalized testing procedures that are now available to state transportation agencies to keep the public safe and prevent expensive reconstruction.

NEXT STEPS

Put It into Practice

REVIEW
See Section 29 of AASHTO LRFD Bridge Construction Specifications for the most up-to-date guidelines on adhesive anchor systems.

TEST
Test your agency’s anchor systems according to the specifications and guidelines proposed in NCHRP Report 757.

DESIGN
Add safety factors to the manufacturer’s stated sustained load limits and pullout torque strength for installation.

INSTALL
Use only certified adhesive anchor installers and exceed the manufacturer’s minimum curing time before attaching loads.

PARTNER
Apply for NCHRP implementation funding. See trb.org/nchrp.
About the Research

RESEARCH STRATEGY

Investigators thoroughly reviewed state, national, and international guidelines, specifications, quality assurance directives, and test methods. Then they developed experiments for evaluating adhesive creep rates and anchor performance in various in-service conditions. Researchers in labs at the University of Florida and at the University of Stuttgart in Germany tested three approved adhesives of different composition under different sustained loading conditions to identify how quickly various loading and environmental conditions lead to failure.

WHAT WE LEARNED

Researchers found that existing short-term tests of fully cured adhesives do not accurately predict their long-term performance, and failures can occur quickly when loading is over 75 percent of an adhesive’s predicted strength. These failures occur when an adhesive’s polymers deform; the resulting deformation then migrates within the adhesive and down the anchor. To prevent failures, researchers proposed that designers assume that adhesives will be half as strong under long-term sustained loading as predicted by short-term loading. They also proposed that installers allow curing for 24 hours beyond the manufacturer’s minimum curing time. NCHRP Report 757 includes a full suite of AASHTO testing and materials specifications, design guidelines, design specifications, construction specifications, and quality assurance guidelines.

WHY IT MATTERS

Preventing the failure of overhead panels mandates the use of approved and tested adhesive anchor systems and their proper installation. Recently a $1,200 adhesive failed due to its material properties and to rushed construction, triggering a facility redesign and installation that cost $54 million. Test results from this NCHRP study were incorporated into new AASHTO specifications and formalized testing procedures that are now available to state transportation agencies to keep the public safe and prevent expensive reconstruction.

As adhesive anchors fail, the hanger plates that hold up a tunnel’s ceiling panels will begin to pull away from the roof of the tunnel.