
Powers Fasteners Position Paper on Adhesive Anchor Systems

Powers Fasteners supplies several adhesive anchoring systems to the construction, industrial and highway transportation markets. Adhesive anchoring systems lend themselves to a wide variety of applications in concrete and masonry substrates. Some of these products have been used for structural attachments for over 15 years, including Power Fast Fast Set and Power Fast Standard Set epoxies and Chem-Stud adhesive capsules

Due to the I-90 connector tunnel accident on July 10, 2006 in Boston, Massachusetts and the subsequent investigation and report released by the National Transportation Safety Board (NTSB) on July 10, 2007, the long term functioning of adhesive anchors, as well as proper installation and adhesive anchor selection have become significant topics. Please see our attached Engineering Statement.

With respect to the July, 2006 failure of the tunnel ceiling section, the following information has been substantiated:

1. As a result of information made available to them by Powers, the Massachusetts Highway Department ("MHD") was well aware of the differences between Power-Fast "Fast Set" and Power-Fast "Standard Set", including their respective creep characteristics. This information was shared with MHD prior to the installation of the I-90 connector tunnel ceiling system. This is documented. MHD staff responsible for review and oversight of materials approval on the Big Dig project were specifically made aware of these differences. (*please see attachment "A"*)
2. Documentation also shows that all parties with responsibility for the design, marketing, construction, inspection, and oversight of the tunnel ceiling assembly were made aware, by Powers, that there was a difference between "Fast Set" and "Standard Set" with respect to their possible performance under sustained and short-term loads. Indeed, the engineering report supplied by Powers to the Big Dig project was specifically incorporated into the final ceiling design plans approved by the tunnel's design engineer. The NTSB found that this report "did refer to [the] two epoxy formulations and did state that the Fast Set version was approved for short-term loads only."
3. On the very day that the construction contractor, Modern Continental, signed the contract for the ceiling system with the distributor of the ceiling system components, Powers received from the distributor an order for 120, 15 Ounce Standard Set epoxy cartridges. This was enough material to cover all of the ceiling anchor installations.
4. Powers shipped the epoxy order to the distributor 8 weeks after receiving the order. Unbeknownst to Powers, Modern Continental started the ceiling anchor installation prior to Powers shipping the product to its distributor.
5. Powers was unaware that anything other than Standard Set epoxy was used for the ceiling anchors.
6. The NTSB determined that there were no records of any inspections having been performed on the ceiling system from the time the tunnel was opened to traffic in January, 2003, to the time of the ceiling failure in 2006.
7. Even today there are many states, including the State of Massachusetts, that have products on their DOT approved lists that have not passed ICC-ES creep requirements.

In addition, it has been noted that several mistakes were made when installing the 52,000 pounds of concrete ceiling panels that ultimately fell in the I-90 Connector. The mistakes made with regard to the epoxy anchoring installation of the ceiling on the I-90 Connector include the following:

1. **Un-cleaned Anchor Holes-** An improperly cleaned hole inhibits the adhesive from bonding the rod to the walls of the drilled anchor hole. There was evidence that a number of the failed rods showed concrete dust, indicating the holes were not properly cleaned after drilling and prior to injection of the epoxy.
2. **Wet Diamond Drilled Holes-** Powers epoxy or any adhesive should not be installed into a diamond drilled hole which is wet. In fact, even with diamond drilled holes that are dry, pullout tests are recommended since this manufacturer's product labels, published installation instructions and test data are based on installation with carbide tipped drill bits per ANSI B212.15. The Boston tunnels continue to leak water and the installation of the connector ceiling was done with diamond drills. A Powers engineer who visited the site asked to be allowed to conduct pullout tests on the anchors and was refused by the contractor.
3. **Improperly Coated Anchor Bolts-** Bolts with a reduced amount of epoxy hold less for obvious reasons. We know that 19 of the 20 failed anchors involved in the ceiling failure had voids indicating an improper coating of epoxy.
4. **Reduced Bond Length-** The NTSB determined that plug caps when used with epoxy in overhead applications reduced the bond length of anchor rod by approximately ½-inch. This was not accounted for in the specification of the bolts for the connector ceiling tunnel.
5. **Installation in Very Cold Weather-** Powers' design literature has always specified, as is common with many pure epoxies, that these products are not to be installed at less than 40 degrees F. Installation of some epoxy anchor bolts were done in the dead of winter.
6. **Proper Mixing-** Powers' literature makes it clear that for any injection adhesive anchor to work properly, a mixing nozzle needs to be used with the adhesive generating a uniform color when dispensed. The first bead of adhesive that comes from the nozzle of a new cartridge is not always uniform and should not be used in the anchor hole. Sample failed bolts from the connector tunnel showed discoloration which can indicate improper mixing of the adhesive.
7. **Special Inspection-** Installation of adhesive anchors based on International Code Council, Evaluation Services (ICC-ES) recommendations require compliance with special inspections during installation. The I-90 connector ceiling had no such special inspection as required by ICC-ES (or ICBO ES at the time).

