

Proper Installation of Adhesive Anchors

Lessons learned from anchor failure, new training available

by Mallory Whaley, Concrete Reinforcing Steel Institute

Late in the evening of July 10, 2006, a section of precast concrete ceiling in Boston's I-90 tunnel came loose and fell to the pavement below, hitting a passenger vehicle and killing a woman. The cause was proved to be the incorrect use of an adhesive anchoring system in the tunnel, popularly known as "the Big Dig."

Adhesive anchoring systems are comprised of post-installed anchors that transfer loads to concrete by bonding between the concrete, adhesive, and anchors. They are useful in bridge and highway construction applications because contractors can place the concrete and come back later to attach signs, railings, lights, and more.

The National Transportation Safety Board's (NTSB's) investigation into the tunnel failure faulted the tunnel's designers and builders for using an inappropriate epoxy for the sustained load. Over time, the epoxy deformed and fractured, which allowed the anchors to separate from the concrete tunnel roof, causing the ceiling panels to fall.

One of the safety issues identified in the NTSB report was the lack of national standards for adhesive anchors at the time of tunnel design and construction. Standard practice was to follow the manufacturer's instructions on the adhesive packaging. In 2007, the NTSB requested that the American Concrete Institute (ACI) warn design and construction companies of the dangers of using incorrectly applied adhesive anchors. ACI moved to adopt new standards, but then needed a way to ensure concrete professionals were in compliance with the developed practice.

"It became evident that if we were going to put this in the code, we were going to need certification guidelines," said Neal Anderson, Concrete Reinforcing Steel Institute's (CRSI's) vice president of engineering and seminar instructor.

In response to the tunnel failure, ACI and CRSI are offering a seminar, "Adhesive Anchors: Their Behavior and Code Design Requirements," for designers and builders.

The seminar and the adhesive anchoring installer certification program, held in various locations across the country, will address the following subjects:

- Properties of common adhesives
- Lessons learned from failure
- Tension and shear failure modes
- Capacity reduction factors
- Tension and shear interaction
- Qualification standards for adhesive anchors
- Design of supplemental reinforcement



An example of a correctly installed adhesive anchor. All photos: Neal Anderson.



The hole on the left is correctly cleaned. The two holes on the right are still dusty. An epoxy adhesive will not correctly adhere to an improperly cleaned hole.



An adhesive anchor using reinforcing steel.

NTSB Recommendation

The National Transportation Safety Board's recommendation to the American Concrete Institute:

"Use your building codes, forums, educational materials, and publications to inform design and construction agencies of the potential for gradual deformation (creep) in anchor adhesives and to make them aware of the possible risks associated with using adhesive anchors in concrete under sustained tensile-load applications."

From ntsb.gov

- The importance of proper anchor installation procedures in concrete
Ideally, attendees should be able to come away from the seminar being able to:
 - read, comprehend, and execute anchor installation instructions;
 - assess ambient conditions, condition of concrete, materials, equipment, and tools;
 - determine when to proceed with installation or seek additional guidance from a supervisor; and
 - pass the written and practical exams.

At the end of the seminar, a 75-question, written test, along with two, hands-on examinations are administered. The first hands-on exam assesses vertical-down installation of an adhesive threaded rod anchor. Proper drilling, cleaning, and adhesive anchor installation techniques are evaluated. The second hands-on evaluation focuses on overhead injection of an adhesive using a retaining cap and a piston plug.

Attendees successfully completing the seminar receive 0.75 Continuing Education Credits or 7.5 Learning Hours, worth 7.5 Professional Development Hours and receive a copy of Volume 2 of *The Reinforced Concrete Design Manual in Accordance with ACI 318-11*. In addition to the in-person seminar, ACI also offers an online version titled "Adhesive Anchor Installation."

For more information, visit www.concreteseminars.com. 

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