Furthermore, many professionals and the media have questioned the wisdom of hanging large heavy concrete slabs overhead with adhesive. It has been reported that mechanical undercut anchors were originally specified for the ceiling supports and were ultimately used for the repair and reinforcement of the ceiling grid in the tunnel. It should also be noted that Powers' design literature in 1999 (during the time of the tunnel installation) and today recommends a safety factor of 10:1 or higher for overhead and life safety applications using adhesive anchors. The safety factor used to design the connector ceiling anchorage was a 4:1.

POWERS ADHESIVES ANCHORS ICC-ES APPROVED

The following Powers adhesive anchor products have been independently tested to ICC-ES acceptance criteria, including the ICC-ES AC58 specified creep test:

- ✓ **Powers AC100 Plus**
- ✓ **Powers Chem-Stud Capsule Anchors**
- ✓ **Power-Fast *Standard Set* Epoxy**

Based on this elevated temperature creep test, these Powers products have been evaluated and permitted for use by ICC-ES for sustained long-term loads, such as dead or live loads.

ICC-ES APPROVED ADHESIVES WITH SOME LIMITATION

Power-Fast *Fast Set* has satisfied certain ICC-ES criteria but has not passed the optional ICC-ES AC58 specified creep test. It should be noted that there are 9 other ICC-ES approved adhesives with restrictions similar to *Fast Set* from such reputable manufacturers as Simpson, Sika, Unitex, Fischerwerke and more ([please see attachment "B"](#)). These products have been evaluated and are permitted by ICC-ES for use in short-term loads only, such as seismic or wind at the specified loads in the data tables of the ICC-ES reports. These products must also have their allowable working loads reduced by an additional factor of safety of 25%.

PRODUCTS WITH NO ICC-ES APPROVAL BUT HAVING DOT APPROVALS

In addition, Powers has identified approximately 700 Department of Transportation Approval listings for adhesives which do not have ICC-ES approval ([please see attachment "C"](#)). Powers does not sell any anchoring adhesives without ICC-ES approval with the exception of the Hammer-Capsule which has been independently tested to AC58 criteria including the optional creep test.

After fifteen years and over three million Power-Fast *Fast Set* cartridges sold, Powers' experience with the *Fast Set* version is that it performs reliably. After an estimated 30-50 million installed adhesive anchors with *Fast-Set*, the experience has shown the material works well in ambient temperatures assuming the project is designed properly and the product is installed in accordance with published installation instructions. Out of an abundance of caution and pending its evaluation of the NTSB report on the I-90 accident, Powers would recommend against the use of Power-Fast *Fast Set* or any adhesive not meeting AC58 criteria for creep in an overhead or sustained tensile load application. If there is an application that is identified to exceed the conditions of Powers product literature for Power-Fast which is listed at www.powers.com/pdfs/chemical/08402.pdf or these recommendations, it may be appropriate to consider inspections of such anchorages out of caution to determine if any further action is warranted. Powers recommends, at a minimum, that the determination of whether the product is improperly installed or improperly used in an application such as a direct axial tension load overhead include visual inspection and a pullout test on the anchorage in its functional state.

Users or designers with any concern about long-term sustained loads may want to consider specification of Powers' three products that have been evaluated by ICC-ES to meet the AC58 criteria for resistance to creep at elevated temperatures:

Powers AC100 Plus
Powers Chem-Stud Capsules
Power-Fast *Standard Set* Epoxy

Complete information on these products is available at www.powers.com

Users and design professionals should be confident that the three Powers products listed above are not only reliable but have been tested and evaluated in accordance with AC58 for creep and that Powers stands behind the performance of its products as it has for more than 75 years.



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Powers is a family owned business and seeks to provide quality anchoring solutions for concrete that are reliable for the professional contractor and design engineer.

Please note that the above recommendations are in no way intended to be a substitute for the judgment of the design professional.